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The Effect of Ankle Weights on the Jumping Performance of a Selected Group of High School Basketball Players

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THE EFFECT OF ANKLE WEIGHTS ON THE JUMPING PERFORMANCE OF A SELECTED GROUP OF HIGH SCHOOL BASKETBALL PLAYERS

by

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This thesis submitted by Dennis W. Gienger 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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Department Health, Physical Education, and Recreation

Degree Master of Science

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ABSTRACT

The purpose of this study was to ascertain what effects the use of ankle weights would have on standing broad jumping performance of selected high school basketball players.

Three groups of twelve subjects each were used in this study. Each group was tested at the start of the experimental period, after six weeks of training and at the end of the twelfth training week. The test involved standing broad jumping performance measured to the nearest one-fourth inch.

Comparisons were made between the means within each group on the pre-, mid-, and final tests. Comparisons were also made between the three groups by testing the significance of the differences between the group means on the pre-, mid-, and final tests. The null hypothesis was assumed in making comparisons with rejection at the .01 level. This hypothesis was tested with the "t" technique for the significance of the difference between means.

The results of the comparisons showed that the use of ankle weights can result in a significant amount of improvement in jumping performance at the .01 level during the first six weeks of training, and that there may be little real value in continuing to use them after this time.

CHAPTER I

THE PROBLEM AND ITS SCOPE

INTRODUCTION

Some basketball coaches incorporate weight training into the conditioning program during the first three or four weeks of the basketball season. However, most of them discontinue this practice when the competitive season begins. An investigation to determine the effects of weight training on basketball players during the competitive season was needed. The experiment was extended over a period of thirteen weeks. Twenty-four high school basketball players and twelve physical education students at Rugby High School, Rugby, North Dakota, served as subjects.

Statement of the Problem

This study was undertaken to determine the effect of ankle weights on the standing broad jump performance of a selected group of high school basketball players during a period of twelve training weeks.

Need for the Study

Basketball coaches, in the past several years, have been using ankle weights and other weight training methods for the purpose of increasing jumping performance and strength which are very important in the game of basketball today.

In this study, the writer used ankle weights to determine if there were any values to be gained from their use as far as jumping performance of a selected group of high school basketball players was concerned.

Definition of Terms

1. Experimental Group I - the group of twelve boys on the varsity basketball team that took part in the practice sessions wearing ankle weights over their basketball shoes.

2. Experimental Group II - the group of twelve boys on the junior varsity basketball team that took part in practice sessions wearing regular basketball shoes and no ankle weights.

3. Control Group - the group of twelve physical education students selected at random from a senior high physical education class.

4. Ankle Weights - weighted leather bags that strapped around the ankle above the basketball shoe.

5. Weight Load - the number of pounds that was used by each subject in Experimental Group I. This was two and one half pounds per shoe.

6. Training Period - the twelve weeks during which the subjects participated in training activities.

7. Experimental Period - the thirteen weeks over which the study was extended. This was one week longer than the training period because of a break over the Christmas holidays during which no training took place.

Limitations of the Study

1. The experimenter had no way of controlling the subjects' outside activities--such as sleeping, dieting, and other forms of athletic activity.

2. The experimenter had no way of controlling possible psychological effects on those using the ankle weights.

Delimitations

1. This study was limited to twenty-four basketball players and twelve physical education students from Rugby High School, Rugby, North Dakota.

2. The training period was limited to twelve weeks.

3. The grouping of subjects was not done on a matched pairs basis.

Survey of Related Literature

The literature fails to reveal extensive studies dealing with the effects of ankle weights on the standing broad jump performance of high school basketball players. Extensive studies have, however, been conducted concerning other types of weight training programs and their effect on the jumping ability of various basketball players.

In justifying a weight training program, Counsilman[1] attempted to disprove the "muscle-bound" theory by studying the agility and coordination of eighteen weight lifters at

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[1]J. E. Counsilman, "Does Weight Training Belong in the Program?" Journal of Health, Physical Education and Recreation, XXVI (January, 1955), pp. 17-18, 20.

Cortland State Teachers College. Counsilman administered such agility tests as the burpee, zigzag test, and the crisscross test to the weight lifters. The weight lifters were found to be above average in the three tests of flexibility. Counsilman further concluded that there was little evidence to show that weight training caused "muscle-boundness" or slowed the athlete. Instead, weight training seems to improve power, speed, and strength. From the view of the physiologist as well as the physical educator and coach, weight training has a place in the program.

Campbell[2] made a study at Wartburg College, Waverly, Iowa, to determine how weight training affected the physical fitness of athletic squads when it was used as a supplement to normal training during either the first half of the competitive season or during the second half. Campbell stated that the first half of training season, irrespective of training methods, appeared to be more effective for the improvement of physical fitness than did the second half. He also stated that in view of the losses suffered by the groups that dropped weight training after the first half, it would appear that weight training should be continued throughout the season, and that supplementing the normal conditioning program with weight training produces a significantly greater increase in physical fitness than does a normal conditioning program alone.

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[2]R. L. Campbell, "Effects of Supplemental Weight Training on the Physical Fitness of Athletic Squads", Research Quarterly, XXXIII (October, 1962), pp. 343-348.

Buehler[3] stated that some people who are afraid of weight lifting programs because of the "muscle-bound" possibility will be interested to know that several authorities state that such a possibility is now called the "muscle-bound myth". It is therefore impossible for a boy to become muscle-bound if he uses a joint to its full range of motion, uses antagonistic muscles in the same exercise period, and finishes the exercise period with a speed and endurance drill followed by a warm shower.

Calvin[4] conducted a prolonged study to determine the effect of a program of progressive resistive exercises in the form of weight training on the motor coordination of high school boys. An experimental group participated in weight training exercises for four months, while the control group participated in a regular physical education class. All subjects were administered tests of motor coordination in the pre- and post- experimental period.

At the conclusion of the experimental period a statistical analysis of the data indicated that the experimental group improved in motor coordination more significantly than did the control group.

Results of this study gave no indication that muscular development associated with weight training over a four month

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[3]D. W. Buehler, "Body Building," Athletic Journal, XXXX (February, 1960), p. 46.

[4]Sidney Calvin, "Effect of Progressive Resistance Exercises on the Motor Coordination of Boys", Research Quarterly, XXX (December, 1959), pp. 387-399.

period of time, had in any way a deleterious effect on the motor coordination of a group of boys ranging in age from fourteen to eighteen years.

In attempting to answer the question as to how much an athlete can improve his vertical jump, Burnham's[5] studies have shown that athletes have been able to improve as much as six to eight inches in their vertical jump. These improvements were made during heavy resistance exercise programs conducted over periods of various lengths. The programs were designed to include exercises for the development of strength in those muscles which are important in jumping.

Anderson[6] made a study on the effects of weighted ankle spats (three pounds on each shoe) on the jumping performance of ten high school basketball players for a period of seven weeks. It was concluded that those subjects using the weighted ankle spats showed a significant gain at the .05 level of confidence over the control group in the vertical jump test. The experimental group showed a mean increase of 1.37 inches in vertical jumping ability from the pre-test to the final test.

One of the most widely published weight training

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[5]Stan Burnham, "What to Expect from Weight Training", Athletic Journal, XXXXII (June, 1962), p. 30.

[6]Kenneth A. Anderson, "The Effect of the Weighted Ankle Spat on the Jumping Performance, Agility, and Endurance of High School Basketball Players", (Master's Thesis, Department of Physical Education, University of Wisconsin, 1961).

programs was that of Garth[7] used by the University of Iowa basketball team. It was found that through a systematic weight program a basketball player can increase his vertical jump from .75 of an inch to six inches. In this study an average increase of 2.7 inches occurred. Nineteen members of the University of Iowa basketball team worked with weights on Monday, Wednesday, and Friday prior to basketball practice. The program lasted for six weeks before the competitive season started. The subjects performed five weight training exercises during the experiment. They were tested once each week during the program by a Jump and Reach Test. As a result of this program, Iowa's six-foot seven inch center, Bill Logan, increased his vertical jump by more than six inches.

