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Weight and Isometric Training in Relation to Certain Aspects of Golf Performance

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WEIGHT AND ISOMETRIC TRAINING IN RELATION TO CERTAIN

ASPECTS OF GOLF PERFORMANCE

by

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This Thesis submitted by Richard L. Wenzel in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

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ABSTRACT

The purpose of this study was to determine whether a weight lifting and isometric exercise program could be developed, which would enable a golfer to increase his distance off the tee without adversely affecting the accuracy of various golf shots.

One group of ten subjects was used in this study. This group was tested in the fall of 1966 to determine the distance and accuracy with which they could hit the ball off the tee. The golfers were also tested for the degree of accuracy which they possessed in hitting the chip shot both for distance and angle deviation. They were then put on a training program, of weight lifting and isometric exercises, for an eight week period after Christmas.

Comparisons were made between the mean differences for each item on the initial and final tests. The null hypothesis was assumed in making the comparisons with rejection at the .01 level. This hypothesis was tested with the "t" technique for the significance of the difference between means derived from correlated scores from small samples.

The results of the comparison showed significant improvement in all of the items tested except driving deviation.

CHAPTER I

INTRODUCTION

Golf is a highly competitive sport which requires a great deal of coordination and finesse in conjunction with a certain degree of strength. Because of the diligent practice necessary to achieve even a moderate degree of success, the writer has given much thought and consideration to the concept of an off season training program for golfers. The basic concept behind this program would be to maintain or improve the strength of the individual which is helpful in achieving greater distance and yet not cause a detrimental deviation in the accuracy factor involved in golf. Even though distance is an essential element in hitting the ball off the tee when using a wood or long iron, it may become detrimental if the deviation becomes too great.

Statement of the Problem

The purpose of this study was to ascertain whether a weight training and isometric program could lengthen the distance of the drive off the tee without causing an increase of the deviation in the flight of the ball. The writer was also interested in whether this program might affect the accuracy of the chip shot.

Need for the Study

The writer believed that there were two reasons which made this study feasible. First, there is the belief held by many golfers

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that muscular strength is detrimental to chipping and putting finesse or touch. Secondly, there is a definite comparative relationship necessary between distance and accuracy in order to assure reasonable success in golf. Research must be done to establish whether distance can be increased without affecting adversely the accuracy of shots.

Purpose of the Study

The writer, who was freshman and assistant varsity golf coach at the University of North Dakota, undertook this study to see if a program could be developed which would aid in producing greater distance off the tee without adversely affecting individual short games.

This study was conducted also in the hope that every golfer could profit from the information that may be forthcoming from this study. It is hoped that the program will be adaptable enough so that every golfer could possibly use some of the training devices to aid in developing his respective game.

Delimitations of the Study

The individuals who participated in this study were golfers who had already acquired a reasonable degree of golf proficiency. The writer felt that it was necessary that the ball be hit with a certain degree of distance and accuracy in order to effectively evaluate the test results.

The study was delimited further in that only the driving and chipping facets of golf were tested due to the amount of time required in testing and retesting and to the degree of statistical computation involved.

Definition of Terms

Weight training   – a program using weights which is designed to build strength in the muscles that are used in golf without building bulk.

Isometric program – refers to an exercise or set of exercises which use primarily resistance and counter-resistance to build strength without the use of elaborate equipment.

Deviation   – is an angular measurement between the tee and the point of aim, and the line of flight of the ball.

Finesse   – is a term used to denote proficiency of execution or perfection of form.

Touch   – is a term used to denote the feeling of the shot in the fingers which is beneficial in the execution of a good golf shot. The term is usually used in connection with chipping or putting.

Tee   – is the area on a golf course from which the ball is put into play by the golfer when he attempts to hit the ball as far and accurately toward the hole as is possible.

Green   – is the area located at the end of a golf hole which contains the cup or hole into which the golfer is attempting to hit the ball.

