



5-1-1967

The Comparison of the Effects of Two Training Methods to Increase Muscular Strength, Endurance, Power, Speed and Agility of Adolescent Boys of Fertile High School

Charles L. Johnson

Follow this and additional works at: <https://commons.und.edu/theses>

Recommended Citation

Johnson, Charles L., "The Comparison of the Effects of Two Training Methods to Increase Muscular Strength, Endurance, Power, Speed and Agility of Adolescent Boys of Fertile High School" (1967). *Theses and Dissertations*. 3989.

<https://commons.und.edu/theses/3989>

This Thesis is brought to you for free and open access by the Theses, Dissertations, and Senior Projects at UND Scholarly Commons. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of UND Scholarly Commons. For more information, please contact und.common@library.und.edu.

THE COMPARISON OF THE EFFECTS OF TWO TRAINING METHODS
TO INCREASE MUSCULAR STRENGTH, ENDURANCE, POWER, SPEED AND AGILITY
OF ADOLESCENT BOYS OF FERTILE HIGH SCHOOL

by

Charles L. Johnson

B.S. in Physical Education

Valley City State College

1952

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

May

1967

T1967
J63

This thesis, submitted by Charles L. Johnson 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.

W. C. Koenig
Chairman

John L. Guaday
Eldon M. Gode

Christopher J. Hamme
Dean of the Graduate School

ACKNOWLEDGEMENTS

The writer wishes to express his grateful appreciation for the valuable assistance and guidance received while this research was being pursued. Special acknowledgement and thanks to Mr. Walter G. Koenig, whose constant guidance and assistance helped carry the work to its completion.

A special thanks is extended to Dr. John Quaday for the helpful suggestions and criticism.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	v
ABSTRACT	vi
 Chapter	
I. INTRODUCTION	1
Statement of the Problem	1
Need for the Study	1
Definitions	2
Limitations	2
Review of Related Literature	3
Summary of Review of Related Literature	9
II. METHOD OF PROCEDURE	11
Source of Data	11
Description of Experimental Group I Program	11
Description of Experimental Group II Training Program	12
Method of Collecting Data	13
Description of the Tests	13
III. ANALYSIS OF RESULTS	17
Within Group Comparison of Group I (Weight Training) ..	17
Within Group Comparison of Group II (Endurance Training) ..	19
Between Group Comparisons	21
IV. DISCUSSION	28
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	31
Summary	31
Conclusions	31
Recommendations	32
APPENDIX A	33
APPENDIX B	36
BIBLIOGRAPHY	67

LIST OF TABLES

Table	Page
1. Comparison of Mean Scores and Differences Between Means for the Two Groups	24
2. Comparison of Significance of Differences Between Means of Pre-Test and Final Test for the Experimental Group I with Respect to Selected Measures	25
3. Comparison of Significance of Differences Between Means of Pre-Test and Final Test for the Experimental Group II with Respect to Selected Measures	26
4. Comparison of Significance of Mean Differences Between Groups on Final Test	27

ABSTRACT

The purpose of this study was to compare changes observed during an experimental period involving two training methods utilized to increase muscular strength, endurance, power, speed, and agility.

The subjects selected for this study were freshman and sophomore students at the High School of Fertile, Minnesota enrolled in the required physical education classes. This selection was a random choice of one weight training group and one endurance training group. Both groups participated in their respective exercise programs for a period of eight weeks.

Each group was tested on six test items consisting of push-ups, burpees, shuttle run, broad jump, pull-ups, and sit-ups. These test items were administered at the beginning of the experimental period and after the eight weeks of training.

Comparisons were made between the mean differences within each group on each test item as indicated by the pre-test and re-test. The null hypothesis was assumed with respect to the differences within groups. This hypothesis was tested with the "t" technique for the difference between means derived from correlated scores from small samples. Comparisons were also made between the weight training group and endurance training group by testing the significance of the difference between the mean differences found with the groups. The between group comparison used the "t" technique for correlated data from small samples.

Based on the results of this study, both groups changed significantly on test items within the groups. However, the treatment of the data with respect to the differences between the two groups indicated a significant difference at the .05 level of confidence in the push-up test item.

CHAPTER I

INTRODUCTION

The national interest in developing and maintaining the physical fitness of youth continues to be high. Interests are to develop and maintain physical fitness quickly and most effectively with participation in activities in the physical education classes and team sports. The effectiveness of a particular conditioning program on an individual or group of individuals is of great interest and this can best be achieved when based on scientific research.

STATEMENT OF THE PROBLEM

The purpose of the study was to compare changes observed during an experimental period involving two training methods utilized to increase muscular strength, endurance, power, speed, and agility. Group I was assigned a regular program of weight training and isometric contraction exercises. The exercise program for Group II consisted of running various distances.

NEED FOR THE STUDY

It is believed that information gained through this study could be used to guide physical educators and coaches in the selection of methods for gaining maximum benefits in terms of power, agility, speed, endurance, and muscular strength.

The student should benefit from the end results by learning which method or combination of methods is best for developing all-

around physical fitness. The students should also learn the values of testing to the physical educator as well as to the classroom teacher.

DEFINITIONS

Experimental Group I: Experimental group I consisted of students who trained lifting weights and using isometric contraction exercises.

Experimental Group II: Experimental group II exercised by running middle distances, dashes and relays, jogging and playing soccer.

Weight Training: Making use of barbells and dumbbells, to which can be added graduated weights, so that both the load to be lifted as well as the number of repetitions may be varied.

Isometric Contraction: This is an effort against an immovable resistance.

LIMITATIONS

The following limitations must be taken into consideration when interpreting the results of this study.

1. No attempt was made to equate groups except by membership in physical education classes from the 9th and 10th grades in the Fertile High School, Fertile, Minnesota.
2. No control was exercised over the sleep, diet, and daily habits of the subjects.
3. Exercise by the individuals outside of class was not taken into consideration.
4. Previous testing experiences of the subjects were not considered.
5. The degree of interest on the part of students may have affected results in some cases.
6. The length of training for both groups was two hours a week for eight weeks.

7. Some students missed some parts of the training experience.
8. Physical education classes were fifty-five minutes in length including fifteen minutes for dressing and showering.
9. Facilities were limited in view of the number of participants in each group.

REVIEW OF RELATED LITERATURE

One aspect of fitness is primarily physical in nature. To improve physical fitness, efforts should be carried on with regard for all fitness qualities - spiritual, mental, emotional, and social. Regular exercise is needed in achieving and maintaining physical fitness. Most people are not able to achieve physical fitness by their daily activities so they have to supplement these activities with planned conditioning programs and team sports.

Edward Capen¹ compared the changes observed in two groups of male college students who participated in his investigation. One group of subjects participated in a weight training program, and the other group was assigned to a conditioning program. Capen found that the weight training program gave greater general improvement in muscular strength than did the controlled program with-out weight training. He also found that weight training did not result in muscular tightness or decrease in the speed of muscular contraction as had been commonly assumed.

The purpose of Robert A. Dire's² study was to determine whether or not participation in a weight training program increased muscular

¹Edward Capen, The Effect of Systematic Weight Training on Power, Strength and Endurance, Research Quarterly, XXI No. 2 (May 1950), pp. 83-93.

²Robert A. Dire, An Analysis of the Effects of a Weight Training Program On Selected Measures of Muscular Strength, Endurance, Power, Speed, and Agility of Adolescent Boys. (Unpublished Master's Thesis)

strength, endurance, power, speed, and agility of adolescent boys. Both groups were composed of subjects from the physical education classes, with the experimental group meeting three times a week after school to lift weights. The control group participated only in the physical education class activities. The study was carried on for twelve weeks with the conclusion that systematic weight training did produce significant changes in selected measures of muscular strength and endurance, power, speed, and agility in adolescent boys.

A study conducted by F. J. Nagle and L. W. Irwin³ involved three groups, two experimental and one control, each consisting of twenty college freshmen. Each subject was tested doing moderate and all-out exercise on a bicycle ergometer. Selected physiological responses and the circulorespiratory endurance times were measured. An eight week training period followed during which the experimental groups participated in weight training programs and the subjects in the control group in archery or bait casting. After the eight week training period, the tests were again administered.

Though there was an indication of improved circulorespiratory response by both experimental groups following training, statistical treatment of data revealed no significant differences among the three groups in their responses to exercise.

Ivan Kusinite and Clifford Keeney⁴ tested two groups of twenty-

³Francis J. Nagle and Leslie W. Erwin, Effects of Two Systems of Weight Training On Circulorespiratory Endurance and Related Physiological Factors, Research Quarterly XXXI, (1960), p. 371.

⁴Ivan Kusinite and Clifford E. Keeney, Effects of Progressive Weight Training On Health and Physical Fitness of Adolescent Boys, Research Quarterly XXIV, (October, 1958), p.300.

three junior high boys. An experimental group had eight weeks of progressive resistance training, while the control group participated only in regularly scheduled physical education classes. The study attempted to determine the effects of progressive weight training on health and physical fitness of the adolescent boy. The study concluded that the experimental group increased in ability to do push-ups, pull-ups, the Harvard step test, dodge run, the burpee test and trunk extension. In no case did the improvement of the control group exceed significantly the improvement of the experimental group with respect to measurements made.

A study was conducted by J. Masley, A. Hairabedin and D. Donaldson⁵ to determine whether increased strength gained through weight training was accompanied by an increase in muscular co-ordination and speed of movement. The subjects were sixty-nine male volunteers from the freshman and sophomore required physical education classes at Pennsylvania State College. These subjects were distributed as follows: twenty-six in the volley-ball group, nineteen in the sports lecture group and twenty-four in the weight training group. On the basis of the data collected the following conclusions seemed warranted: (1) A six week period of weight training increased strength more than a similar period of volley-ball or inactivity. (2) A larger increase in speed and co-ordination resulted from six weeks of weight training than from volley-ball and inactivity for a like period.

⁵John Masely, Ara Hairabedin and Don Donaldson, "Weight Training in Relation to Strength, Speed, and Co-ordination", Research Quarterly XXIV, No. 3, (October 1953), pp. 308-315.

(3) Increased strength gained through training with weights was apparently associated with increased muscular co-ordination and speed. (4) Training with weights for a six week period had no apparent detrimental effect upon the subjects.

Edward Chui's⁶ study of weight training effect on athletic power was undertaken with groups of twenty-three in weight training and twenty-two in the required physical education program at the State University of Iowa. The data obtained indicated that the subjects in weight training seemed to increase the amount of potential power whereas the other group did not show such consistent increase. The study concerned itself solely with potential athletic power. Improvements in endurance, strength and circulorespiratory efficiency were not considered.

The effects of a weight training program on running speed, running endurance and on power were studied by Roger Huffman.⁷ The study involved fifty-one ninth grade boys in the Dickinson High School, Dickinson, North Dakota. Thirty-four boys were put in the weight training group and seventeen in the non-weight training group. After an experimental period of six weeks, Huffman concluded that the weight training group had made superior gains in power tests.