Brown and Riley[8] conducted a study on the effect of weight training on leg strength and vertical jump, using forty candidates for a college freshman basketball team as subjects. Two groups of twenty subjects each were equated on the basis of scores from the Roger's Physical Fitness Index. One group was subjected to a five week weight training program while the other acted as a control group. The weight training group met three days a week and was tested every Friday. The con-

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[7]Richard L. Garth, "A Study of the Effect of Weight Training on the Jumping Ability of Basketball Players," (Unpublished Master's Thesis, Department of Physical Education, University of Iowa, 1954), pp. 18-54.

[8]Robert J. Brown and Douglas R. Riley, "Effect of Weight Training on Leg Strength and Vertical Jump," Scholastic Coach, XXVII(December, 1957), pp. 44-47.

trol group was tested prior to and after the five week training program. The chalk variation of the Sargent Jump Test was used to measure vertical jump, while the belt method with the leg dynamometer was used to measure leg strength. After the five weeks, the weight training group showed mean increases of 2.9 inches in the vertical jump and 161 pounds in leg strength. The 2.9 inch increase showed a "t" of 8.7 which was significant beyond the .01 level of confidence.

In stressing the importance of physical fitness, Vanderburgh[9], the basketball coach at Fresno College, California, stated that physical fitness is a prime requisite for success in basketball. A team's fitness often makes the difference between a mediocre season and a good one, and it is often the determining factor in games between closely matched rivals. Vanderburgh regards resistance type exercises as being highly efficient conditioners of basketball players. Half squats, arm curls, and arm presses, along with jumping for height make an excellent program for basketball players.

One of the most complete studies in the area of weighted practice equipment was conducted by Lukas[10] at the University of Wisconsin. Eighteen members of the varsity or

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[9]W. G. Vanderburgh, "Physical and Psychological Conditioning for Competitive Basketball", Journal of Health, Physical Education and Recreation, XXVII (November, 1956), p. 42.

[10]D. Wayne Lukas, "The Effects of a Weighted Training Shoe on the Jumping Performance, Agility, Running Speed, and Endurance of College Basketball Players", (Unpublished Master's Thesis, Department of Physical Education, University of Wisconsin, 1960).

freshman basketball team served as subjects in this experiment. The subjects were assigned to one of three groups:

1. Control group, which took part in the testing procedure and had no training of any kind.

2. Regular shoe group, which took part in all training activities wearing regular basketball shoes and took part in all testing sessions.

3. Weighted shoe group, which took part in all training wearing weighted basketball shoes but wore regular shoes in all testing situations.

Two hour practice sessions were held five days a week for five weeks. Lukas concluded the study by making the following statements:

1. Although both the weighted shoe and regular shoe groups made greater gains than the control group, there was no significant difference between the three groups in the standing broad jump.

2. The gains in endurance made by the weighted shoe group were significantly greater than the gains made by the regular shoe group over the control group.

3. Although there was no significant difference, the weighted shoe group showed a mean increase in the thirty-yard-dash from the pre test to the final test which was greater than the gain made by the regular shoe group.

In a study pertaining to standing broad jump as well as vertical jump, Capen[11] discovered that after a period of

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[11]Edward K. Capen, "The Effect of Systematic Weight

twelve weeks of weight training by a group of college men, there was an increase of 13.1 per cent in the performance of the standing Sargent Jump. The author also found an increase of 10.3 per cent in the running Sargent Jump, and a gain of 6.0 per cent in the standing broad jump.

Summary of Review of Related Literature

By analyzing the related literature one may make a general hypothesis that weight training definitely increases jumping ability of high school basketball players. This statement is based upon the following conclusions drawn from the related literature.

1. Weight training programs and ankle weights help to develop jumping ability.

2. Weight training programs develop and increase leg strength.

3. Weight training does not cause "muscle-boundness" and slow muscular actions.

Training on Power, Strength, and Endurance", Research Quarterly, Vol. XXI, (May, 1950), p. 87.

CHAPTER II

METHODOLOGY

The Sample

The subjects used for this study were members of the varsity basketball team, junior varsity basketball team, and a physical education class at Rugby High School, Rugby, North Dakota. The varsity basketball team, or experimental group I, was made up of five seniors, five juniors, one sophomore, and one freshman. The junior varsity basketball team, or experimental group II, was made up of four juniors and eight sophomores. The physical education class, or control group, was made up of seven seniors and five juniors. The control group was selected by asking for twelve volunteers from a large physical education class. None of the boys in the control group were members of school athletic teams.

Training Activities

The training activities of experimental groups I and II were, for the major part, the same except that experimental group I wore the ankle weights. For all testing sessions, the ankle weights were removed. The control group participated only in the required physical education program.

The training program was carried out over a thirteen week period beginning on October 30, 1967 (the start of the basketball season) and extending until January 29, 1968. Because of a one week break at Christmas, the actual training program lasted twelve weeks.

The training sessions for both experimental groups were held in the Rugby Armory. Sessions lasted for two hours.

Experimental Group I practiced with the weights daily for four weeks until the first game of the season. After seasonal games began, the weights were used only on Monday, Tuesday, and Wednesday of each of the remaining eight training weeks.

Experimental Group II practiced Monday through Friday with no exceptions and played the same game schedule as did Experimental Group I.

Experimental Group I wore the ankle weights for the full two hour practice sessions. Training activities included wind sprints, running laps, spot running, jumping wall taps, various basketball drills, and regular scrimmage sessions.

Testing Procedure

All of the subjects were tested in the standing broad jump performance at the start of the experimental period, at the midpoint, and at the end of the thirteen weeks.

The standing broad jump test was administered by placing a graduated piece of tape on the armory floor. The subject toed a line at the start of the graduated tape line, and jumped forward from both feet. The measurement was taken from the take-off line to the nearest point touched by any part of the body. The best of three jumps was recorded.

1. Pre-test - This was administered to the three groups on October 30, 1967. All testing procedures were explained to the three groups. A warm-up period was allowed prior to the test trials.

2. Mid-test - This test was given in the same manner as the pre-test after six weeks of training on December 11, 1967.

3. The Final test was conducted on January 29, 1968, after the thirteenth week of the basketball season and the twelfth training week. The test was administered in the same manner as the previous two.

Statistical Procedure

The means of the three groups were calculated. It was necessary to test the significance of the difference between the means on the pre-test. This between-group comparison was necessary to determine whether the three groups could be considered comparable. The significance of the difference between the means was tested in a similar manner on the mid and final tests to determine whether any between-group differences of significance were present at those times.

This experimenter assumed the null hypothesis in analyzing the differences between means. That hypothesis asserts that there is no true difference between two population means, and that the difference found between the sample means is a chance difference and is accidental and unimportant.

For within-group comparison, investigation of several methods to test the null hypothesis indicated that the "t" technique for testing the significance of the difference between means derived from correlated scores from small samples was suitable for use in this study.[1]

To make between-group comparisons the "t" technique for testing the significance of the difference between uncorrelated means was used in this study. This test determines the ratio between the mean difference and the sampling error of the mean difference. This ratio is expressed as "t" and is checked for significance in a "t" table.[2]

For this study it was decided to retain the null hypothesis at the .01 level of confidence.

The standard deviation was calculated from the data by using the Short Method described by Garrett.[3]

The standard error of the mean was calculated using Garrett's formula for small samples.[4]

The reliability of the difference between two means for between-group comparison was computed by the formula for the standard error of the mean difference according to Clarke.[5]

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

[2]Henery E. Garrett, Statistics in Psychology and Education, (New York: Longmans, Green and Co., 1958), p. 449.

[3]Ibid., p. 53.

[4]Ibid., p. 191.