Flight of the ball– is the term used to denote the direction in which the ball is hit.

Driving	- is the shot used to put the ball into play on the golf hole and is usually made with the driver or number one wood on holes that are two hundred yards or longer in length.
Chipping	- is the shot used in golf where there is a relatively short distance to be covered and the ball is not yet on the green and when accuracy is of the greatest concern.
Woods	- are the longest clubs in a set, usually made of wood and used primarily to achieve distance when hitting the ball.
Short game	- is a term used to denote chipping and putting which are an important part of golf.
Off season	- is a term usually referring to the months of October through April when most golfers in this area can not or do not play golf.

Review of Literature

Many golf courses today are constructed in such a manner that the individual who is able to hit the ball off the tee with a considerable degree of distance will have a significant advantage. It is important to remember, however, that additional distance can become detrimental if there is an increase in the angle deviation of the shot. A golf swing that is relatively effortless, rhythmic and dependent upon the natural strength of the muscles used in golf will be more beneficial in achieving this distance than a swing that relies upon brute force only.

The amount of literature which directly relates to weight training and isometric exercises and their effect on golf performance is somewhat limited. Several articles have been written which touch upon the fringe areas.

Slater-Hammel[1] noted in his study that the following muscles are in use during some portion of the driving phase of the golf stroke:

1. Triceps brachii, right and left.
2. Latissimus dorsi, right side.
3. Pectoralis major, right side.
4. Posterior deltoid, right and left.
5. Biceps brachii, right side.

Gary Player[2] stated that the important muscles for a golfer were in the hands, wrists, forearms and legs. He recommended that, to strengthen these muscles, a golfer should do some weight lifting and running. He further recommended to strengthen the wrists and forearms a pair of five or ten pound weights should be used in supination and pronation exercises.

Weight lifting, feared for many years as a dangerous way of building up the body, may instead be the best training methof for all athletes--not only football players, shotputters and other heavyweights but even for swimmers, golfers, and tennis players.[3]

Dorothy Stull[4] stated that the weight lifting procedure used by golfers should include:

[1]Arthur T. Slater-Hammel, "Action Current Study of Contraction Movement Relationships in Golf Stroke," Research Quarterly, Vol. XVIV (October, 1948), p. 172.

[2]Gary Player, "Hit It My Way," Sports Illustrated, (March 21, 1966), p. 40.

[3]Dorothy Stull, "A Big Lift For Fitness," Sports Illustrated, (February 11, 1957), p. 44.

[4]Ibid., pp. 46-47.

1. The military press for the shoulders and triceps.
2. The lateral raise for the deltoid muscles.
3. The wrist curl for the forearms.
4. The alternate press for the arm and side muscles.
5. The squat for the thighs and hips.
6. The pullover for the muscles of the chest.
7. The shoulder shrug for the arms and shoulders.
8. The bent arm lateral rise for the pectorals.

Murray and Karpovich[5] noted in their book that Frank Stranahan, who was one of the leading money winners on the professional golf tour, lifted weights to the extent that he could handle three hundred pounds in the clean and jerk, four hundred pounds in the squat and more than five hundred pounds in the dead lift. Stranahan believed that weight lifting helped his golf and stated that, if he had to give up one of these activities, he would give up golf.

Murray and Karpovich[6] recommended that golfers use the following resistance exercises:

1. Clean and press, ten repetitions.
2. Rapid alternate press with dumbbells, ten repetitions with each arm.
3. Curl, ten repetitions.
4. Reverse curl, ten repetitions.
5. Slow squat, ten repetitions, two sets.
6. Pullovers, ten repetitions.
7. Bent arm lateral raise, supine.
8. Forearm exercises.

According to Murray and Karpovich,[7] strength of the muscle depends on the cross section of muscle fibers, and the size of these fibers becomes larger when exercised. Moreover, the connective membranes that envelop individual fibers and bundles of fibers become

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[5]James A. Murray and Peter Karpovich, Weight Training In Athletics, Englewood Cliffs: Prentice Hall, 1956, p. 148.