⁶Edward Chui, "The Effect of Systematic Weight Training On Athletic Power", Research Quarterly XXI, (October 1950), pp. 188-194.

⁷Roger Huffman, "An Analysis of the Effects of Weight Training Program on Selected Factors of the Athletic Skill in Adolescent Boys", (Unpublished Individual Research Paper, Department Physical Education, University of North Dakota, 1959).

James A. Mittun⁸ conducted a similar study of weight training effect on basketball players. The players were divided into a weight training group of twelve and a non-weight training group of twelve. Findings showed that there was significant improvement in the selected power measure and in two of the selected basketball skill measures on the part of the weight training group.

A study of the effects of weight training on speed of movement by Bruce M. Wilkin⁹ was conducted primarily to disprove the idea that weight lifting caused "muscle boundness". Wilkin divided seventy-three university students into a non-weight lifting group, experienced weight lifting group and an elementary weight lifting group. Over a period of one semester, weight training was found to have no slowing effect on speed of arm movement. In addition, chronic weight lifters were not "muscle bound" in the sense that movement was impaired. The results of this study also suggested that daily training with weights may improve muscular endurance.

Isometric contraction is, in fact, neither new nor revolutionary, but only recently has it been widely applied to a variety of sports. Scientists as far back as 1920 conducted experiments in which they tied one leg of a frog and observed that the muscles of the tied leg grew more than did those of the untied leg.¹⁰

⁸J. A. Mittun, "An Analysis of the Effects of a Weight Training Program of Selected Measures of Power, Agility, and Basketball Skills in Adolescent Boys"., (Unpublished Individual Research Paper, Department of Physical Education, University of North Dakota, 1960).

⁹Bruce M. Wilkin, "The Effect of Weight Training On Speed of Movement", Research Quarterly XXIII, (October, 1952) pp. 361-369.

¹⁰Gilbert Rogin, "Get Strong Without Moving", Sports Illustrated, (October 30, 1961), Vol. 15 No. 18., pp. 18-21.

According to Dr. Arthur H. Stienhaus and Dr. Peter Karpovich, isometric contraction has its limitations. It does nothing for either the heart or the lungs, and it does not increase endurance or stamina.¹¹

Wesley K. Ruff,¹² associate professor of physical education at Stanford, felt that isometric contraction could be helpful to a person without room or facilities for exercise. This type of exercise could assist in improving all-around fitness, provided it is used in conjunction with exercises like running, which builds up the cardiovascular and respiratory systems. According to Ruff, isometric contractions can be a helpful supplement, but not a complete answer to physical fitness. Therefore, this form of exercise may take its place among the more conventional forms of exercise.

Most coaches are in agreement that the best method for building strength is to overload the prescribed muscles. The methods of overloading these muscles have been controversial. Many coaches have felt that isometric exercises, using a maximum force against an immovable resistance would be the most efficient method. Other coaches have felt that a progressive resistance exercise program of weight training would prove to be more beneficial.¹³

A study carried on by Hettinger and Muller, in 1953, created an interest in isometric exercise experimentation. These two researchers studied isometric contractions in which the intensity and duration of the exercise were measured to determine their effects on

¹¹Ibid. p. 19.

¹²Ibid. p. 20.

¹³Bill Morgan, "Static Exercises", Scholastic Coach, (February 1963) p. 24.

muscular strength and size. Increase of the maximal load of resistance had no extra benefits.¹⁴

Raymond J. Vanyo¹⁵ conducted a study involving thirty male students from Richardson Junior High School, San Bernardino, California. They were hand picked by the writer and placed into equated groups according to their time trials and the fast, average, and slow were mixed in each group. One group trained with weights, concentrating on upper arm and shoulder girdle muscles, and the other group had no particular weight training program but were out for track. On the pre-test each subject was tested three times for speed in the 60 yard dash with a thirty minute rest period between trials. The re-test was the same. Both groups showed significant improvement in the sixty yard dash. The difference between group means on the final test was not statistically significant, although the improvement of the weight training group was greater.

SUMMARY OF REVIEW OF RELATED LITERATURE

From the review of related literature, one may come to the conclusion that weight training, isometric contraction training, and running may contribute to muscular strength, endurance, power, speed, and agility. The following conclusions can be drawn from the related literature:

1. Daily training with weights may improve muscular endurance.

¹⁴Ibid. p. 24.

¹⁵Raymond J. Vanyo, "Weight Training Concentrated On the Arms and Shoulders and Its Effect Upon Speed of Junior High School Boys in the 60 Yard Dash", (Unpublished Master's Thesis, University of North Dakota, 1963), pp. 32-34.

2. Isometric contraction can be of value in the development of strength.
3. The development of the upper body by weight training may help to improve speed of running.

CHAPTER II

METHOD OF PROCEDURE

SOURCE OF DATA

Fifty-seven members of the ninth and tenth grade boys' physical education classes from the Fertile High School were used as subjects. The writer selected as his two groups the entire enrollment of two physical education classes. No attempt was made to equate the groups. They were encouraged to do their best during the training program and in the tests.

Experimental Group I consisted of twenty-nine subjects who trained with weights and isometric contractions for eight weeks.

Experimental Group II consisted of twenty-eight subjects who trained by periods of running for eight weeks.

DESCRIPTION OF EXPERIMENTAL GROUP I TRAINING PROGRAM

Experimental Group I conditioned by lifting weights and doing isometric contractions for eight weeks. They met twice a week for forty minutes each meeting and performed the following exercises:

Weight Training Exercises - (1) Supine Pullover, (2) Regular Squat, (3) Heel Raiser, (4) High Dead Lift. (Descriptions of these exercises can be found in Appendix A p. 35.)

Isometric Contraction Exercises - (1) Neck Pull, (2) Back Contractor, (3) Shoulder Conditioner, (4) Taut Trunk, (5) Arm Conditioner. (Descriptions of these exercises can be found in Appendix A p. 34.)

These exercises were selected to strengthen the muscles located in the neck, shoulders, trunk and legs. Strength in these muscles is necessary for good muscular fitness. The weight training exercises required six repetitions with more weights added as each subject was able to handle the given resistance. The isometric contractions were held for six seconds of all out effort and were followed by one second of relaxation. Three repetitions of isometric exercises were required.

DESCRIPTION OF THE EXPERIMENTAL GROUP II TRAINING PROGRAM

Experimental Group II consisted of twenty-eight boys who participated in various running events for an eight week period. They met twice a week for forty minutes for each training period and participated on various combinations from among the following running exercises: (1) Distance Running - Mile and 880, (2) Relays - Mile and 880, (3) Sprints - 440, 220, 100, (4) Soccer. The format of each period was changed during each training period to include the different distances, relays, and dashes over a period of time.

Relays and the distance running were modified for their use in the gymnasium during inclement weather. Games involving running were implemented when the weather was adverse over a long period of time.

All dashes, sprints, relays, and distance runs were designed with development of endurance in mind. The time, form, start and other track fundamentals were not taught or considered.

METHOD OF COLLECTING DATA

Both groups were tested prior to the start of the eight week training program and again at the completion of the program. Test items used were push-ups, burpees, shuttle run, chin-ups, and sit-ups.

DESCRIPTION OF THE TESTS

Push-ups - The student lay face down on the floor, with hands flat on the floor, shoulder width. With the body stiff, the student raised the body with the toes and hands touching the floor and with the elbows fully extended. To complete one push-up the student bent the elbow so the nose touched the floor. A partner counted each exercise cycle and, on completion of the exercise, positions were reversed.

Broad Jump - The student stood with his toes at the take-off line, his feet several inches apart. He attempted to jump as far as possible. Before jumping, he bent his knees. In jumping, he simultaneously extended his knees and swung his arms forward. No restrictions were placed on his arm movements. However, the student was told that: (1) The jump would not count if he fell backward, (2) His score would be the best of three jumps allowed. The three attempts included jumps not scored because of falling backward. If the student fell backward three times, an additional jump was given.

Measurements were taken from the take off line to the back of the heel nearest the line at contact. The score which was finally recorded was the best of three jumps, and was measured in inches to the nearest inch. The recorder stood to the side to observe the exact point of contact of the rear heel.

Chin-ups - A horizontal metal or wood bar was used that was high enough so the student could hang off the floor with his arms stretched overhead and legs fully extended. The student jumped up and gripped the bar with his palms pronated. From the hanging position he pulled himself up by his arms until he could place his chin over the bar. He then lowered his body to the starting position. The student was told to do as many pull-ups as possible and not stop until he was no longer able to pull himself up. He was cautioned that if his elbows were not fully extended or his chin not over the bar, he would be penalized one half. The examiner counted the number of pull-ups aloud to the student each time he lowered himself fully.

Kicking, twisting, or raising of legs was not allowed. If the student started swaying, the examiner put his forearm against the student's legs to stop this movement.

Shuttle Run - Two parallel lines, ten yards apart, were marked off in the gymnasium. The wall was one line with the starting and finishing line ten yards from the wall. The timer was stationed at the starting line. At the start the student stood behind the starting line, with one toe at the line. He was told that at the command "go" he was to run to opposite line, ten yards away, touch the wall with foot or hand, return to the starting line and repeat this cycle ten times for a total of one hundred yards. The object was to cover the distance as fast as possible. An observer counted the trips aloud for the runner's benefit. The examiner kept time and recorded this time to the nearest tenth of a second. If the student fell down, he was allowed another trial.

Sit-ups - The student lay in a supine position on the floor.

A partner straddled the legs of the subject with hands on the subject's knees and did the counting. The subject put his hands behind his head and then raised the upper part of his body so that he could touch an elbow to a knee. He then returned to his original position. The student had two minutes in which to complete as many sit-ups as possible. The timer stopped the exercises after two minutes, with the subject's partner giving the number of sit-ups to the recorder. The partner and subject then changed positions. The partner made certain that the subject completed all phases of the exercise correctly. No credit was given for sit-ups incorrectly completed. The total number of cycles completed in two minutes was reported to the instructor.

Burpees - The student stood erect. He then squatted and put his hands down on the floor. He then quickly thrust his feet backward and retracted them to a squat position. He returned to a standing position, and this completed one cycle. The student had one minute in which to complete as many cycles as possible. A partner counted and made sure he completed the exercise correctly. Credit was not given for burpees incorrectly completed. The total number of cycles completed in one minute was reported to the instructor.

STATISTICAL PROCEDURE

The null hypothesis was assumed in comparing the means of the two groups. The null hypothesis asserts that there is no true difference between the two means, and that the difference found between the means is therefore, unimportant and accidental.¹

¹Henry E. Garrett, Statistics in Psychology and Education, New: Longmans, Green and Co., 1955, p. 213.

There were several possible tests of the null hypothesis.