[5]H. Harrison Clarke, Application of Measurement to Health and Physical Education, (Englewood Cliffs, Prentice-Hall Inc., 1960), p. 449.

The small "t" was calculated according to Garrett's methods.[6] Tables were constructed, conclusions were drawn, and recommendations made in later chapters.

Complete analyzed data including raw scores, means, standard deviations, between-group comparisons, and within-group comparisons on the pre-test, mid-test and final test for all groups are presented in Appendices A through D.

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[6]Garrett, loc. cit., p. 191.

CHAPTER III

ANALYSIS OF DATA

This study was undertaken to determine whether there were any significant differences in jumping ability resulting from a basketball training program which employed ankle weights and one which did not. An equated Control Group was utilized for the purpose of controlling factors due to growth and maturation. This Control Group participated in a required program of activities not related to this study.

The following results were obtained by an analysis of the data collected in this study.

Between-Group Comparisons of the Pre-Test

To determine whether the groups could be considered comparable, the "t" technique for testing the significance of the difference between uncorrelated means was applied to the raw scores on the preliminary tests of jumping ability for the three groups.

On the pre-test the Control Group jumped a mean distance of 81.46 inches with a standard deviation of 6.95 inches. The mean distance for Experimental Group I on the pre-test was 87.20 inches with a standard deviation of 8.98 inches. The mean difference was 5.74 inches, and the standard error of the mean difference for these two groups was

3.29 inches. The "t" value was 1.74 which was not significant at the .01 level of confidence. The observed difference was considered to be due to chance, and the Control Group and Experimental Group I were considered comparable (see Table one, page 18).

Experimental Group II jumped a mean distance of 86.35 inches with a standard deviation of 7.12 inches. Comparing this with the Control Group, the difference between means was 4.89 inches and the standard error of the mean difference was 2.87 inches. The "t" value of 1.70 was not significant at the .01 level of confidence. The observed difference was considered to be due to chance, and the Control Group and Experimental Group II were considered comparable (see Table one, page 18).

A comparison on the pre-test for Experimental Groups I and II resulted in a mean difference of 0.85 inches. The standard error of the mean difference was 3.30 inches. The "t" value of 0.26 was not significant at the .01 level of confidence. The observed difference was considered to be due to chance, and Experimental Group I and Experimental Group II were considered to be comparable (see Table one, page 18).

As a result of the above findings, the three groups were believed to be statistically comparable at the start of the experimental period.

TABLE 1

BETWEEN-GROUP MEAN COMPARISONS OF PRE-TEST RESULTS

Group Means	Mean Difference (Between groups)	Standard Error	"t" value	Level of Confidence
Control Group 81.46 inches Experimental Group I 87.20 inches	5.74 inches	3.29	1.74	Not significant at .01 level
Control Group 81.46 inches Experimental Group II 86.35 inches	4.89 inches	2.87	1.70	Not significant at .01 level
Experimental Group I 87.20 inches Experimental Group II 86.35 inches	0.85 inches	3.30	0.26	Not significant at .01 level

Between-Group Comparisons of the Mid-test

On the mid-test the Control Group had a mean distance of 82.19 inches and a standard deviation of 6.50 inches. The mean for Experimental Group I (ankle weights) was 92.38 inches with a standard deviation of 6.61 inches. The standard error of the mean difference for these two groups was 2.85 inches. The "t" value of 3.57 was significant at the .01 level of confidence. The null hypothesis was rejected (see Table two, page 20).

Experimental Group II had a mean distance of 87.28 inches and a standard deviation of 6.56 inches. Comparing this with the Control Group, the standard error of the mean difference was 2.84 inches. The "t" value was 1.80 which was not significant at the .01 level of confidence. The null hypothesis was retained (see Table two, page 20).

A comparison on the mid-test for Experimental Group I and Experimental Group II resulted in a mean difference of 5.10 inches. The standard error of the mean difference was 2.69 inches. The "t" value of 1.89 was not significant at the .01 level of confidence. The null hypothesis was retained (see Table two, page 20).

As a result of the above, it was found that there was a significant amount of improvement made by Experimental Group I over the Control Group. It was also revealed that there was no significant difference between Experimental Group II and the Control Group or between Experimental Groups I and II on the mid-test.

TABLE 2

BETWEEN-GROUP MEAN COMPARISONS OF MID-TEST RESULTS

Group Means	Mean Difference (Between Groups)	Standard Error	"t" value	Level of Confidence
Control Group 82.19 inches Experimental Group I 92.38 inches	10.19 inches	2.85 inches	3.57	Significant at .01 level
Control Group 82.19 Experimental Group II 87.28 inches	5.09 inches	2.84 inches	1.80	Not significant at .01 level
Experimental Group I 92.38 Experimental Group II 87.28	5.10 inches	2.69 inches	1.89	Not significant at .01 level

Between-Group Comparisons on the Final Test

On the final test the Control Group had a mean distance of 83.44 inches and a standard deviation of 7.94 inches. The mean for Experimental Group I was 93.56 inches with a standard deviation of 5.96 inches. The standard error of the mean difference for these two groups was 2.87 inches. The "t" value of 3.53 was significant at the .01 level of confidence. The null hypothesis was rejected (see Table three, page 22).

Experimental Group II had a mean distance of 88.14 inches and a standard deviation of 6.85 inches. Comparing this with the Control Group, the standard error of the mean difference was 3.02 inches. The "t" value was 1.55 which was not significant at the .01 level of confidence. The null hypothesis was retained (see Table three, page 22).

A comparison on the final test for Experimental Group I and Experimental Group II resulted in a mean difference of 5.42 inches. The standard error of the mean difference was 2.62 inches. The "t" value of 2.07 was not significant at the .01 level of confidence. The null hypothesis was retained (see Table three, page 22).

As a result of the above, it was found that there was a significant amount of improvement made by Experimental Group I over the Control Group. It was also found that there was no significant difference between Experimental Group II and the Control Group or between Experimental Groups I and II on the final test.

TABLE 3

BETWEEN-GROUP MEAN COMPARISONS OF FINAL TEST RESULTS

Group Means	Mean Difference (Between Groups)	Standard Error	"t" value	Level of Confidence
Control Group 83.44 inches Experimental Group I 93.56 inches	10.12 inches	2.87 inches	3.53	Significant at .01 level
Control Group 83.44 inches Experimental Group II 88.14 inches	4.70 inches	3.02 inches	1.55	Not significant at .01 level
Experimental Group I 93.56 inches Experimental Group II 88.14 inches	5.42 inches	2.62 inches	2.07	Not significant at .01 level

Results of With-in Group Comparisons

The "t" technique for testing the significance of the difference between correlated means was applied to compare the pre-test data to the mid-test data, and also to compare the mid-test data to final test data for each group.

The Control Group had a mean difference of 0.73 inches between the pre-test and mid-test. The mean distance on the pre-test was 81.46 inches, and the mid-test mean was 82.19 inches. The estimate of sampling error of the mean difference was 0.35. This resulted in a "t" value of 2.08 which was not significant at the .01 level of confidence. The null hypothesis was retained (see Table four, page 25).

Experimental Group I had a mean distance of 87.20 inches on the pre-test and a mean of 92.38 inches on the mid-test, resulting in a mean difference of 5.18 inches. The estimate of sampling error of the mean difference was 1.38, which resulted in "t" value of 3.83. This was significant at the .01 level and the null hypothesis was rejected (see Table four, page 25).

Experimental Group II had a mean distance of 86.35 inches on the pre-test and a mean distance of 87.28 inches on the mid-test, which resulted in a mean difference of 0.93 inches. The estimate of sampling error of the mean difference was 0.67. This resulted in a "t" value of 1.89 which was not significant at the .01 level of confidence. The null hypothesis was retained (see Table four, page 25).