[6]Ibid., p. 146.

[7]Ibid., p. 38.

thicker and tougher, thereby greatly adding to the bulk of the muscle. The tendons also become much stronger. If the individual wants to develop strength in a muscle, he must use weights that are hard to lift.

Gary Wiren,[8] the assistant golf coach at the University of Oregon, stated that not many years ago, athletes were led to believe that the use of weights resulted in their becoming muscle bound and incompetent. Modern performances in all forms of athletics vividly demonstrate this to be untrue. If other factors are comparable, the stronger athlete will be the better athlete when engaged in competition. This strength is most efficiently developed through some system of isotonic or isometric exercise.

The University of Oregon uses a routine for their golfers in the off season, which involves a system of graduating repetitions. The individual starts with a prescribed amount of weight and lifts this weight eight times. He then works up to twelve repetitions with this weight before more weight is added. The repetitions are then started at eight again. This program includes the following exercises:[9]

1. Warm up.
2. Reverse curl.
3. Press.
4. Wrist curl.
5. 3/4 squat.
6. Lateral side
7. Sit ups.
8. Isometrics using twelve second periods.
9. Running or jogging.

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[8]Gary Wiren, Unpublished Handed Out Material to Varsity Golfers, From the University of Oregon, (October 27, 1965).

[9]Ibid.

Every golfer participates in this program, and it was suggested to the golfers that they work into this routine gradually so that they do not overdo the training at the beginning and then quit because it gets to be too much work. It is also important that the golfer does not become fatigued, work out when he is getting a virus infection, or when he is getting or has a cold.

Summary of Review of Related Literature

From the review of related literature, one may make a general hypothesis that muscles do play an important part in the hitting phase of golf. The success which Frank Stranahan and Gary Player have had in golf would seem to indicate that, by strengthening the golf muscles, the golfer can hit the ball a greater distance without adversely affecting his swing. The literature reveals that weight lifting and isometric exercises are feasible in developing strength in the muscles which are used during the golf swing. However, there is a lack of information as to the extent of increase or what effect this increase might have on the accuracy of the golf shot.

CHAPTER II

PROCEDURE

Source of Data

The participants in this study consisted of ten golfers from
the University of North Dakota: eight varsity or freshmen golf team
members and two graduate students.

These golfers volunteered to take part in this study after the
proposed program was outlined to them at a meeting of prospective golf
team candidates which was held at the University of North Dakota Field-
house in the fall of 1966. At this meeting the writer outlined the
golf proficiency tests and the training program which consisted of
weight lifting and isometric conditioning.

Description of the Weight Training Program

The subjects conditioned with the weight training and isometric
program for an eight week period starting at the beginning of the second
semester. They met two days per week and performed the following nine
weight exercises in conjunction with a number of isometric exercises:

1. Military Press—Pushing bar bell from upper chest
   position to overhead and return.

2. Shoulder Shrug—Holding bar bell in front of body,
   raise and throw the shoulders backward.

3. Pull Over--From supine position bring bar bell from over top of head to over chest and return.

4. Three Quarter Squat--Place bar bell on shoulders and, keeping back straight, bend the knees to three quarter squat position.

5. Wrist Curl--From sitting position with the arms resting on the thighs, bring bar bell upward using wrists.

6. Reverse Curl--In standing position, grasp bar bell with palms down and raise bar to neck position keeping elbows fixed.

7. Lateral Raise--Using dumbbells, abduct them from side of body to the overhead position and return.

8. Alternate Press--With dumbbells at shoulder position, raise them overhead alternately.

9. Bent Arm Lateral Raise--Supine position arms abducted lift dumbbells to overchest position by flexing elbows, (See Appendix A, page 29).

These exercises, plus the isometric exercises, were selected to strengthen the muscles of the wrists, forearms, shoulders, upper back, chest, and the legs. These muscle groups are the essential muscles which are used in performing the golf swing.