The "t" technique for testing the significance of the difference between means derived from correlated scores from small samples appeared to be best suited for the within groups comparison.² This test determined the ratio between the mean difference and the estimate of sampling error of the mean difference. This ratio was expressed as "t" and was proportional to the degree of freedom (N-1) allowed in determining the relationship between the mean differences and the estimate of sampling error of the mean difference.³

The "t" technique was also used for testing the significance of the mean differences of the two groups derived from uncorrelated scores from small samples. This test determined the ratio between the mean differences of the two groups. The value of "t" is proportional to the degrees of freedom (N_1+N_2-2) allowed in determining the relationship of the difference between mean differences and the estimate of sampling error for the distribution of difference between the mean differences.

The writer selected the .05 level of significance for this study. The mathematical procedure and complete data are presented in Appendix B. p.37.

²Quinn McNemar, Psychological Statistics, (New York: John Wiley and Sons, Inc., 1949) p. 225.

³Ibid., p. 352

CHAPTER III

ANALYSIS OF RESULTS

The purpose of this study was to compare results obtained through two different methods of training for muscular strength, endurance, power, speed and agility. Two boys' physical education classes of freshmen and sophomores at Fertile High School in Fertile, Minnesota, were involved. Group I trained with weights and isometric exercises, and Group II participated in endurance training involving primarily running. Comparisons were made between the means of the test and re-test within each group and the difference between the means of the two groups on the final test. Data comparing mean scores and difference between means for the two groups are compiled in Table 1 page 24.

WITHIN GROUP COMPARISON OF GROUP I (WEIGHT TRAINING)

Push-ups

The weight training group had a mean score of 42.93 push-ups in the pre-test and a mean score of 43.52 in the final test. This represents a mean difference of 1.62 push-ups between the pre-test and final test. The estimate of the sampling error of the mean difference was 3.32. The "t" value of .49 with 28 degrees of freedom was not significant at the .05 level of significance and the null hypothesis was accepted. (See Table 2 p.25).

Burpees

Group I had a mean score of 36.48 burpees in the pre-test and

mean score of 33.38 in the final test. This indicates that the subjects were able to complete 3.10 fewer burpees in the allotted time in the re-test. The estimate of sampling error of the mean difference was 1.14. The "t" value of 2.72 with 28 degrees of freedom indicated significance at the .05 level of confidence and the null hypothesis was rejected. (See Table 2 p. 25) The ability of the weight training group to execute this exercise decreased significantly during the experimental period.

Shuttle Run

Group I had a mean score of 23.94 seconds in the pre-test shuttle run and a mean score of 24.02 seconds in the re-test. This means the mean time was slower on the re-test. The estimate of sampling error of the mean difference was .17. With 28 degrees of freedom, this "t" value indicated no significant difference between the two means and therefore the null hypothesis was retained. (See Table 2 p. 25)

Broad Jump

The weight training group had a mean score of 76.35 inches in the pre-test broad jump and a mean score of 77.24 inches in the re-test. There was a mean difference of 1.24 inches. The estimate of the sampling error of the mean difference was .41. The "t" value of 1.38 with 28 degrees of freedom was not significant at the .05 level.

Pull-ups

In the pull-ups, group I increased from a mean of 6.66 pull-ups in the pre-test to a mean score of 7.83 in the re-test. The mean difference was 1.17 pull-ups and the standard error of measure-

ment was .41. With 28 degrees of freedom, this "t" value of 2.89, indicated a significant difference between the two means and the null hypothesis was rejected. (See Table 2 p. 25)

Sit-ups

In performing sit-ups, the weight training group had a mean score of 48.97 sit-ups in the pre-test and increased to a mean score of 51.00 sit-ups in the re-test. There was a mean difference of 2.03 sit-ups. The estimate of sampling error of the mean difference was 1.78. With 28 degrees of freedom, the "t" value of 1.14 was not significant at the .05 level. (See Table 2 p. 25)

WITHIN GROUP COMPARISON OF GROUP II (ENDURANCE TRAINING)

Push-ups

The endurance training group had a mean score of 36.75 push-ups in the pre-test and a marked increase to a mean score of 48.28 push-ups in the re-test. This represents a mean difference of 11.18 push-ups between the pre-test and final test and the estimate of the sampling error of the mean difference was 2.24. With 27 degrees of freedom, this "t" value of 4.98 indicated a significant difference at the .05 level and the null hypothesis was rejected. (See Table 3 p. 26)

Burpees

Group II had a mean score of 35.31 burpees in the pre-test and a mean score of 33.04 in the re-test. This indicates that group II was able to complete fewer burpees in the allotted time in the

re-test. The mean difference was 1.54 burpees. The estimate of sampling error of the mean difference was 1.14. The "t" value of 2.72 with 27 degrees of freedom was significant and the null hypothesis was rejected. (See Table 3 p. 26)

Shuttle Run

The endurance training group's pre-test mean score in the shuttle run test item was 24.26 seconds and the re-test mean score was an improvement to a mean time of 23.99 seconds. The mean difference was .27 seconds. The estimate of sampling error of the mean difference was .18. The improvement according to the "t" value of 1.19 was not significant. (See Table 3 p. 26)

Broad Jump

In the pre-test of the broad jump, the endurance training group had a mean score of 74.89 inches; in the re-test this group had a mean score of 75.07 inches. A mean score increase of .18 inches between the pre-test and re-test was shown. The estimate of the sampling error of the mean difference was 1.44. The "t" value of .14 with 27 degrees of freedom indicated no significance so the null hypothesis was retained. (See Table 3 p. 26)

Pull-ups

The pull-up test mean score of group II increased from 4.96 pull-ups in the pre-test to 6.43 pull-ups in the re-test, showing a 1.46 mean difference. The estimate of the sampling error of the mean difference was .29. With 27 degrees of freedom, this "t" value of 5.03 indicated a significant difference at the .05 level and the

null hypothesis was rejected. (See Table 3 p. 26)

Sit-ups

The endurance training group had a mean score of 45.93 sit-ups on the pre-test and a mean improvement of 7.29 to 52.39 sit-ups on the re-test mean. The estimate of sampling error of this mean difference was 1.37. The "t" value of 5.32 with 27 degrees of freedom proved to be significant. (See Table 3 p. 26)

During the experimental period the endurance training group improved significantly in abdominal strength as measured by the sit-up. This group also improved significantly in arm and shoulder strength as measured by the push-up.

BETWEEN GROUP COMPARISONS

Group I had a mean difference of 1.62 push-ups between the pre-test and re-test of the push-up test item. Group II had a mean score increase of 11.18 push-ups between the pre-test and re-test. The estimate of sampling error of this mean difference was 2.73. The difference between the mean differences of the two groups was 9.56 push-ups. The "t" value of 3.50 with 55 degrees of freedom was significant and the null hypothesis was rejected. (See Table 4 p. 27.) Although both groups improved, the improvement of Group II (Endurance Training) was significantly greater than that of Group I.

Both groups had a decrease in their mean scores in the burpee test item. Group I decreased more, having a mean difference of 3.10 fewer burpees between means of pre-test and re-test. Group II had a decrease of 1.54 burpees between pre-test and re-test means.

The estimate of sampling error of this mean difference was 1.70.

The difference between the mean differences of the two groups was 1.56. The "t" value of .90 with 55 degrees of freedom was not significant at the .05 level of confidence, and the null hypothesis was retained. (See Table 4 p. 27.)

Group II had a mean score increase of .22 seconds between the pre-test and re-test in the shuttle run item. Group I had a decrease in mean difference score of .03 between the pre-test and re-test. The difference between the mean differences was .30 seconds. The estimate of sampling error between the mean differences was .25. The "t" value of 1.20 with 55 degrees of freedom was not significant at the .05 level of significance. The null hypothesis was retained. (See Table 4 p. 27)

Both groups showed improvement in the broad jump. The weight training group mean difference was 1.24 inches and endurance group mean difference was .18 inches. The difference between the mean differences was 1.06 inches. With 55 degrees of freedom, the "t" value of .62 was not significant. (See Table 4 p. 27)

Both groups improved significantly during the eight week training period in the pull-up test item. Group I mean difference was 1.17 pull-ups and group II mean difference was 1.46 pull-ups. The variation between the mean differences was .29. The "t" value of .58 with 55 degrees of freedom was not significant, and the null hypothesis was retained. (See Table 4 p. 27)

In the sit-up test item, both groups improved, but the improvement was significant only in group II. The mean difference of group I was 2.03 sit-ups and the mean difference of group II

was 6.46 sit-ups. The difference between mean differences was 4.43 sit-ups. The sampling error estimate of the difference between the mean differences was 2.34. With 55 degrees of freedom, the "t" value of 1.97 was not significant, and the null hypothesis was retained. (See Table 4 p. 27.)

The weight training group changed significantly in two of the six items during the experimental period but one of the changes (Burpees) was of a declining nature. The endurance group improved significantly in three items (push-ups, pull-ups, and sit-ups) during the same period. However the endurance group declined significantly in the burpee test item.

TABLE 1

COMPARISON OF MEAN SCORES AND
DIFFERENCE BETWEEN MEANS
FOR THE TWO GROUPS

Area of Comparison	Group	Mean Score of Pre-Test	Mean Score of Final Test	Difference of Mean
Push Ups	I	42.93	43.52	Increase of .59
Push Ups	II	36.75	48.29	Increase of 11.54
Burpees	I	36.48	33.38	Decrease of 3.10
Burpees	II	35.31	33.04	Decrease of 2.32
Shuttle Run	I	23.94	24.02	Decrease of .08 sec.
Shuttle Run	II	24.26	23.99	Increase of .27 sec.
Broad Jump	I	76.35	77.24	Increase of .89 inches
Broad Jump	II	74.89	75.07	Increase of .18 inches
Pull Ups	I	6.66	7.83	Increase of 1.17
Pull Ups	II	4.96	6.43	Increase of 1.47
Sit Ups	I	48.97	51.00	Increase of 2.03
Sit Ups	II	45.93	52.39	Increase of 6.46

Group I - Experimental Group I (Weight Training)
Group II - Experimental Group II (Endurance Training)

TABLE 2

COMPARISON OF SIGNIFICANCE OF DIFFERENCE
 BETWEEN MEANS OF PRE-TEST AND FINAL TEST FOR THE
 EXPERIMENTAL GROUP I WITH RESPECT TO SELECTED MEASURES

Selected Measures	Mean Difference	Standard Error	"t" Value	Significance at .05 level
Push Ups	1.62	3.32	.49	No
Burpees	-3.10 (Loss)	1.14	-2.72	Yes
Shuttle Run	-.08	.17	-.47	No
Broad Jump	1.24	.90	1.38	No
Full Ups	1.17	.41	2.89	Yes
Sit Ups	2.03	1.78	1.14	No

TABLE 3

COMPARISON OF SIGNIFICANCE OF DIFFERENCE
 BETWEEN MEANS OF PRE-TEST AND FINAL TEST FOR THE
 EXPERIMENTAL GROUP II WITH RESPECT TO SELECTED MEASURES

Selected Measures	D Mean Difference	Standard Error	"t" Value	Significance at .05 level
Push Ups	11.18	2.24	4.98	Yes
Burpees	-1.54 (Loss)	1.14	2.72	Yes
Shuttle Run	.22	.18	1.19	No
Broad Jump	.18	1.44	.14	No
Pull Ups	1.46	.29	5.03	Yes
Sit Ups	6.46	1.37	4.72	Yes

TABLE 4

COMPARISON OF SIGNIFICANCE
OF MEAN DIFFERENCES
BETWEEN GROUPS ON FINAL TEST

Test Item	Mean Difference Of Group I	Mean Difference Of Group II	Difference Between Mean Differences	"t" Value	Significance at .05 Level
Push Ups	1.62	11.18	9.56	3.50	Yes
Burpees	3.10	1.54	1.56	.90	No
Shuttle Run	-.08	.27.	.35	1.20	No
Broad Jump	1.24	.18	1.06	.62	No
Pull Ups	1.17	1.46	.29	.58	No
Sit Ups	2.03	6.46	4.43	1.97	No

Group I - Experimental Group I (Weight Training)

Group II - Experimental Group II (Endurance Training)

CHAPTER IV

DISCUSSION

The pre-test mean scores of Group II were lower in all test items than the pre-test mean scores of Group I. It would appear that there might have been more chance for improvement in the scores of Group II. The post-test mean scores of Group II did not equal the pre-test mean scores of Group I, with two exceptions.