The "t" technique for testing the significance of the difference between the means indicated that only Experimental Group I had increased significantly at the .01 level of confidence after six weeks of this study were completed.

In comparing the mid-test data to the final test data, it was found that the Control Group had a mean difference of 1.25 inches between the mid-test and the final test. The mean distance on the mid-test was 82.19 inches, and the final test mean was 83.44 inches. The estimate of the sampling error of the mean difference was 0.56. This resulted in a "t" value of 2.23 which was not significant at the .01 level of confidence. The null hypothesis was retained (see Table five, page 26).

Experimental Group I had a mean distance of 92.56 inches on the mid-test and a mean distance of 93.56 inches on the final test, resulting in a mean difference of 1.18 inches. The estimate of sampling error of the mean difference was 0.78, which resulted in a "t" value of 1.51. This was not significant at the .01 level of confidence. The null hypothesis was retained (see Table five, page 26).

Experimental Group II had a mean distance of 87.28 inches on the mid-test and a mean distance of 88.14 inches on the final test which resulted in a mean difference of 0.86 inches. The estimate of sampling error of the mean difference was 0.58. This resulted in a "t" value of 1.40 which was not significant at the .01 level of confidence. The null hypothesis was retained (see Table five, page 26).

The "t" technique for testing the significance of the difference between the means indicated that none of the three groups made a significant amount of improvement during the period between the mid and final tests.

TABLE 4

WITH-IN GROUP MEAN COMPARISONS ON
THE PRE-TEST AND MID-TEST

Group	Mean Difference (Pre-Test Mid-Test)	Standard Error	"t" Value	Level of Significance
Control Group	0.73 inches	0.35	2.08	Not significant at .01 level
Experimental Group I	5.18 inches	1.38	3.83	Significant at .01 level
Experimental Group II	0.93 inches	0.67	1.89	Not significant at .01 level

TABLE 5

WITH-IN GROUP MEAN COMPARISONS ON
THE MID-TEST AND FINAL TEST

Group	Mean Difference (Mid-Test Final Test)	Standard Error	"t" Value	Level of Significance
Control Group	1.25 inches	0.56	2.23	Not Significant at .01 level
Experimental Group I	1.18 inches	0.78	1.51	Not Significant at .01 level
Experimental Group II	0.86 inches	0.58	1.40	Not Significant at .01 level

CHAPTER IV

DISCUSSION

The purpose of this study was to determine what effects the use of ankle weights would have on standing broad jumping performance of selected high school basketball players.

The placing of subjects into the three groups could not be completely controlled. Though not as comparable as might be desired, group mean performances on the pre-test were not significantly different at the .01 level of confidence at the start of the experiment.

In discussing the results, it should be noted that the three groups involved in this study were under the supervision of different persons. This writer coached the varsity basketball team, an assistant coach handled the junior varsity basketball team, and a physical educator was in charge of the Control Group. The motivational level of the subjects may have been different due to this circumstance. The three groups were tested by this writer.

There is a possibility that the one week layoff at Christmas may have had an effect on the amount of improvement that Groups I and II made. During vacation the writer had no knowledge of the activities that the thirty-six subjects may have participated in. The week layoff came between the seventh and eighth training weeks. It came during the last half of the training period when improvement was not as great as during the first half. It may be advisable to plan experimental periods that are not abridged by school vacations.

The mean of the Control Group on the pre-test was the lowest of the three groups. This was due, in part, to one subject who jumped 63.50 inches. More careful screening of Control Group subjects could have prevented this. Also, extra subjects could have been included in the Control Group for use in balancing jumping ability between groups at the start of the experiment.

In making between-group mean comparisons on the mid-test, Group I improved over both other groups, but only the improvement of Group I over the Control Group was significant at the .01 level of confidence. On the final test, none of the three groups improved significantly at the .01 level of confidence. It appears that little can be gained in the way of jumping improvement after the first six weeks of training.

Each of the three groups showed with-in mean improvement in jumping performance during the first six weeks of the study. Only the improvement of the ankle weight group was significant at the .01 level of confidence. This group showed a mean improvement of 5.18 inches per subject. The amount of improvement was limited by one subject who showed a loss of 1.50 inches during this period of time. The less physically developed subjects made the greatest amount of improvement. The greatest gain was by a six foot three inch, 145 pound player who improved his jumping performance fifteen inches. The more physically mature subjects made little improvement. There were five subjects that seemed to fall in this category and their differences from pre- to mid-test ranged from -1.50 to 2.50 inches.

The with-in group improvement of the junior varsity is partly accounted for by subject one, a six foot, 135 pound player lacking in coordination, who increased his jumping performance by seven inches from pre- to mid-test.

The three groups showed with-in mean improvement in jumping performance during the last seven weeks of the study but none of the increases were significant at the .01 level of confidence.

This study seems to be consistent with results of maturation studies, which indicate that development is greatest during the first part of training periods, then tapers off.

In the writer's opinion, there was considerable merit in the use of the ankle weights. The subjects experimental group I believed that the use of the weights was improving their jumping performance. They also were very much interested in the progress made from pre-to final test.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

In this study, twelve varsity basketball players, twelve junior varsity basketball players and twelve physical education students from Rugby High School served as subjects. The varsity and junior varsity players participated in a similar training program with the only difference being the use of two and one-half pound ankle weights by the varsity. The Control Group took part in the testing phase of the study but did not participate in any type of organized activities other than physical education classes.

Each group was tested at the start of the experimental period, after six weeks of training and at the end of the twelfth training week. The test was in standing broad jumping performance and was measured to the nearest one-fourth inch. In each of the tests subjects were given three jumps. The best of the three trials was recorded.

Comparisons were made between the means within each group on the pre-, mid-, and final tests. The significance of the difference between means within each group was determined by the "t" technique for testing the significance of the difference between means derived from correlated scores from small samples.

Comparisons were also made between the three groups by testing the significance of the differences between the group means found on the pre-, mid-, and final tests. The "t" technique was used for between group comparisons of uncorrelated scores from small samples.

The following results were obtained:

1. Experimental Group I showed significant improvement over the Control Group at the .01 level of confidence on the mid- and final tests.

2. Experimental Group I (Varsity with ankle weights) did not improve significantly at the .01 level of confidence over Experimental Group II (Junior Varsity without ankle weights) during the first half of the experimental period but there was more improvement in jumping performance on the part of Experimental Group I.

3. Experimental Group I had not improved significantly at the .01 level of confidence over the other two groups by the end of the experimental period.

4. Experimental Group I showed significant with-in group improvement at the .01 level of confidence during the first six weeks of the experimental period but not during the last six weeks.

Conclusion

The results indicate that the use of ankle weights can result in a significant amount of improvement in jumping performance at the .01 level of confidence during the first six weeks of training, and that there may be little value in continuing to use them after this time.

Recommendations

1. It is recommended that a study be conducted to determine the psychological effects of using ankle weights.

2. It is recommended that in studies of this type, the matched-pair technique be used for selecting subjects.

3. It is recommended that a study be made to determine what benefits can be gained by using ankle weights other than improving jumping performance.

4. It is recommended that a study be designed to determine the effect of ankle weights on vertical jumping performance of high school basketball players.

5. It is recommended that a study be conducted using ankle weights proportional to body weight to determine what weight is best suited for increasing jumping performance.