Each weight lifting exercise was performed twice starting with eight repetitions and building up to twelve repetitions. When the subject was capable of twelve repetitions additional weight was added, and he started with eight repetitions again. An average time of one hour was required to complete these nine exercises and the isometric exercises.

Individual records were kept of the daily progress of the subjects in performing their exercises during the eight week training period.

Description of the Isometric Training Program

The subjects also performed the following isometric exercises during the exercise period to give additional training exercises to the various muscle groups:

1. Left Arm Resistance Exercise—Abduct left hand to side of body with back of hand against wall to the left.

2. Right Hand Resistance Exercise—Same position as before, place right palm against the left hand acting as resistance.

3. Dead Lift—With bar about four rungs from bottom of rack, bend at waist bend arms and attempt to pull bar to chest.

4. Body Hang—Grasp chinning bar and hang. (See Appendix A, page 31).

Each of these four exercises was repeated twice by each subject for a period of twelve seconds using approximately seventy-five per cent effort. The body hang was done without a specific time element with the subject hanging until he had to drop.

Method of Collecting Data

Each of the participating subjects was tested in the fall to determine the distance that he could hit the golf ball in the air using his driver. The angle of deviation from the intended line of flight was also measured. Each subject was also tested for the amount of accuracy which he demonstrated in chipping from a distance of thirty yards. After the golfers had completed the training program, which lasted from January through March, they were retested in the spring. This retest was given late in May after the golfers had had time to play golf and practice the various skills.

The measuring instruments used to compute the distance and angle deviation of the drive consisted of a surveyor's transit, tripod and measuring rod. The chipping accuracy was measured by using a circular protractor placed over the cup and extending lines to divide the green into quadrants. The distance and angle deviation of each shot were then measured and transposed onto a scaled chart which allowed the writer to determine the angle deviation of each shot from the spot where the shot was taken.

Description of the Tests

Driving test--The writer, through the use of the transit and tripod, was able to measure the exact distance and deviation of the shot. The tripod was placed immediately behind the golfer and in direct line with the target, and the measuring rod was placed at the spot where the ball landed. Each golfer was allowed ten shots with his driver. The best five were recorded for the statistical procedures that were to be used.

Chipping test--The writer tested the golfer's chipping accuracy by placing a circular protractor over the cup so that the 0-180 degree axis was on a direct line with the shot to the green. A line was extended across the green on this axis extending thirty yards off the green to the spot from which the chip shot was being made. Another line was fixed to the center of the protractor and cup so that it could be extended to the spot where the ball stopped. The distance was measured with a tape measure and the angle computed on the circular protractor. This information was then transposed onto a scaled chart which had angle deviations extending from both the cup

and the spot from where the shot was taken. By using a ruler to measure the distance of each shot on the deviation angle from the cup it was possible to determine the deviation angle from the position where the shot had been made by the use of intersecting lines. Each golfer was allowed ten shots and the best five were recorded for use in the statistical procedures.

Description of the Hitting Control Method

The writer felt that, due to the long period of time between the original test and the retest, the golfers would have to be able to hit the ball in order to have somewhat the same degree of proficiency as they had possessed during the first test. To control the hitting of the ball, the subjects were given the use of the indoor golf facilities at the University of North Dakota Fieldhouse which consisted of enclosed areas where the golfers could hit actual golf balls into nets. The golfers were encouraged to use these facilities whenever they had the opportunity.

Statistical Procedure

For purposes of this study, the null hypothesis was assumed in analyzing the difference between the means recorded on the test and the retest by this group. This hypothesis asserts that there is no true difference between the two mean scores, and that the difference found between the sample means is a chance difference and is accidental and unimportant.[1]

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

Investigation of several possible tests of 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.

For this study, the writer selected the .01 level of significance as his criterion. Complete data and the mathematical procedures utilized in the statistical analysis are presented in Appendix B, page 32.