Both groups showed a mean increase in push-ups but only the improvement of Group II was statistically significant at the .05 level. The pre-test mean score of Group II was approximately six push-ups lower than the pre-test mean score of Group I. Group II's final test mean score improved 15.54 push-ups, so there was very good improvement. The lack of significant improvement in the mean scores of Group I could be accounted for by subjects two and seven who decreased from one hundred push-ups on the pre-test to fifty push-ups on the final test. Group II's improvement is partly accounted for by subjects seventeen and twenty-eight who made tremendous improvement from the pre- to post-test scores.

On the burpee test scores, both groups showed a mean decrease from the pre- to the post-test. Many subjects in each group showed a decrease of from one to seventeen burpees between the two tests. There appears to be no logical explanation for this decrease. It might be possible that the subjects were not highly motivated and

did not try their utmost during the post-testing on this item.

The burpee exercise is not one that stimulates most people.

In the shuttle run, Group II showed a faster mean time in the final test than in the pre-test. The pre-test mean of Group I was lower than the pre-test mean of Group II which would affect the chances for improvement in Group I. The raw scores show that in the re-test ten subjects in Group I ran the distance in less time and that nineteen subjects required slightly more time to complete the run.

Both groups showed a mean increase in the broad jump. Group I scored higher in the pre- and post-tests than did Group II, but the improvement was not significant at the .05 level. The pre-test mean score of Group I was higher than was the post-test mean score of Group II.

Both groups showed significant improvement in chin-ups at the .05 level of significance, but Group II's improvement was greater. Most of the subjects in this group improved or equalled their pre-test scores with only two subjects showing a decrease in number of chin-ups. In Group I all but four subjects improved. Subjects twenty-seven and twenty-eight of Group I demonstrated a tremendous increase in the number of chin-ups they could do on the post-test. In comparing the means of the two groups, Group II's final mean score did not reach the level of the pre-test mean score of Group I. It would seem that there would be more chance for improvement for the subjects in Group II.

Both groups improved in sit-ups, but only Group II's improvement was significant at the .05 level. Again Group II's pre-test mean score was lower than the pre-test mean score of Group I.

It would seem that there would be more chance for improvement in Group II. Group II's final test mean score improvement of 6.46 sit-ups was very good. This was the first item of the test where Group II's post-test mean was higher than the post-test mean of Group I. Contributing to the Group I's failure to improve significantly was the fact that ten subjects decreased in the number of sit-ups from the pre- to the post-test. Group II's improvement can be attributed to the fact that only two subjects showed a decrease in the number of sit-ups from the pre- to the post-test.

The purpose of this study was to compare two methods of training and effects of this training on adolescent boys. Group II was supervised more than the weight and isometric group because the instructor felt that the running group needed more encouragement. The instructor thought that almost all boys were interested in lifting weights. The instructor's way of thinking may have had a negative effect on the motivation of Group I during the training period and the post-test. This could account partially for the lower mean improvement of Group I in most items of the test.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

The purpose of this study was to compare changes observed in the utilization of two training methods for increasing muscular strength, endurance, power, speed, and agility of adolescent boys.

The subjects selected were from the freshmen and sophomore boys' physical education classes at the Fertile High School. The subjects were members of the required physical education classes and divided into the two experimental groups, Group I and Group II. The two groups participated in a planned eight week training period. The subjects were tested at the beginning and the end of the eight week period.

Comparisons were made between the mean difference within each group on each item of the pre-test and final test. The significance of difference was tested by the "t" technique for the difference between means derived from correlated scores from small samples. Comparison was also made between the two groups by testing the significance of the difference between the mean differences found within groups. The "t" technique was used for between group comparison of uncorrelated data from small samples.

CONCLUSIONS

The following conclusions seem warranted from this study:

1. Running seems to have a positive affect on the ability to perform chin-ups, push-ups, and sit-ups.
2. Isometric and weight training do affect the ability to perform chin-ups.
3. Both groups decreased in their ability to perform the burpees.

RECOMMENDATIONS

1. It is recommended that a longer training period should be used for this type of study using more subjects.
2. It is recommended that a study be conducted at a time of the year when the environment will not have an adverse affect on the attitude of the participants.
3. It is recommended that a similar study be conducted to determine the effect of cross country running.
4. It is recommended that a similar study be conducted using several different physiological test items to measure the differences observed in relation to these two training methods.
5. It is recommended that a control group participating in the regular physical education activities be added to a similar study.
6. It is recommended that a similar study be designed using the matched paired techniques for equating groups.
7. It is recommended that a similar experiment be conducted in which the participants would meet more times per week during the experimental period.

DESCRIPTION OF THE EXERCISES USED IN THE WEIGHT TRAINING PROGRAM

ISOMETRIC EXERCISES

1. For The Neck

- a. Hold a towel behind head
- b. Pull the ends of the towel so that pressure is exerted on the neck.
- c. Exert pressure for six seconds, then relax for one second. Repeat three times.

2. For The Back

- a. Sit on a stool several inches from wall. Keep spine straight, abdomen in, feet firmly on floor.
- b. Thrust arms downward, squeeze shoulder blades together.
- c. Keeping elbows straight, press palms as hard as possible against wall until tension is felt directly between shoulder blades.
- d. Hold six seconds, relax one second. Repeat three times.

3. For Shoulders

- a. Sit on stool in door-way. Keep spine straight, abdomen in, feet firmly on floor.
- b. Raise the arms over-head in a V, placing hand outside door jamb, palm facing in.
- c. Keeping elbows straight; pull in with open palms as hard as possible until tension is felt in upper shoulders.
- d. Hold six seconds, relax one second. Repeat three times.

4. For Taut Trunk

- a. Sit on stool in middle of door-way. Keep spine straight, abdomen in, feet firmly on floor.
- b. Raise the arms over-head in a V, placing hands in side door jamb, palms facing out.
- c. Keeping elbows straight, push out with back of hands as hard as you can until tension is felt in upper sides.
- d. Hold six seconds, relax one second. Repeat three times.

5. For The Arms

- a. Sit on stool or chair, keeping the spine straight, abdomen in, feet flat on floor.
- b. Place palm of hands down on table until tension is felt in back of upper arms. (triceps)
- c. Hold six seconds, relax one second. Repeat three times. For front of upper arm (biceps), place hands under table and

push upward until tension is felt in front of upper arm.

WEIGHT LIFTING EXERCISES

1. Heel Raiser

- a. Place the weight across the shoulders and behind the neck. Use a rolled up towel or sponge for comfort.
- b. Place the balls of the feet on a two inch by six inch block of wood to maintain balance through-out the exercise.
- c. Raise the heels off the floor as high as possible and lower self slowly until the heels touch the floor again.
- d. Keep the back straight and neck erect.
- e. Inhale as the heels are lifted off the floor and exhale as the lift has been completed.

2. High Dead Lift

- a. Start lift from the dead lift position. (holding weight at thigh level)
- b. Grasp bar with pronated grip with hands shoulder-width apart.
- c. Lift the barbells, keep the elbows high, straight up under the chin.
- d. Inhale at the beginning of the lift, exhale as the lift has been completed.
- e. Keep feet pointed straight ahead and back straight, with head erect.

3. Supine Pull Over

- a. Lay supine on floor mat, with arms extended straight back over the head.
- b. Grasp the barbell with the hands about shoulder-width apart.
- c. Lift the weight from the floor back over the head, with arms straight, until the weight is directly above the chest. Then lower weights back to the floor.
- d. Proper beathing is recommended.

4. Regular Squat

- a. Place the bar across the shoulder and behind the neck.
- b. Grasp weight behind neck with hands slightly wider than shoulder-width apart.
- c. The feet should be spread about shoulder-width apart and pointed straight ahead.
- d. Keep head high, back straight and buttocks low.
- e. Bend knees to half squat position and return to standing position.
- f. Do not go beyond the sitting position.
- g. Inhale at the beginning and exhale when the exercise is completed.