6. It is recommended that a similar experiment should be undertaken using a larger number of subjects.

7. It is recommended that similar studies be arranged so they will not be abridged by school vacation periods.

APPENDIX A

THE BEST STANDING BROAD JUMP FOR
EXPERIMENTAL GROUP I ON
THE PRE-TEST

Subject	Best Jump inches
1	75.50
2	75.50
3.	77.75
4	81.75
5	84.00
6	85.00
7	85.50
8	86.00
9	95.00
10	97.25
11	97.75
12	104.00
Group Mean	87.20

THE BEST STANDING BROAD JUMP FOR
EXPERIMENTAL GROUP I ON
THE MID-TEST

Subject	Best Jump inches
1	84.25
2	90.50
3	85.00
4	90.00
5	86.00
6	93.75
7	84.00
8	93.25
9	100.00
10	97.50
11	100.25
12	104.00
Group Mean	92.38

THE BEST STANDING BROAD JUMP FOR
EXPERIMENTAL GROUP I ON
THE FINAL TEST

Subject	Best Jump inches
1	85.00
2	95.00
3	85.50
4	91.00
5	88.75
6	91.00
7	90.50
8	93.00
9	97.00
10	100.00
11	101.00
12	105.00
Group Mean	93.56

THE BEST STANDING BROAD JUMP FOR
EXPERIMENTAL GROUP II
ON THE PRE-TEST

Subject	Best Jump inches
1	73.00
2	77.00
3	82.00
4	82.25
5	83.50
6	86.25
7	87.50
8	87.75
9	88.50
10	95.00
11	96.50
12	97.00
Group Mean	86.35

THE BEST STANDING BROAD JUMP FOR
EXPERIMENTAL GROUP II
ON THE MID-TEST

Subject	Best Jump inches
1	80.00
2	77.50
3	82.00
4	82.00
5	82.50
6	85.00
7	91.00
8	88.00
9	90.00
10	98.00
11	94.50
12	97.00
Group Mean	87.28

THE BEST STANDING BROAD JUMP FOR
. EXPERIMENTAL GROUP II
ON THE FINAL TEST

Subject	Best Jump inches
1	81.00
2	77.00
3	81.00
4	84.00
5	84.50
6	90.00
7	89.00
8	89.00
9	88.00
10	100.50
11	95.00
12	98.25
Group Mean	88.14

THE BEST STANDING BROAD JUMP FOR
THE CONTROL GROUP ON
THE PRE-TEST

Subject	Best Jump inches
1	63.50
2	76.00
3	76.50
4	78.00
5	82.00
6	83.75
7	83.75
8	84.00
9	86.00
10	86.00
11	86.00
12	92.00
Group Mean	81.46

THE BEST STANDING BROAD JUMP FOR
THE CONTROL GROUP ON
THE MID-TEST

Subject	Best Jump inches
1	65.00
2	77.50
3	78.00
4	80.50
5	81.00
6	86.00
7	84.00
8	83.00
9	85.50
10	87.50
11	86.50
12	91.75
Group Mean	82.19

THE BEST STANDING BROAD JUMP FOR
THE CONTROL GROUP ON
THE FINAL TEST

Subject	Best Jump inches
1	66.00
2	82.00
3	82.00
4	82.00
5	83.25
6	87.00
7	83.25
8	84.75
9	83.25
10	89.75
11	86.00
12	92.00
Group Mean	83.44

APPENDIX B

DATA FOR EQUATING EXPERIMENTAL GROUP I

Subject	Pre-Test		Mid-Test		Final Test	
	X	X^2	X	X^2	X	X^2
1	75.50	5700.25	84.25	7098.06	85.00	7225.00
2	75.50	5700.25	90.50	8190.25	95.00	9025.00
3	77.75	6045.06	85.00	7225.00	85.50	7310.25
4	81.75	6683.06	90.00	8100.00	91.00	8281.00
5	84.00	7056.00	86.00	7396.00	88.75	7876.56
6	85.00	7225.00	93.75	8789.06	91.00	8281.00
7	85.50	7310.25	84.00	7056.00	90.50	8190.25
8	86.00	7396.00	93.25	8695.56	93.00	8649.00
9	95.00	9025.00	100.00	10000.00	97.00	9409.00
10	97.25	9457.56	97.50	9506.25	100.00	10000.00
11	97.75	9555.06	100.25	10050.07	101.00	10201.00
12	104.00	10816.00	104.00	10816.00	105.00	11025.00
ΣX	1049.00		1108.50		1122.75	
ΣX^2		91969.49		102922.25		105473.00

THE STANDARD DEVIATION AND STANDARD ERROR
OF THE MEAN ON THE PRE-TEST
FOR EXPERIMENTAL GROUP I

$N = 12$

$\Sigma X = 1045.00$

$\Sigma X^2 = 91969.49$

$$\sigma = \sqrt{\frac{N\Sigma X^2 - (\Sigma X)^2}{N}}$$

$$= \sqrt{\frac{12.9196949 - (1045.00)^2}{12}}$$

$$= \sqrt{\frac{11,608.88}{12}}$$

$$= \frac{107.75}{12}$$

$$= 8.98$$

$$= 8.98$$

$$S.E._m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{8.98}{\sqrt{12}}$$

$$= \frac{8.98}{3.46}$$

$$= 2.60$$

THE STANDARD DEVIATION AND STANDARD ERROR
OF THE MEAN ON THE MID-TEST
FOR EXPERIMENTAL GROUP I

$N = 12$

$\sum X = 1108.50$

$\sum X^2 = 102922.25$

$$\sigma = \sqrt{\frac{N \sum X^2 - (\sum X)^2}{N}}$$

$$= \sqrt{\frac{12 \cdot 102922.25 - (1108.50)^2}{12}}$$

$$= \sqrt{\frac{1,235,067.00 - 1,228,772.25}{12}}$$

$$= \sqrt{\frac{6294.75}{12}}$$

$$= \frac{79.34}{12}$$

$$= 6.61$$

$$\sigma = 6.61$$

$$S.E._m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{6.61}{\sqrt{12}}$$

$$= \frac{6.61}{3.46}$$

$$= 1.91$$

THE STANDARD DEVIATION AND STANDARD ERROR OF THE MEAN OF FINAL TEST FOR EXPERIMENTAL GROUP I

$N = 12$

$\Sigma X = 1122.75$

$\Sigma X^2 = 105473.06$

$$\sigma = \sqrt{\frac{N\Sigma X^2 - (\Sigma X)^2}{N}}$$

$$= \sqrt{\frac{12.105473.06 - (1122.75)^2}{12}}$$

$$= \sqrt{1,265,676.72 - 1,260,567.56}$$

$$= \sqrt{\frac{5109.16}{12}}$$

$$= \frac{71.48}{12}$$

$$= 5.96$$

$$= 5.96$$

$$S.E_m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{5.96}{\sqrt{12}}$$

$$= \frac{5.96}{3.46}$$

$$= 1.73$$

DATA FOR EQUATING EXPERIMENTAL GROUP II

Subject	Pre-Test		Mid-Test		Final Test	
	X	X^2	X	X^2	X	X^2
1	73.00	5329.00	80.00	6400.00	81.00	6561.00
2	77.00	5929.00	77.50	6006.25	77.00	5929.00
3	82.00	6724.00	82.00	6724.00	81.00	6561.00
4	82.25	6765.06	82.00	6724.00	84.00	7056.00
5	83.50	6972.25	82.50	6806.25	84.50	7140.25
6	86.25	7439.06	85.00	7225.00	90.00	8100.00
7	87.50	7656.25	91.00	8281.00	89.00	7921.00
8	87.75	7700.06	88.00	7744.00	89.00	7921.00
9	88.50	7832.25	90.00	8100.00	88.00	7744.00
10	95.00	9025.00	98.00	9604.00	100.50	10100.25
11	96.50	9312.25	94.50	8930.25	95.00	9025.00
12	97.00	9409.00	97.00	9409.00	98.25	9653.06
ΣX	1036.25		1047.50		1057.25	
ΣX^2		90093.18		91953.75		93711.56