CHAPTER III

ANALYSIS OF DATA

The purpose of this study was to determine whether or not
participation in a program of weight lifting and isometric exercises
would affect performance in golf skills. The study dealt primarily
with driving distance, angle deviation and chipping accuracy. The
scores were compared in a test re-test situation.

As mentioned previously, the group was not selected at random
because the writer felt that it was important that a certain degree
of consistency be present in order to accurately evaluate the data.
The subjects were tested in the fall on their driving distance and
accuracy and on their chipping accuracy. They then participated in
the weight lifting and isometric exercise program. The retest was
taken in the spring after the golfers had had sufficient time to
practice the golf skills.

Results of Comparison

Driving Distance: The group had a mean score of 598.10 feet
in the initial test and a mean score of 631.80 feet in the retest
(see Table 1 on page 16).

The mean driving distance on the retest was 33.7 feet further
than it had been on the initial test. A "t" value of 4.169 was
significant at the .01 level.

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Driving Deviation: The group had a mean angle deviation of 5.37 degrees from the desired direction in the initial test and 4.69 degrees in the retest (see Table 1 on page 16).

A decrease in angle deviation of .68 degrees was evident between the performances on the two tests. A "t" value of 1.088 was not significant at the .01 level.

Chipping Distance: The group scored a mean distance of 12.17 feet from the cup on the initial chipping test. The retest mean was 6.21 feet (see Table 1 on page 16).

The results of the two tests showed a mean improvement of 5.96 feet. A "t" value of 5.697 was significant at the .01 level.

Chipping Deviation: The mean deviation from the desired direction was 6.64 degrees in the initial chipping test (see Table 1 on page 16. The retest mean was 4.02 and the mean difference was 2.62 degrees between the tests. A "t" value of 2.702 was significant at the .01 level.

TABLE 1

MEAN SCORES IN TESTS

Name of Test	Number	Initial Test	Retest
Driving Distance	50	598.10	631.80
Drive Deviation	50	5.37	4.69
Chipping Distance	50	12.17	6.21
Chipping Deviation	50	6.64	4.02

Note: The five best shots in each test were recorded for each of the ten subjects.

As shown by the analysis of data presented in Table 2 below, the group exhibited improvement to a significant degree in all items except driving deviation.

TABLE 2

SIGNIFICANCE OF RESULTS USING "t" TEST

Test Item	"t" Value	Level Significance
Driving Distance	4.169	Significant at .01 level
Driving Deviation	1.088	Not significant
Chipping Distance	5.697	Significant at .01 level
Chipping Deviation	2.702	Significant at .01 level

As shown by the analysis of data presented in Table 3 on page 18, every one of the individual subjects showed improvement in driving distance.

Table 4 on page 19 shows that six of the ten subjects showed improvement in the drive deviation.

Table 3 and Table 4 indicate that the subjects showed more consistency in driving distance than they did in driving deviation.

TABLE 3

MEAN IMPROVEMENT IN DRIVING DISTANCE BY SUBJECT

Subject	Mean of Pre-Test	Mean of Post-Test	Difference Between Means
1	602	620	18
2	584	652	68
3	610	688	78
4	570	584	14
5	621	648	27
6	572	584	12
7	592	644	52
8	554	612	58
9	656	660	4
10	620	626	6

Note: All distances are recorded in feet.

TABLE 4

MEAN CHANGE IN DRIVING DEVIATION BY SUBJECTS

Subject	Mean of Pre-Test	Mean of Post-Test	Difference Between Means
1	3.8	7.7	-3.9
2	7.9	5.5	2.4
3	5.5	2.6	2.9
4	4.2	4.8	- .6
5	4.9	3.5	1.4
6	6.3	4.0	2.3
7	3.1	4.6	-1.5
8	5.2	1.8	3.4
9	6.6	5.1	1.5
10	6.0	7.0	-1.0

Note: All measurements are recorded in degrees.