PRE-TEST AND RE-TEST OF WEIGHT TRAINING GROUP I IN PUSH-UPS

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	67	50	-17	289
2.	100	50	-50	2500
3.	4	7	3	9
4.	27	40	13	169
5.	40	50	10	100
6.	45	56	11	121
7.	100	50	-50	2500
8.	44	40	-4	16
9.	50	50	0	0
10.	44	40	-4	16
11.	41	61	20	400
12.	30	34	4	16
13.	40	60	20	400
14.	32	36	4	16
15.	60	70	10	100
16.	50	60	+10	100
17.	25	20	-5	25
18.	30	42	12	144
19.	36	58	22	484
20.	20	26	+6	36
21.	47	70	23	529
22.	65	60	-5	25
23.	37	42	5	25
24.	35	40	5	25
25.	21	20	-1	1
26.	30	20	-10	100
27.	20	20	0	0
28.	50	70	20	400
29.	55	50	-5	25
<hr/>				
	1245	1282	47	9011

Mean Score of Pre-Test	42.93
Mean Score of Re-Test	43.52
Sum of the Difference	47
Sum of the Difference Squared	9011

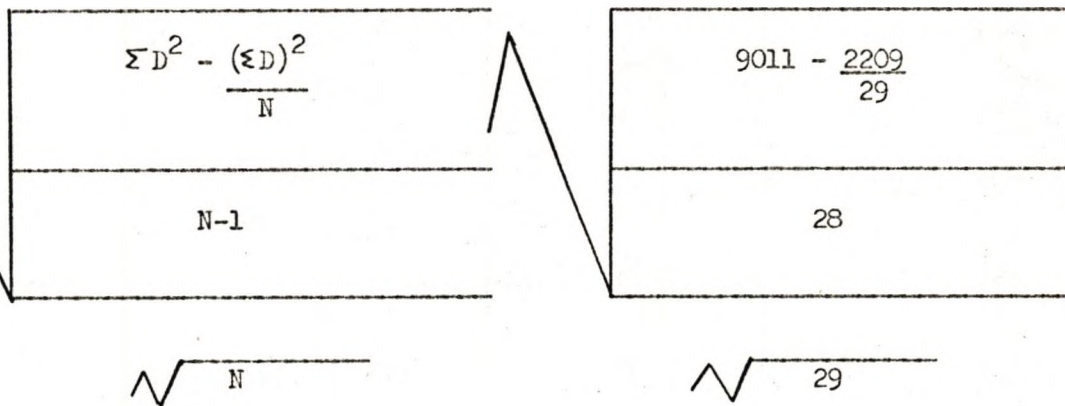
THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
 DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST Push-ups

GROUP I Weight Training

N = 29
 ΣD = 47
 ΣD^2 = 9011

$S_{\frac{D}{D}}$ (estimate of sampling error of \bar{D}) = $\frac{S_D}{\sqrt{N}}$ =



$S_{\frac{D}{D}}$ = 3.32

\bar{D} (Mean Difference) = $\frac{D}{N} = \frac{47}{29} = 1.62$

"t" = $\frac{\bar{D}}{S_{\frac{D}{D}}} = \frac{1.62}{3.32} = \underline{\underline{.49}}$

df = N-1 = 28

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF ENDURANCE TRAINING GROUP II IN BURPEES

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	40	37	-3	9
2.	36	37	1	1
3.	40	35	-5	25
4.	36	26	-10	100
5.	36	36	0	0
6.	27	25	-2	4
7.	35	31	-4	16
8.	30	40	10	100
9.	33	43	10	100
10.	32	24	-8	64
11.	39	32	-7	49
12.	30	35	5	25
13.	32	25	-7	49
14.	29	25	-4	16
15.	40	38	-2	4
16.	41	36	-5	25
17.	42	35	-7	49
18.	30	35	5	25
19.	30	24	-6	36
20.	41	32	-9	81
21.	24	25	1	1
22.	36	43	7	49
23.	44	37	-7	49
24.	36	22	-14	196
25.	36	34	-2	4
26.	42	43	1	1
27.	30	38	8	64
28.	43	32	11	121
	<hr/>	<hr/>	<hr/>	<hr/>
	990	925	-43	1263

Mean Score of Pre-Test 35.36

Mean Score of Re-Test 33.04

Sum of the Difference 43

Sum of the Difference Squared 1263

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

TEST Burpees

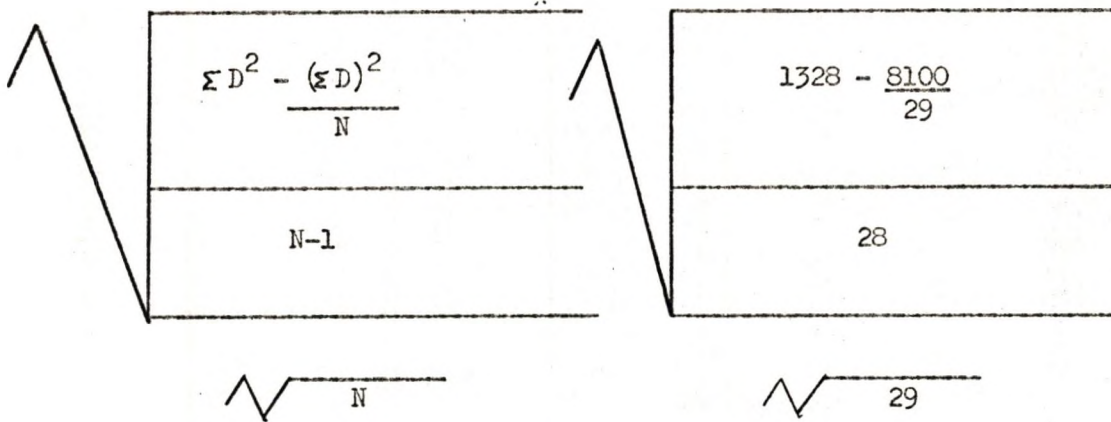
GROUP I Weight Training

$N = \underline{29}$

$\Sigma D = \underline{-90}$

$\Sigma D^2 = \underline{1328}$

$S_{\frac{D}{D}}$ (estimate of sampling error of \bar{D}) = $\frac{S_D}{N} =$



$\frac{S_D}{D} = \underline{1.14}$

\bar{D} (Mean Difference) = $\frac{D}{N} = \frac{-90}{29} = -3.10$

"t" = $\frac{\bar{D}}{S_{\frac{D}{D}}} = \frac{-3.10}{1.14} = \underline{-2.72}$

df = N-1 = 28

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF WEIGHT TRAINING GROUP I IN SHUTTLE RUN

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	22.5	24.2	-1.7	2.89
2.	24.2	24.2	-.0	.00
3.	31.6	31.9	-.3	.90
4.	25.4	26.0	-.6	.36
5.	23.8	24.7	-.9	.81
6.	23.9	24.0	-.1	.10
7.	22.6	22.6	.0	.00
8.	22.7	22.8	-.1	.01
9.	21.8	22.0	-.2	.04
10.	24.8	24.2	+.6	.36
11.	23.0	23.5	-.5	.25
12.	23.4	23.5	-.1	.01
13.	22.5	23.1	-.6	.36
14.	24.0	24.8	-.8	.64
15.	24.7	24.6	+.1	.01
16.	22.7	24.1	-1.4	1.96
17.	25.2	25.5	-.3	.09
18.	23.3	22.5	+.8	.64
19.	22.9	22.2	+.7	.49
20.	23.7	22.8	+.9	.81
21.	25.4	24.9	+.5	.25
22.	23.9	22.4	+1.5	2.25
23.	25.0	22.8	+2.2	4.84
24.	22.9	24.7	-1.8	3.24
25.	24.9	25.0	-.1	.01
26.	24.3	24.5	-.2	.04
27.	24.8	24.3	+.5	.25
28.	22.5	22.1	+.4	.16
29.	21.9	22.8	-.9	.81
<hr/>				
	694.30	696.50	-2.2	22.58

Mean Score of Pre-Test	23.94
Mean Score of Re-Test	24.02
Sum of the Difference	-2.2
Sum of the Difference Squared	22.58

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

TEST Shuttle Run

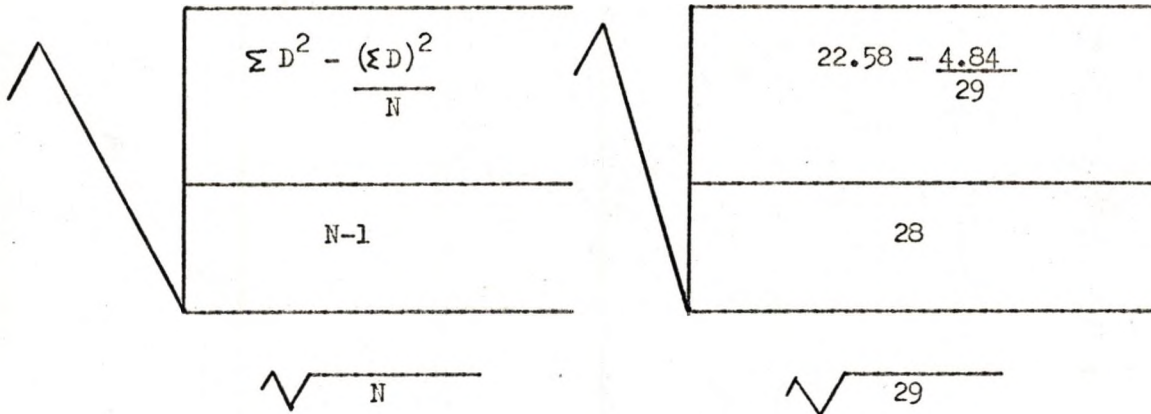
GROUP I Weight Training

$N = \underline{29}$

$\Sigma D = \underline{-2.2}$

$\Sigma D^2 = \underline{22.58}$

$S_{\bar{D}}$ (estimate of sampling error of \bar{D}) = $\frac{S_D}{\sqrt{N}}$



$S_{\bar{D}} = \underline{.17}$

\bar{D} (Mean Difference) = $\frac{D}{N} = \frac{-2.2}{29} = -.08$

"t" = $\frac{\bar{D}}{S_{\bar{D}}} = \frac{-.08}{.17} = -.47$

df = N-1 = 28

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF WEIGHT TRAINING GROUP I IN BROAD JUMP

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	86	88	2	4
2.	45	41	-4	16
3.	68	68	0	0
4.	76	74	-2	4
5.	75	74	-1	1
6.	78	83	5	25
7.	76	78	2	4
8.	86	92	6	36
9.	77	70	-7	49
10.	81	86	5	25
11.	86	88	2	4
12.	86	81	-5	25
13.	79	85	6	36
14.	71	68	-3	9
15.	72	74	2	4
16.	68	61	-7	49
17.	83	76	-7	49
18.	87	95	8	64
19.	80	77	-3	9
20.	74	73	-1	1
21.	80	90	10	100
22.	83	92	9	81
23.	76	78	2	4
24.	64	68	4	16
25.	66	65	-1	1
26.	70	78	8	64
27.	83	84	1	1
28.	75	74	-1	1
29.	83	79	-4	16
	<hr/>	<hr/>	<hr/>	<hr/>
	2204	2240	36	698

Mean Score of Pre-Test	76.35
Mean Score of Re-Test	77.24
Sum of the Difference	36
Sum of the Difference Squared	698

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

TEST Broad Jump

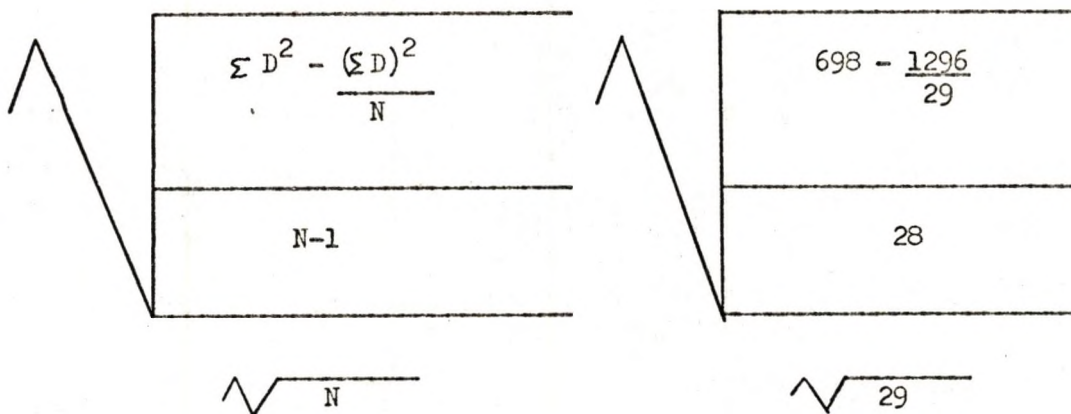
GROUP I Weight Training

N = 29

ΣD = 36

ΣD^2 = 698

$$S_{\bar{D}} \text{ (estimate of sampling error of } \bar{D}) = \frac{S_D}{\sqrt{N}} =$$