THE STANDARD DEVIATION AND STANDARD ERROR OF THE MEAN ON THE PRE-TEST FOR EXPERIMENTAL GROUP II

$N = 12$

$\Sigma X = 1036.25$

$\Sigma X^2 = 90093.18$

$$\sigma = \sqrt{\frac{N\Sigma X^2 - (\Sigma X)^2}{N}}$$

$$= \sqrt{\frac{12 \cdot 90093.19 - (1036.25)^2}{12}}$$

$$= \sqrt{\frac{1,081,118.16 - 1,073,814.06}{12}}$$

$$= \sqrt{\frac{7304.10}{12}}$$

$$= \frac{85.44}{12}$$

$$= 7.12$$

$$S.E._m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{7.12}{\sqrt{12}}$$

$$= \frac{7.12}{3.46}$$

$$= 2.05$$

THE STANDARD DEVIATION AND STANDARD ERROR OF THE MEAN ON THE MID-TEST FOR EXPERIMENTAL GROUP II

$N = 12$

$\Sigma X = 1047.50$

$\Sigma X^2 = 91953.75$

$$\sigma = \sqrt{\frac{N\Sigma X^2 - (\Sigma X)^2}{12}}$$

$$= \sqrt{\frac{12 \cdot 91953.75 - (1047.50)^2}{12}}$$

$$= \sqrt{1,103,445.00 - 1,098,256.25}$$

$$= \sqrt{\frac{6188.\ 75}{12}}$$

$$= \frac{78.67}{12}$$

$$= 6.56$$

$$= 6.56$$

$$S.E._m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{6.56}{\sqrt{12}}$$

$$= \frac{6.56}{3.46}$$

$$= 1.89$$

THE STANDARD DEVIATION AND STANDARD ERROR OF THE MEAN ON THE FINAL TEST FOR EXPERIMENTAL GROUP II

$N = 12$

$\Sigma X = 1057.25$

$\Sigma X^2 = 93711.56$

$$\sigma = \sqrt{\frac{N\Sigma X^2 - (\Sigma X)^2}{N}}$$

$$= \sqrt{\frac{12 \cdot 93711.56 - (1057.25)^2}{12}}$$

$$= \sqrt{1,124,538.72 - 1,117,777.56}$$

$$= \sqrt{\frac{6761.16}{12}}$$

$$= \frac{82.22}{12}$$

$$\doteq 6.85$$

$$S.E._m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{6.85}{\sqrt{12}}$$

$$= \frac{6.85}{3.46}$$

$$= 1.97$$

DATA FOR EQUATING THE CONTROL GROUP

Subject	Pre-Test		Mid-Test		Final Test	
	X	X^2	X	X^2	X	X^2
1	63.50	4032.25	65.00	4225.00	66.00	4356.00
2	76.00	5776.00	77.50	6006.25	82.00	6724.00
3	76.50	5852.25	78.00	6084.00	82.00	6724.00
4	78.00	6084.00	80.50	6480.25	82.00	6724.00
5	82.00	6724.00	81.00	6561.00	83.25	6930.56
6	83.75	7014.06	86.00	7396.00	87.00	7569.00
7	83.75	7014.06	84.00	7056.00	83.25	6930.56
8	84.00	7056.00	83.00	6889.00	84.75	7182.56
9	86.00	7396.00	85.50	7310.25	83.25	6930.56
10	86.00	7396.00	87.50	7656.25	89.75	8055.06
11	86.00	7396.00	86.50	7482.25	86.00	7396.00
12	92.00	8464.00	91.75	8418.06	92.00	8464.00
ΣX	977.50		986.25		1001.25	
ΣX^2		80204.62		81564.31		83986.30

CONTROL GROUP STANDARD DEVIATION AND
STANDARD ERROR OF THE MEAN ON THE PRE-TEST

$N = 12$

$\Sigma X = 977.50$

$\Sigma X^2 = 80204.62$

$$\sigma = \sqrt{\frac{N\Sigma X^2 - (\Sigma X)^2}{N}}$$

$$= \sqrt{\frac{12 \cdot 80204.62 - (977.50)^2}{12}}$$

$$= \sqrt{\frac{962455.44 - 955506.25}{12}}$$

$$= \sqrt{\frac{6949.19}{12}}$$

$$= \frac{83.36}{12}$$

$$= 6.95$$

$$= 6.95$$

$$S.E._m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{6.95}{\sqrt{12}}$$

$$= \frac{6.95}{3.46}$$

$$= 2.01$$

CONTROL GROUP STANDARD DEVIATION AND
STANDARD ERROR OF THE MEAN ON THE MID-TEST

N = 12

$\Sigma X = 986.25$

$\Sigma X^2 = 81564.31$

$$\sigma = \sqrt{\frac{N\Sigma X^2 \cdot (\Sigma X)^2}{N}}$$

$$= \sqrt{\frac{12 \cdot 81564.31 - (986.25)^2}{12}}$$

$$= \sqrt{\frac{97.8771.72 - 97.2689.06}{12}}$$

$$= \sqrt{\frac{6082.66}{12}}$$

$$= \frac{77.99}{12}$$

$= 6.50$

$= 6.50$

$$S.E._m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{6.50}{\sqrt{12}}$$

$$= \frac{6.50}{3.46}$$

$= 2.12$

CONTROL GROUP STANDARD DEVIATION AND
STANDARD ERROR OF THE MEAN ON THE FINAL TEST

$$N = 12$$

$$\Sigma X = 1001.25$$

$$\Sigma X^2 = 83986.30$$

$$\sigma = \sqrt{\frac{N \Sigma X^2 - (\Sigma X)^2}{N}}$$

$$= \sqrt{\frac{12 \cdot 83986.30 - (1001.25)^2}{12}}$$

$$= \sqrt{\frac{1007835.60 - 100250.16}{12}}$$

$$= \sqrt{907585.44}$$

$$= \frac{95.26}{12}$$

$$= 7.94$$

$$= 7.94$$

$$S.E._m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{7.94}{\sqrt{12}}$$

$$= \frac{7.94}{3.46}$$

$$= 2.29$$

APPENDIX C

BETWEEN-GROUP COMPARISON ON THE PRE-TEST ON THE CONTROL GROUP AND EXPERIMENTAL GROUP I

$$S.E._d = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(2.01)^2 + (2.60)^2}$$

$$= \sqrt{4.04 + 6.76}$$

$$= \sqrt{10.80}$$

$$= 3.29$$

$d = m_1 - m_2 = 81.46 - 87.20 = 5.74$

$"t" = \frac{d}{S.E_d} = \frac{5.74}{3.29} = 1.74$

$df = (n - 1) + (n_2 - 1)$

$= (12 - 1) + (12 - 1)$

$= 22$

"t" at .01 level = 2.819

Not significant at the .01 level

BETWEEN GROUP COMPARISON ON THE PRE-TEST OF THE CONTROL GROUP AND EXPERIMENTAL GROUP II

$$S.E. = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(2.01)^2 + (2.05)^2}$$

$$= \sqrt{4.04 + 4.20}$$

$$= \sqrt{8.24}$$

$$= 2.87$$

$$d = m_1 - m_2 = 81.46 - 86.35 = 4.89$$

$$\text{"t"} = \frac{d}{S.E_d} = \frac{4.89}{2.87} = 1.70$$

$$df = (N - 1) + (N_2 - 1)$$

$$= 22$$

Not significant at .01 level

"t" at .01 level = 2.819

BETWEEN GROUP COMPARISON ON THE PRE-TEST OF EXPERIMENTAL GROUP I AND EXPERIMENTAL GROUP II

$$S.E. = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(2.60)^2 + (2.05)^2}$$

$$= \sqrt{6.76 + 4.20}$$

$$= \sqrt{10.96}$$

$$= 3.30$$

$$d = m_1 - m_2 = 87.20 - 86.35 = 0.85$$

$$\text{"t"} = \frac{d}{S.E._d} = \frac{0.85}{3.30} = 0.26$$

$$df = (N - 1) + (N_2 - 1)$$

$$= (12 - 1) + (12 - 1)$$

$$= 22$$

"t" at .01 level = 2.819

Not significant at .01 level

BETWEEN GROUP COMPARISON ON THE MID-TEST OF THE CONTROL GROUP AND EXPERIMENTAL GROUP I

$$S.E. = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(2.12)^2 + (1.91)^2}$$