As shown by the analysis of data presented in Table 5 on page 20 every one of the subjects showed improvement in the chipping distance factor.

TABLE 5

MEAN IMPROVEMENT IN CHIPPING DISTANCE

Subject	Mean of Pre-Test	Mean of Post-Test	Difference of Means
1	8.3	5.9	2.4
2	15.3	5.2	10.1
3	11.8	6.1	5.7
4	10.6	7.5	3.1
5	13.5	5.2	8.3
6	12.3	6.1	6.2
7	14.1	4.4	9.7
8	11.6	4.4	7.2
9	13.2	10.2	3.0
10	12.7	7.4	5.3

Note: All distances are recorded in feet.

Table 6 on page 21 shows that seven of the ten subjects showed improvement in the chipping deviation factor. This implies that the ball was hit accurately toward the hole on the desired line of flight.

TABLE 6

MEAN CHANGE IN CHIPPING DEVIATION BY SUBJECTS

Subjects	Mean of Pre-Test	Mean of Post-Test	Difference Between Means
1	4.0	4.5	-0.5
2	9.7	4.0	5.7
3	3.3	5.5	-2.2
4	7.7	1.8	5.9
5	6.2	5.0	1.2
6	4.5	5.9	-1.4
7	11.4	4.8	6.6
8	3.9	3.3	0.6
9	9.3	2.0	7.3
10	6.4	3.3	3.1

Note: All measurements are recorded in degrees.

Table 7 on page 22 shows that the chipping distance item had the greatest "t" value. Driving deviation showed the lowest "t" value.

TABLE 7

RANK ORDER OF "t"

Test Item	"t" Value
Chipping Distance	5.697
Driving Distance	4.169
Chipping Deviation	2.702
Driving Deviation	1.088

CHAPTER IV

DISCUSSION

The degree of success which any person has in playing golf is dependent, to a large extent, upon his ability to hit the ball a reasonable distance off the tee. Proficiency on the tee shot with respect to distance can make the shot to the green an easier one. However, distance without accuracy often gets the golfer into a great deal of trouble and may leave him a very difficult second shot. With these thoughts in mind, the writer decided to investigate what effects a weight lifting and isometric exercise program might have on the distance and deviation factors in golf. It appeared logical that a stronger golfer should be able to hit the ball farther. But would increased power affect the accuracy of the various golf shots?

The results of the study showed that the subjects not only were able to hit the ball farther off the tee but that the angle deviation of the drive was actually less than that recorded on the initial test. The study revealed that every one of the ten subjects improved his distance off the tee, and also that six of the ten subjects actually hit the tee shot with less angle deviation on the retest. Analysis of the data concerning the angle deviation of the drive showed that on the initial test the subjects had a mean score of only 5.37 degrees. This made it rather difficult for the subjects

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to show any significant improvement on the retest.

Because it has often been suggested that increased muscle strength, which is an asset to gaining distance, would be detrimental to the golfer's short game, the writer also tested the golfer's chipping accuracy. The study revealed that the chip shot accuracy was not hurt by the training program. The distance from the cup and the angle deviation of the chip shot were actually decreased in the retest situation. Of the ten golfers who took part in this study, only three had angle deviations greater in the retest than in the initial test and all ten were closer to the cup with respect to distance on their chip shots in the retest than they were in the initial test.

In the writer's opinion, there was considerable merit in the weight lifting and isometric exercise program in which the subjects participated. They worked diligently at the program and took a great interest in it. The results showed that distance improved while the line of flight or angle deviation of the shot was not impaired. Several of the subjects continued to use the program even during the golfing season and the others planned to continue with the program during the off season.