$S_{\bar{D}} = \underline{.90}$

\bar{D} (Mean Difference) = $\frac{D}{N} = \frac{36}{29} = 1.24$

"t" = $\frac{\bar{D}}{S_{\bar{D}}} = \frac{1.24}{.90} = \underline{1.38}$

df = N-1 = 28

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF WEIGHT TRAINING GROUP I IN PULL-UPS

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	7	10	3	9
2.	0	0	0	0
3.	9	4	-5	25
4.	8	9	1	1
5.	8	11	3	9
6.	8	10	2	4
7.	8	10	2	4
8.	7	10	3	9
9.	8	8	0	0
10.	10	10	0	0
11.	7	5	-2	4
12.	9	12	3	9
13.	4	4	0	0
14.	3	6	3	9
15.	6	5	-1	1
16.	2	3	1	1
17.	5	8	3	9
18.	7	9	2	4
19.	6	7	1	1
20.	5	6	1	1
21.	6	7	1	1
22.	10	10	0	0
23.	10	11	1	1
24.	1	1	0	0
25.	7	4	-3	9
26.	2	4	2	4
27.	14	20	6	36
28.	6	11	5	25
29.	10	12	2	4
	<hr/>	<hr/>	<hr/>	<hr/>
	193	227	34	174

Mean Score of Pre-Test	6.66
Mean Score of Re-Test	7.83
Sum of the Difference	34
Sum of the Difference Squared	174

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

TEST Pull-ups

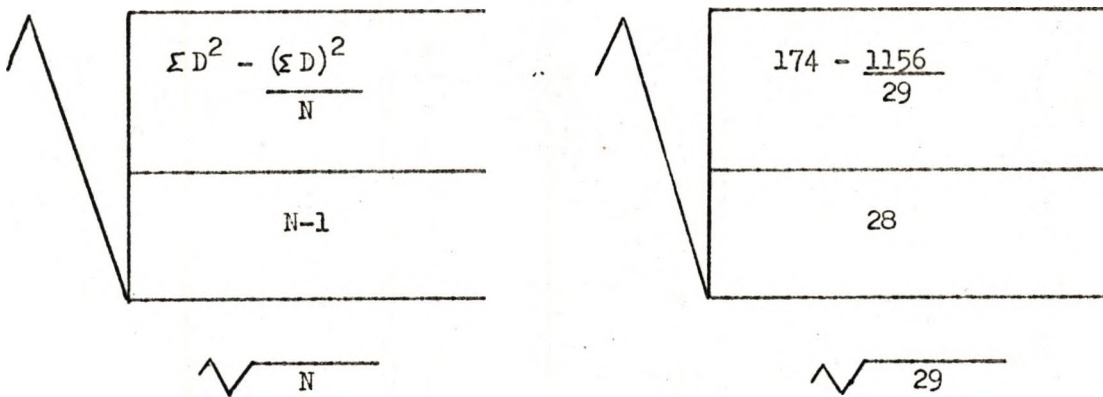
GROUP I Weight Training

$$N = \underline{29}$$

$$\Sigma D = \underline{34}$$

$$\Sigma D^2 = \underline{174}$$

$$S_{\frac{D}{D}} \text{ (estimate of sampling error of } \bar{D}) = \frac{S_D}{\sqrt{N}} =$$



$$S_{\frac{D}{D}} = \underline{.41}$$

$$\bar{D} \text{ (Mean Difference)} = \frac{D}{N} = \frac{34}{29} = \underline{1.17}$$

$$"t" = \frac{\bar{D}}{S_{\frac{D}{D}}} = \frac{1.17}{.41} = \underline{2.89}$$

$$df = N-1 = 28$$

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF WEIGHT TRAINING GROUP I IN SIT-UPS

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	67	61	-6	36
2.	68	77	9	81
3.	15	40	25	625
4.	40	40	0	0
5.	58	60	2	4
6.	72	64	-8	64
7.	67	78	11	121
8.	54	67	13	169
9.	54	65	11	121
10.	40	50	10	100
11.	56	61	5	25
12.	40	55	15	225
13.	44	56	12	144
14.	46	60	14	196
15.	50	54	4	16
16.	48	65	17	289
17.	40	43	3	9
18.	39	32	-7	49
19.	31	34	3	9
20.	47	37	-10	100
21.	63	50	-13	169
22.	47	36	-11	121
23.	49	50	1	1
24.	53	44	-9	81
25.	42	35	-7	49
26.	43	42	-1	1
27.	40	30	-10	100
28.	50	53	3	9
29.	57	40	-17	289
	<hr/>	<hr/>	<hr/>	<hr/>
	1420	1479	59	2703

Mean Score of Pre-Test	48.97
Mean Score of Re-Test	51.00
Sum of the Difference	59
Sum of the Difference Squared	2703

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

TEST Sit-ups

GROUP I Weight Training

$$N = \underline{\quad 29 \quad}$$

$$\Sigma D = \underline{\quad 59 \quad}$$

$$\Sigma D^2 = \underline{\quad 2703 \quad}$$

$$S_{\bar{D}} \text{ (estimate of sampling error of } \bar{D}) = \frac{S_D}{\sqrt{N}} =$$

$\frac{\Sigma D^2 - \frac{(\Sigma D)^2}{N}}{N-1}$	$\frac{2703 - \frac{3481}{29}}{28}$
\sqrt{N}	$\sqrt{29}$

$$\frac{S_D}{\bar{D}} = \underline{1.78}$$

$$\bar{D} \text{ (Mean Difference)} = \frac{D}{N} = \frac{59}{29} = 2.03$$

$$"t" = \frac{\bar{D}}{S_{\bar{D}}} = \frac{2.03}{1.78} = 1.14$$

$$df = N-1 = 28$$

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF ENDURANCE TRAINING GROUP II IN PUSH-UPS

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	37	40	3	9
2.	40	50	10	100
3.	30	50	20	400
4.	30	52	22	484
5.	35	32	-3	9
6.	17	24	7	49
7.	26	31	5	25
8.	25	35	10	100
9.	41	30	-11	121
10.	30	35	5	25
11.	40	50	10	100
12.	30	35	5	25
13.	62	75	13	169
14.	17	20	3	9
15.	20	34	14	196
16.	50	60	10	100
17.	33	80	47	2209
18.	18	35	17	289
19.	28	46	18	324
20.	50	70	20	400
21.	24	25	1	1
22.	50	75	25	625
23.	50	51	1	01
24.	55	54	-1	1
25.	40	60	20	400
26.	71	81	10	100
27.	10	20	10	100
28.	70	102	32	1024
	<hr/>	<hr/>	<hr/>	<hr/>
	1029	1352	323	7024

Mean Score of Pre-Test 36.75

Mean Score of Re-Test 48.29

Sum of the Difference 323

Sum of the Difference Squared 7024

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

TEST Push-ups

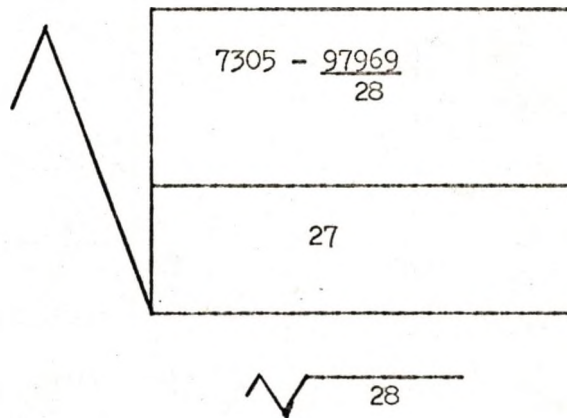
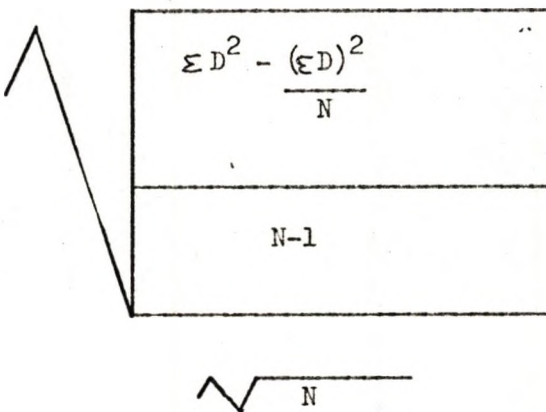
GROUP II Endurance Training

N = 28

ΣD = 313

ΣD^2 = 7305

$$S_{\bar{D}} \text{ (estimate of sampling error of } \bar{D}) = \frac{S_D}{\sqrt{N}} =$$



$S_{\bar{D}}$ = 2.24

\bar{D} (Mean Difference) = $\frac{D}{N} = \frac{313}{28} = 11.18$

"t" = $\frac{\bar{D}}{S_{\bar{D}}} = \frac{11.18}{2.24} = 4.98$

df = N-1 = 27

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF WEIGHT TRAINING GROUP I IN BURPEES

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	36	36	0	0
2.	42	40	-2	4
3.	4	5	1	1
4.	36	24	-12	144
5.	37	33	-4	16
6.	36	38	2	4
7.	42	39	-3	9
8.	44	39	-5	25
9.	45	37	-8	64
10.	44	39	-5	25
11.	33	35	2	4
12.	39	37	-2	4
13.	37	36	-1	1
14.	18	25	7	49
15.	36	37	1	1
16.	37	35	-2	4
17.	38	21	-17	289
18.	41	39	-2	4
19.	38	36	-2	4
20.	36	37	1	1
21.	31	20	-11	121
22.	43	42	-1	1
23.	43	37	-6	36
24.	39	40	1	1
25.	41	22	-19	361
26.	38	35	-3	9
27.	26	25	-1	1
28.	39	48	9	81
29.	39	31	-8	64
	<hr/>	<hr/>	<hr/>	<hr/>
	1058	968	-90	1328