$$= \sqrt{4.49 + 3.65}$$

$$= \sqrt{8.14}$$

$$= 2.85$$

$d = m_1 - m_2 \quad 82.19 - 92.38 = 10.19$

$"t" = \frac{d}{S.E._d} = \frac{10.19}{2.85} = 3.57$

$df = (N - 1) + (N_2 - 1)$

$= (12 - 1) + (12 - 1)$

$= 22$

Significant at the .01 level

"t" at .01 level = 2.819

BETWEEN GROUP COMPARISON ON THE MID-TEST OF THE CONTROL GROUP AND EXPERIMENTAL GROUP II

$$S.E. = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(2.12)^2 + (1.89)^2}$$

$$= \sqrt{4.49 + 3.57}$$

$$= \sqrt{8.06}$$

$$= 2.84$$

$$d = m_1 - m_2 = 82.19 - 87.28 = 5.09$$

$$"t" = \frac{d}{S.E._d} = \frac{5.09}{2.84} = 1.80$$

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

$$= (12 - 1) + (12 - 1)$$

$$= 22$$

"t" at .01 level = 2.819

Not significant at the .01 level

BETWEEN GROUP COMPARISON ON THE MID-TEST OF EXPERIMENTAL GROUP I AND EXPERIMENTAL GROUP II

$$S.E. = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(1.91)^2 + (1.89)^2}$$

$$= \sqrt{3.65 + 3.57}$$

$$= \sqrt{7.22}$$

$$= 2.69$$

$$d = m_1 - m_2 \quad 92.38 - 87.28 = 5.10$$

$$"t" = \frac{d}{S.E._d} = \frac{5.10}{2.69} = 1.89$$

$$df = (n-1) + (n-1)$$

$$= (12 - 1) + (12 - 1)$$

$$= 22$$

"t" at .01 level = 2.819
Not significant at the .01 level

BETWEEN GROUP COMPARISON ON THE FINAL TEST OF THE CONTROL GROUP AND EXPERIMENTAL GROUP I

$$S.E. = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(2.29)^2 + (1.73)^2}$$

$$= \sqrt{5.24 + 2.99}$$

$$= \sqrt{8.23}$$

$$= 2.87$$

$$d = m_1 - m_2 \quad 83.44 - 93.56 = 10.12$$

$$"t" = \frac{d}{S.E._d} = \frac{10.12}{2.87} = 3.53$$

$$df = (n - 1) + (n_2 - 1)$$

$$= (12 - 1) + (12 - 1)$$

$$= 22$$

"t" at .01 level = 2.819

Significant at .01 level

BETWEEN GROUP COMPARISON ON THE FINAL TEST OF THE CONTROL GROUP AND EXPERIMENTAL GROUP II

$$S.E. = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(2.29)^2 + (1.97)^2}$$

$$= \sqrt{5.24 + 3.88}$$

$$= \sqrt{9.12}$$

$$= 3.02$$

$$d = m_1 - m_2 \quad 83.44 - 88.14 = 4.70$$

$$"t" = \frac{d}{S.E._d} = \frac{4.70}{3.02} = 1.55$$

$$df = (n - 1) + (n_2 - 1)$$

$$= (12 - 1) + (12 - 1)$$

$$= 22$$

"t" at .01 level = 2.819

Not significant at .01 level

BETWEEN GROUP COMPARISON ON THE FINAL TEST OF EXPERIMENTAL GROUP I AND EXPERIMENTAL GROUP II

$$S.E. = \sqrt{(S.E._{m_1})^2 + (S.E._{m_2})^2}$$

$$= \sqrt{(1.73)^2 + (1.97)^2}$$

$$= \sqrt{2.99 + 3.88}$$

$$= \sqrt{6.87}$$

$$= 2.62$$

$$d = m_1 - m_2 \quad 93.56 - 88.14 = 5.42$$

$$\text{"t"} = \frac{d}{S.E._d} = \frac{5.42}{2.62} = 2.07$$

$$df = (n - 1) + (n_2 - 1)$$

$$= (12 - 1) + (12 - 1)$$

$$= 22$$

"t" at .01 level = 2.819

Not significant at .01 level

APPENDIX D

COMPARISON OF EXPERIMENTAL GROUP I
PRE-TEST AND MID-TEST

Subject	Pre-Test	Mid-Test	D	D^2
1	75.50	84.25	8.75	76.56
2	75.50	90.50	15.00	225.00
3	77.75	85.00	7.25	52.56
4	81.75	90.00	8.25	68.06
5	84.00	86.00	2.00	4.00
6	85.00	93.75	8.75	76.56
7	85.50	84.00	-1.50	2.25
8	86.00	93.25	7.25	52.56
9	95.00	100.00	5.00	25.00
10	97.25	97.50	0.25	0.06
11	97.75	100.25	2.50	6.25
12	104.00	104.00	0.00	0.00

$\Sigma D = \underline{63.50}$ $\Sigma D^2 = \underline{588.86}$

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES FOR EXPERIMENTAL GROUP I (PRE-TEST AND MID-TEST)

$N = 12$

$\Sigma D = 63.50$

$\Sigma D^2 = 588.66$

$S_{\bar{D}}$ estimate of sampling error of $\bar{D} = \dfrac{S_D}{\sqrt{N}} = \dfrac{\sqrt{\dfrac{D^2 - \dfrac{(D)^2}{N}}{N - 1}}}{\sqrt{N}}$

$$= \frac{\sqrt{\dfrac{588.86 - \dfrac{4032.25}{12}}{11}}}{3.46}$$

$$= 588.86 - 336.02 = \frac{252.84}{11} = 22.99$$

$$= \sqrt{23.46} = 4.79$$

$$S_{\bar{D}} = \frac{4.79}{3.46} = 1.38$$

$$\bar{D} = \text{(mean difference)} = \frac{63.50}{12} = 5.29$$

$$\text{"t"} = \frac{\bar{D}\ \text{(mean difference)}}{S_{\bar{D}}\ \text{(estimate of sampling error of } \bar{D}\text{)}} = \frac{5.29}{1.38} = 3.83$$

Significant at .01 level

"t" at .01 level = 3.055

COMPARISON OF EXPERIMENTAL GROUP II
PRE-TEST AND MID-TEST

Subject	Pre-Test	Mid-Test	D	D^2
1	73.00	80.00	7.00	49.00
2	77.00	77.50	0.50	0.25
3	82.00	82.00	0.00	0.00
4	82.25	82.00	-0.25	0.06
5	83.50	82.50	-1.00	1.00
6	86.25	85.00	-1.25	1.56
7	87.50	91.00	3.50	12.25
8	87.75	88.00	0.25	0.06
9	88.50	90.00	1.50	2.25
10	95.00	98.00	3.00	9.00
11	96.50	94.50	2.00	4.00
12	97.00	97.00	0.00	0.00

$\Sigma D = \underline{15.25}$ $\Sigma D^2 = \underline{79.43}$

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES FOR EXPERIMENTAL GROUP II (PRE-TEST AND MID-TEST)

$N = 12$

$\Sigma D = 15.25$

$\Sigma D^2 = 79.43$

$S_{\bar{D}}$ estimate of sampling error of $\bar{D} = \dfrac{S_D}{\sqrt{N}} = \dfrac{\sqrt{\dfrac{D^2 - \dfrac{(D)^2}{N}}{N - 1}}}{\sqrt{N}}$

$$= \frac{\sqrt{\dfrac{79.43 - \dfrac{232.56}{12}}{11}}}{3.46}$$

$$= \frac{79.43 - 19.38}{11} = \frac{60.06}{11} = 5.45$$

$$S_{\bar{D}} = \sqrt{5.45} = \frac{2.33}{3.46} = .67$$

$$\bar{D} = \frac{\text{(Mean difference)}}{S_{\bar{D}} \text{ (estimate of sampling error of } \bar{D}} = \frac{1.27}{.67} = 1.89$$