Mean Score of Pre-Test 36.48

Mean Score of Re-Test 33.37

Sum of the Difference 90

Sum of the Difference Squared 1328

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

TEST Burpees

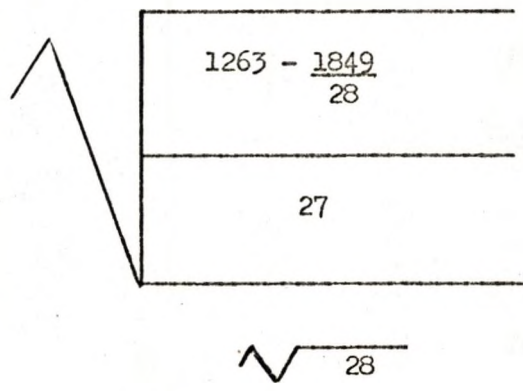
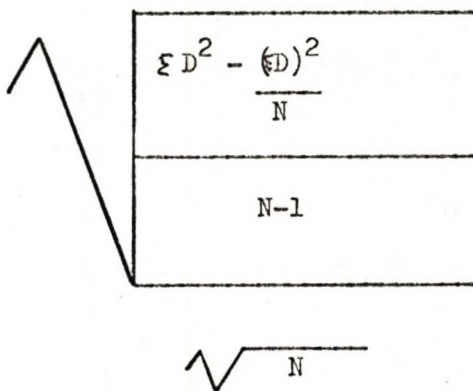
GROUP II Endurance Training

$N = \underline{28}$

$\Sigma D = \underline{-43}$

$\Sigma D^2 = \underline{1263}$

$S_{\bar{D}}$ (estimate of sampling error of $\bar{D} = \frac{S_D}{\sqrt{N}} =$



$S_{\bar{D}} = \underline{1.26}$

\bar{D} (Mean Difference) $= \frac{D}{N} = \frac{-43}{28} = -1.54$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{-1.54}{1.26} = \underline{-1.22}$

df = N-1 = 27

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF ENDURANCE TRAINING GROUP II IN SHUTTLE RUN

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	23.9	22.2	1.7	2.89
2.	23.5	23.0	0.5	0.25
3.	22.5	21.5	1.0	1.00
4.	22.4	22.3	0.1	0.01
5.	25.6	24.6	1.0	1.00
6.	27.0	27.2	-0.2	0.04
7.	26.1	25.6	0.5	0.25
8.	26.0	24.7	1.3	1.69
9.	22.8	22.5	0.3	0.09
10.	25.4	25.0	0.4	0.16
11.	25.0	23.5	1.5	2.25
12.	25.9	26.1	0.2	0.04
13.	24.8	22.8	2.0	4.00
14.	24.2	24.1	0.1	0.01
15.	24.6	23.3	1.3	1.69
16.	23.5	24.0	-0.5	0.25
17.	23.0	23.8	-0.8	0.64
18.	24.4	25.4	-1.0	1.00
19.	23.6	23.9	-0.3	0.09
20.	22.5	24.3	-1.8	3.24
21.	27.7	26.6	-1.1	1.21
22.	23.9	23.7	0.2	0.04
23.	23.4	22.6	0.8	0.64
24.	25.8	25.4	0.4	0.16
25.	23.6	23.2	0.4	0.16
26.	21.9	22.3	-0.4	0.16
27.	23.2	24.0	-0.8	0.64
28.	23.0	24.0	-1.0	1.00
	<hr/>	<hr/>	<hr/>	<hr/>
	679.2	673.2	6.0	24.60

Mean Score of Pre-Test	24.26
Mean Score of Re-Test	23.99
Sum of the Difference	6.0
Sum of the Difference Squared	24.60

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

TEST Shuttle Run

GROUP II Endurance Training

$$N = \underline{28}$$

$$\Sigma D = \underline{6}$$

$$\Sigma D^2 = \underline{24.60}$$

$$S_{\bar{D}} \text{ (estimate of sampling error of } \bar{D}) = \frac{S_D}{\sqrt{N}} =$$

$\frac{\Sigma D^2 - (\Sigma D)^2}{N}$	$24.60 - \frac{36}{28}$
<hr style="border: 0.5px solid black;"/> $N-1$	<hr style="border: 0.5px solid black;"/> 27
\sqrt{N}	$\sqrt{28}$

$$S_{\bar{D}} = \underline{.18}$$

$$\bar{D} \text{ (Mean Difference)} = \frac{D}{N} = \frac{6}{28} = .214$$

$$"t" = \frac{\bar{D}}{S_{\bar{D}}} = \frac{.22}{.18} = \underline{1.19}$$

$$df = N-1 = 27$$

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF ENDURANCE TRAINING GROUP II IN BROAD JUMP

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	76	76	0	0
2.	92	90	-2	4
3.	90	84	-6	36
4.	79	74	-5	25
5.	66	68	2	4
6.	48	42	-6	36
7.	73	82	9	81
8.	67	80	13	169
9.	73	72	-1	1
10.	66	68	2	4
11.	65	64	-1	1
12.	71	72	1	1
13.	84	86	2	4
14.	60	70	10	100
15.	80	80	0	0
16.	59	71	12	144
17.	74	80	6	36
18.	74	52	-22	484
19.	83	78	-5	25
20.	83	75	-8	64
21.	60	68	8	64
22.	88	84	-4	16
23.	79	76	-3	9
24.	72	71	-1	1
25.	72	74	2	4
26.	90	87	-3	9
27.	86	89	3	9
28.	87	89	2	4
	<hr/>	<hr/>	<hr/>	<hr/>
	2097	2102	5	1335

Mean Score of Pre-Test 74.89

Mean Score of Re-Test 75.07

Sum of the Difference 5

Sum of the Difference Squared 1335

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

TEST Broad Jump

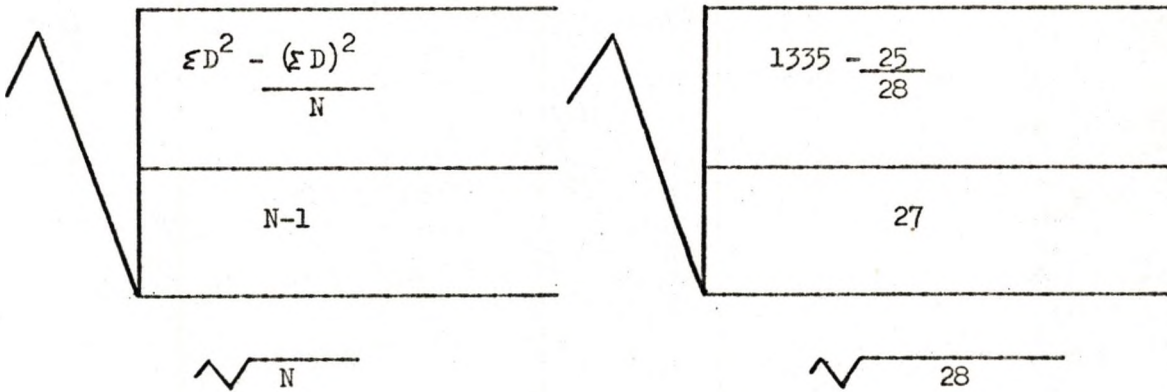
GROUP II Endurance Training

$N = \underline{\quad 28 \quad}$

$\Sigma D = \underline{\quad 5 \quad}$

$\Sigma D^2 = \underline{\quad 1335 \quad}$

$S_{\bar{D}}$ (estimate of sampling error of \bar{D}) = $\frac{S_D}{\sqrt{N}} =$



$S_{\bar{D}} = \underline{\quad 1.33 \quad}$

\bar{D} (Mean Difference) = $\frac{D}{N} = \frac{5}{28} = .18$

"t" = $\frac{\bar{D}}{S_{\bar{D}}} = \frac{.18}{1.44} = .135$

df = N-1 = 27

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF ENDURANCE TRAINING GROUP II IN PULL-UPS

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	9	10	1	1
2.	10	13	3	9
3.	9	9	0	0
4.	5	4	-1	1
5.	5	3	-2	4
6.	0	0	0	0
7.	5	7	2	4
8.	5	8	3	9
9.	3	5	2	4
10.	1	3	2	4
11.	8	9	1	1
12.	0	3	3	9
13.	9	12	3	9
14.	0	1	1	1
15.	4	4	0	0
16.	6	6	0	0
17.	8	10	2	4
18.	1	3	2	4
19.	4	7	3	9
20.	8	10	2	4
21.	0	3	3	9
22.	8	12	4	16
23.	5	6	1	1
24.	8	7	1	1
25.	1	5	4	16
26.	6	6	0	0
27.	3	5	2	4
28.	8	9	1	1
	<hr/>	<hr/>	<hr/>	<hr/>
	139	180	41	125

Mean Score of Pre-Test 4.96

Mean Score of Re-Test 6.43

Sum of the Difference 41

Sum of the Difference Squared 125

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

TEST Pull-ups

GROUP II Endurance Training

$$N = \underline{28}$$

$$\Sigma D = \underline{41}$$

$$\Sigma D^2 = \underline{125}$$

$$S_{\frac{D}{D}} \text{ (estimate of sampling error of } \bar{D} = \frac{S_D}{\sqrt{N}} =$$

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

$$\sqrt{N}$$

$$\frac{125 - \frac{1681}{28}}{27}$$

$$\sqrt{28}$$

$$S_{\frac{D}{D}} = \underline{.29}$$

$$\bar{D} \text{ (Mean Difference)} = \frac{41}{28} = 1.46$$

$$"t" = \frac{\bar{D}}{S} = \frac{1.46}{.29} = \underline{5.03}$$

$$df = N-1 = 27$$

"t" at the .05 level = 2.05

PRE-TEST AND RE-TEST OF ENDURANCE TRAINING GROUP II IN SIT-UPS

<u>Subject</u>	<u>Pre-Test</u>	<u>Re-Test</u>	<u>Sum of Difference</u>	<u>Difference Squared</u>
1.	45	67	22	484
2.	50	61	11	121
3.	50	45	-5	25
4.	50	76	26	676
5.	46	48	2	4
6.	43	54	11	121
7.	40	45	5	25
8.	35	57	22	484
9.	54	56	2	4
10.	45	50	5	25
11.	47	45	-2	4
12.	50	50	0	0
13.	42	54	12	144
14.	43	57	14	196
15.	31	47	16	256
16.	50	56	6	36
17.	53	57	4	16
18.	31	39	8	84
19.	31	42	11	121
20.	60	60	0	0
21.	30	37	7	49
22.	39	75	36	1296
23.	57	45	-12	144
24.	57	57	0	0
25.	57	45	-12	144
26.	62	54	-8	64
27.	31	30	-1	1
28.	57	58	1	1
	<hr/>	<hr/>	<hr/>	<hr/>
	1275	1479	204	2906

Mean Score of Pre-Test	45.93
Mean Score of Re-Test	52.39
Sum of the Difference	204
Sum of the Difference Squared	2906