Not significant at .01 level

COMPARISON OF THE CONTROL GROUP
PRE-TEST AND MID-TEST

Subject	Pre-Test	Mid-Test	D	D^2
1	63.50	65.00	1.50	2.25
2	76.00	77.50	1.50	2.25
3	76.50	78.00	1.50	2.25
4	78.00	80.50	2.50	6.25
5	82.00	81.00	-1.00	1.00
6	83.75	86.00	2.25	5.06
7	83.75	84.00	0.25	0.06
8	84.00	83.00	-1.00	1.00
9	86.00	85.50	-0.50	0.25
10	86.00	87.50	1.50	2.25
11	86.00	86.50	0.50	0.25
12	92.00	91.75	-0.25	0.06

$\Sigma D = \underline{8.75}$ $\Sigma D^2 = \underline{22.93}$

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES FOR THE CONTROL GROUP
(PRE-TEST AND MID-TEST)

$N = 12$

$\Sigma D = 8.75$

$\Sigma D^2 = 22.93$

$S_{\bar{D}}$ estimate of sampling error of $\bar{D} = \dfrac{S_D}{\sqrt{N}} = \dfrac{\sqrt{\dfrac{D^2 - \dfrac{(D)^2}{N}}{N - 1}}}{\sqrt{N}}$

$$= \frac{\sqrt{\dfrac{22.93 - \dfrac{76.56}{12}}{11}}}{3.46}$$

$= 22.93 - 6.38 = 16.55$

$= \dfrac{16.55}{11} = 1.50$

$\sqrt{1.50} = 1.23$

$S_{\bar{D}} = \dfrac{1.23}{3.46} = 0.35$

$\bar{D}$ = (Mean difference) $= \dfrac{8.75}{12} = .729$

"t" $= \dfrac{\bar{D}\text{ (mean difference)}}{S_{\bar{D}}\text{ (Estimate of sampling error of }\bar{D})} = \dfrac{.729}{.32} = 2.08$

Not significant at .01 level

COMPARISON OF EXPERIMENTAL GROUP I
MID-TEST AND FINAL TEST

Subject	Mid-Test	Final Test	D	D^2
1	84.25	85.00	0.75	0.56
2	90.50	95.00	4.50	20.25
3	85.00	85.50	0.50	0.25
4	90.00	91.00	1.00	1.00
5	86.00	88.75	2.75	7.56
6	93.75	91.00	-2.75	7.56
7	84.00	90.50	6.50	42.25
8	93.25	93.00	-0.25	0.06
9	100.00	97.00	-3.00	9.00
10	97.50	100.00	2.50	6.25
11	100.25	101.00	0.75	0.56
12	104.00	105.00	1.00	1.00

$\Sigma D = \underline{14.25}$ $\Sigma D^2 = \underline{96.30}$

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES FOR EXPERIMENTAL GROUP I (MID-TEST AND FINAL TEST)

$N = 12$

$\Sigma D = 14.25$

$\Sigma D^2 = 96.30$

$S_{\bar{D}}$ estimate of sampling error of $\bar{D}$ $= \dfrac{S_D}{\sqrt{N}} = \dfrac{\sqrt{\dfrac{D^2 - \dfrac{(D)^2}{N}}{N - 1}}}{\sqrt{N}}$

$$= \frac{\sqrt{\dfrac{96.30 - \dfrac{203.06}{12}}{11}}}{3.46}$$

$$= \frac{96.30 - 16.92}{11} = \frac{79.38}{11} = 7.22$$

$S_{\bar{D}}$ $\sqrt{7.22}$ $= \dfrac{2.69}{3.46} = .78$

$\bar{D}$ = (Mean difference) $= \dfrac{14.25}{12} = 1.18$

"t" = $\dfrac{\bar{D} \text{ (Mean difference)}}{S_{\bar{D}} \text{ (Estimate of sampling error of } \bar{D})} = \dfrac{1.18}{.78} = 1.51$

Not significant at .01 level

COMPARISON OF EXPERIMENTAL GROUP II
MID-TEST AND FINAL TEST

Subject	Mid-Test	Final Test	D	D^2
1	80.00	81.00	1.00	1.00
2	77.50	77.00	-0.50	0.25
3	82.00	81.00	-1.00	1.00
4	82.00	84.00	2.00	4.00
5	82.50	84.50	2.00	4.00
6	85.00	90.00	5.00	25.00
7	91.00	89.00	-2.00	4.00
8	88.00	89.00	1.00	1.00
9	90.00	88.00	-2.00	4.00
10	98.00	100.50	2.50	6.25
11	94.50	95.00	0.50	0.25
12	97.00	98.25	1.25	1.56

$\Sigma D = \underline{9.75}$ $\Sigma D^2 = \underline{52.31}$

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES FOR EXPERIMENTAL GROUP II (MID-TEST AND FINAL TEST)

$N = 12$

$\Sigma D = 9.75$

$\Sigma D^2 = 52.31$

$S_{\bar{D}}$ estimate of sampling error of $\bar{D}$ $= \dfrac{S_D}{\sqrt{N}} = \dfrac{\sqrt{\dfrac{D^2 - \frac{(D)^2}{N}}{N - 1}}}{\sqrt{N}}$

$$= \frac{\sqrt{\dfrac{52.31 - \frac{95.06}{12}}{11}}}{3.46}$$

$$= \frac{52.31 - 7.92}{11} = \frac{44.39}{11} = 4.04$$

$$\sqrt{4.04} = \frac{2.01}{3.46} = .58$$

$\bar{D}$ (Mean difference) $= \dfrac{9.75}{12} = .81$

$$\text{"t"} = \frac{\bar{D}\ \text{(Mean difference)}}{S_{\bar{D}}\ \text{(estimate of sampling error of } \bar{D}\text{)}} = \frac{.81}{.58} = 1.40$$

Not significant at .01 level

COMPARISON OF THE CONTROL GROUP
MID-TEST AND FINAL TEST

Subject	Mid-Test	Final Test	D	D^2
1	65.00	66.00	1.00	1.00
2	77.50	82.00	4.50	20.25
3	78.00	82.00	4.00	16.00
4	80.50	82.00	1.50	2.25
5	81.00	83.25	2.25	5.06
6	86.00	87.00	1.00	1.00
7	84.00	83.25	-0.75	0.56
8	83.00	84.75	1.75	3.06
9	85.50	83.25	-2.25	5.06
10	87.50	89.75	2.25	5.06
11	86.50	86.00	-0.50	0.25
12	91.75	92.00	0.25	0.06

$\Sigma D = \underline{15.00}$ $\Sigma D^2 = \underline{59.61}$

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES FOR THE CONTROL GROUP (MID-TEST AND FINAL TEST)

$N = 12$

$\Sigma D = 15.00$

$\Sigma D^2 = 59.61$

$S_{\overline{D}}$ estimate of sampling error of $\overline{D} = \dfrac{S_D}{\sqrt{N}} = \dfrac{\sqrt{\dfrac{D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}}$

$$= \frac{\sqrt{\dfrac{59.61 - \frac{225}{12}}{11}}}{3.46}$$

$$= \frac{59.61 - 18.75}{11}$$

$$= \frac{40.86}{11} = 3.71$$

$$S_{\overline{D}} = \frac{\sqrt{3.71}}{} = \frac{1.93}{3.46} = .56$$

$\overline{D}$ = (Mean difference) $= \dfrac{15.00}{12} = 1.25$

$$\text{"t"} = \frac{\overline{D}\ \text{(Mean Difference)}}{S_{\overline{D}}\ \text{(Estimate of sampling error of } \overline{D})} = \frac{1.25}{.56} = 2.23$$

Not significant at .01 level

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