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

TEST Sit-ups

GROUP II Endurance Training

$$N = \underline{\quad 28 \quad}$$

$$\Sigma D = \underline{\quad 204 \quad}$$

$$\Sigma D^2 = \underline{\quad 2906 \quad}$$

$$S_{\frac{D}{D}} \text{ (estimate of sampling error of } \bar{D}) = \frac{S_D}{\sqrt{N}} =$$

$\frac{\Sigma D^2 - \frac{(\Sigma D)^2}{N}}{N-1}$	$\frac{2906 - \frac{41616}{28}}{27}$
$\sqrt{\quad N \quad}$	$\sqrt{\quad 28 \quad}$

$$S_{\frac{D}{D}} = \underline{\quad 1.37 \quad}$$

$$\bar{D} \text{ (Mean Difference)} = \frac{D}{N} = \frac{204}{28} = 6.46$$

$$"t" = \frac{\bar{D}}{S_{\frac{D}{D}}} = \frac{6.46}{1.37} = \underline{\quad 4.72 \quad}$$

$$df = N-1 = 27$$

"t" at the .05 level = 2.05

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

TEST Push-ups

Weight Training Group $\bar{D} = \underline{1.62}$ Endurance Training Group $\bar{D} = \underline{11.18}$

Weight Training Group $S_{\frac{D}{D}} = \underline{1.56}$ Endurance Training Group $S_{\frac{D}{D}} = \underline{2.24}$

$S_{\frac{D}{M_D}}$ (the estimate of the sampling error for the distribution of differences between the mean differences) =

$$\sqrt{\left(\frac{S_{D_1}}{D_1}\right)^2 + \left(\frac{S_{D_2}}{D_2}\right)^2} \quad \sqrt{(1.56)^2 + (2.24)^2}$$

$$\sqrt{2.43 + 5.02} \quad \sqrt{7.45}$$

$$S_{\frac{D}{M_D}} = \underline{2.73}$$

$$\frac{D}{D} = \bar{D}_1 - \bar{D}_2 = 1.62 - 11.18 = \underline{9.56}$$

$$"t" = \frac{\frac{D}{D}}{S_{\frac{D}{M_D}}} = \frac{9.56}{2.73} = \underline{3.50}$$

$$df = (N_1 - 1) + (N_2 - 1) = 55$$

"t" at .05 level = 2.00

Significant at .05 level

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

TEST Burpees

Weight Training Group $\bar{D} = \underline{3.10}$ Endurance Training Group $\bar{D} = \underline{1.54}$

Weight Training Group $S_{\frac{D}{D}} = \underline{1.14}$ Endurance Training Group $S_{\frac{D}{D}} = \underline{1.26}$

$S_{\frac{D}{D}}$ (the estimate of the sampling error for the distribution of differences between the mean differences) =

$$\sqrt{\left(\frac{S_{\frac{D}{D_1}}}{D_1}\right)^2 + \left(\frac{S_{\frac{D}{D_2}}}{D_2}\right)^2} \quad \sqrt{(1.14)^2 + (1.26)^2}$$

$$\sqrt{1.30 + 1.59} \quad \sqrt{2.89}$$

$S_{\frac{D}{D}} = \underline{1.70}$

$\frac{D}{D} = \bar{D}_1 - \bar{D}_2 = 3.10 - 1.54 = \underline{1.56}$

"t" = $\frac{\frac{D}{D}}{S_{\frac{D}{D}}} = \frac{1.56}{1.70} = \underline{.90}$

df = $(N_1 - 1) + (N_2 - 1) = 55$

"t" at .05 level = 2.00

Not significant at .05 level

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

TEST Shuttle Run

Weight Training Group $\bar{D} = \underline{.03}$ Endurance Training Group $\bar{D} = \underline{.22}$

Weight Training Group $S_{\frac{D}{D}} = \underline{.17}$ Endurance Training Group $S_{\frac{D}{D}} = \underline{.18}$

$S_{\frac{D}{M D}}$ (the estimate of the sampling error for the distribution of differences between the mean differences) =

$$\sqrt{\left(\frac{S_{\frac{D}{D_1}}}{D_1}\right)^2 + \left(\frac{S_{\frac{D}{D_2}}}{D_2}\right)^2} \qquad \sqrt{(.17)^2 + (.18)^2}$$

$$\sqrt{.03 + .03} \qquad \sqrt{.06}$$

$S_{\frac{D}{M D}} = \underline{.25}$

$\frac{D}{D} = \bar{D}_1 - \bar{D}_2 = -.08 - .22 = \underline{.30}$

"t" = $\frac{\frac{D}{D}}{S_{\frac{D}{M D}}} = \frac{.30}{.25} = \underline{1.20}$

df = $(N_1 - 1) + (N_2 - 1) = 55$

"t" at .05 level = 2.00

Not Significant at .05 level

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

TEST Broad Jump

Weight Training Group $\bar{D} = \underline{1.24}$ Endurance Training Group $\bar{D} = \underline{.18}$

Weight Training Group $S_{\bar{D}} = \underline{.90}$ Endurance Training Group $S_{\bar{D}} = \underline{1.44}$

$S_{\bar{D}}$ (the estimate of the sampling error for the distribution of differences between the mean differences) =

$$\sqrt{\left(\frac{S_{\bar{D}_1}}{D_1}\right)^2 + \left(\frac{S_{\bar{D}_2}}{D_2}\right)^2} \qquad \sqrt{(.90)^2 + (1.44)^2}$$

$$\sqrt{.81 + 2.07} \qquad 2.88$$

$S_{\bar{D}} = \underline{1.70}$

$\frac{D}{D} = \bar{D}_1 - \bar{D}_2 = 1.24 - .18 = \underline{1.06}$

"t" = $\frac{\frac{D}{D}}{S_{\bar{D}}} = \frac{1.06}{1.70} = \underline{.62}$

df = $(N_1 - 1) + (N_2 - 1) = 55$

"t" at .05 level = 2.00

Not significant at .05 level

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

TEST Pull-ups

Weight Training Group $\bar{D} = \underline{1.17}$ Endurance Training Group $\bar{D} = \underline{1.46}$

Weight Training Group $S_{\frac{D}{D_1}} = \underline{.41}$ Endurance Training Group $S_{\frac{D}{D_2}} = \underline{.29}$

$S_{\frac{D}{M D}}$ (the estimate of the sampling error for the distribution of differences between the mean differences) =

$$\sqrt{\left(\frac{S_{\frac{D}{D_1}}}{D_1}\right)^2 + \left(\frac{S_{\frac{D}{D_2}}}{D_2}\right)^2} \qquad \sqrt{(.41)^2 + (.29)^2}$$

$$\sqrt{.17 + .08} \qquad \sqrt{.25}$$

$S_{\frac{D}{M D}} = \underline{.50}$

$\frac{D}{D} = \bar{D}_1 - \bar{D}_2 = 1.17 - 1.46 = \underline{.29}$

"t" = $\frac{\frac{D}{D}}{S_{\frac{D}{M D}}} = \frac{.29}{.50} = \underline{.58}$

df = $(N_1 - 1) + (N_2 - 1) = 55$

"t" at .05 level = 2.00

Significant at .05 level

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

TEST Sit-ups

Weight Training Group $\bar{D} = \underline{2.03}$ Endurance Training Group $\bar{D} = \underline{6.46}$

Weight Training Group $S_{\frac{D}{D}} = \underline{1.78}$ Endurance Training Group $S_{\frac{D}{D}} = \underline{1.37}$

$S_{\frac{D}{M D}}$ (the estimate of the sampling error for the distribution of differences between the mean differences) =

$$\sqrt{\left(\frac{S_{\frac{D}{D_1}}}{D_1}\right)^2 + \left(\frac{S_{\frac{D}{D_2}}}{D_2}\right)^2} \qquad \sqrt{(1.78)^2 + (1.37)^2}$$

$$\sqrt{3.17 + 1.88} \qquad \sqrt{5.05}$$

$S_{\frac{D}{M D}} = \underline{2.25}$

$\frac{D}{D} = \bar{D}_1 - \bar{D}_2 = 2.03 - 6.46 = \underline{4.43}$

"t" = $\frac{\frac{D}{D}}{S_{\frac{D}{M D}}} = \frac{4.43}{2.25} = \underline{1.97}$

df = $(N_1 - 1) + (N_2 - 1) = 55$

"t" at .05 level = 2.00

Not significant at .05 level

BIBLIOGRAPHY

Books

- Garrett, Henry E., Statistics in Psychology and Education, New: Longmans, Green and Co., 1955, p. 213.
- McNemar, Quinn, Psychological Statistics, (New York: John Wiley and Sons, Inc., 1949) p. 225.

Articles and Periodicals

- Capen, Edward, The Effect of Systematic Weight Training on Power, Strength and Endurance, Research Quarterly XXI, No. 2 (May 1950), pp. 83-93.
- Chui, Edward, "The Effect of Systematic Weight Training On Athletic Power", Research Quarterly XXI, (October 1950), pp. 188-194.
- Kusinite, Ivan and Keeney, Clifford E., Effects of Progressive Weight Training on Health and Physical Fitness of Adolescent Boys, Research Quarterly XXIV, (October, 1958), p. 300.
- Masely, John, Hairabedin, Ara, and Donaldson, Don, "Weight Training in Relation to Strength, Speed, and Co-ordination", Research Quarterly XXIV, No.3, (October 1953), pp. 308-315.
- Morgan, Bill, "Static Exercises", Scholastic Coach, (February 1963) p. 24.
- Nagle, Francis J., and Erwin, Leslie W., Effects of Two Systems of Weight Training On Circulorespiratory Endurance and Related Physiological Factors, Research Quarterly XXXI, (1960) p. 371.
- Rogin, Gilbert, "Get Strong Without Moving", Sports Illustrated, (October 30, 1961), Vol. 15 No. 18, pp. 18-21.
- Wilkin, Bruce M., "The Effect of Weight Training On Speed of Movement", Research Quarterly XXIII, (October, 1952) pp. 361-369.

Unpublished Material

- Dire, Robert A., An Analysis of the Effects of a Weight Training Program On Selected Measures of Muscular Strength, Endurance, Power, Speed, and Agility of Adolescent Boys, (Unpublished Master's Thesis, University of North Dakota)

Huffman, Roger, "An Analysis of the Effects of Weight Training Program on Selected Factors of the Athletic Skill in Adolescent Boys", (Unpublished Individual Research Paper, Department of Physical Education, University of North Dakota, 1959).

Mittun, J. A., "An Analysis of the Effects of a Weight Training Program of Selected Measures of Power, Agility, and Basketball Skills in Adolescent Boys", (Unpublished Individual Research Paper, Department of Physical Education, University of North Dakota, 1960).

Vanyo, Raymond J., "Weight Training Concentrated On the Arms and Shoulders and Its Effect Upon Speed of Junior High School, Boys in the 60 Yard Dash", (Unpublished Master's Thesis, University of North Dakota, 1963), pp. 32-34.