The writer was unable to effectively ascertain how work on the indoor driving range, through the winter, affected the outcome of the total program. It was believed to be a beneficial factor because the subjects were exercising the golf muscles and at the same time were able to maintain the timing of their golf swings.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to ascertain what effect a weight lifting and isometric exercise program would have on hitting the golf ball for distance. The writer also wanted to know if this program would adversely affect the accuracy of either the drive or the short chip shot with respect to deviation.

The program began in the fall with the administration of two tests through which were calculated the distance and angle deviation of the drive and also the distance from the cup and the angle deviation of the chip shot. The data for the drive were determined by using a transit, tripod and measuring rod while the chip shot was measured using a tape measure and a circular protractor. The ten subjects were then placed on the weight lifting and isometric program for an eight week period starting after Christmas. The subjects were also encouraged to use the indoor golf facilities which were available at the University Fieldhouse. The group was then retested in the spring after the subjects had a chance to practice the various golf skills.

The data from the initial test and the retest were then computed to determine the differences between the means. The null hypothesis was assumed for this study and the "t" technique for

testing the significance of the differences between the means derived from correlated scores from small samples was used to make a within group comparison of pre-test scores to post-test scores.

Conclusions

The following conclusions were believed justified by the analysis of the data obtained in this study:

1. The subjects showed significant improvement at the criterion .01 level in the following test items: driving distance, chipping distance and chipping deviation.

2. The subjects did not show significant improvement in the driving deviation factor at the .01 level, but there was improvement.

3. The weight lifting and isometric exercise program appeared to be a beneficial factor in increasing the driving distance without adversely affecting the accuracy of either the drive or the chip shot.

4. In none of the skills tested was the mean performance on the post-test poorer than that on the preliminary test.

Recommendations

The following recommendations are made as a result of this study:

1. Since the study was limited to 10 subjects, this investigator recommends the test battery be given to a larger sample to further substantiate the results.

2. It is also recommended that a study be made to evaluate what effect the weight lifting and isometric exercise program would have on the putting aspect of golf.

3. The writer recommends that a study be made using the same training program and test battery but using an experimental group and a control group.

4. It is also recommended that the training program start right after the golf season ends and last until spring to ascertain if a longer training period would be more beneficial than the eight week period used in this study.

5. The writer recommends that the initial test and retest each be given twice under the same conditions to facilitate obtaining more accurate scores for the statistical treatment of the data.

DESCRIPTION OF THE WEIGHT TRAINING EXERCISES

1. <u>Military Press</u>

   a. Start exercise with the bar bell at upper chest.
   b. Keep the elbows well forward with the arms at least
      shoulder width apart.
   c. Keep the feet pointed straight ahead and spread about
      shoulder width apart for balance.
   d. Keep the back straight by lowering the hips.
   e. Push bar bell to locked arms overhead position then
      lower to chest.
   f. Inhale at the beginning of the lift, exhale as the
      lift is completed.

2. <u>Shoulder Shrug</u>

   a. Start the exercise from the dead lift position,
      (holding the weight at thigh level).
   b. Hold the weight at arms length in front of the thighs.
   c. Lift the weight up by pulling the shoulders up and back.
   d. Keep the feet pointed straight ahead with the head erect
      and the back straight.
   e. Inhale at the beginning of the lift, exhale when the
      lift has been completed.

3. <u>Pull Over</u>

   a. Lay supine on the floor with the arms stretched back over
      the head.
   b. Grasp the bar bell with the hands pronated about shoulder
      width apart.
   c. Lift the weight from the floor back over the head until
      the weight is directly over the chest. Then lower the
      weight back to the floor.
   d. Keep the arms straight and fully extended during the
      exercise.
   e. Inhale as the weight is lifted from the floor and exhale
      as the weight is returned to the floor.

4. <u>Three Quarter Squat</u>

   a. Place the bar across the shoulders and behind neck.
   b. Place heels of the feet on a two-inch block of wood
      and keep the feet straight ahead and shoulder width
      to maintain balance throughout the exercise.
   c. Keep the head high, back straight and buttocks low.
   d. Bend knees to the desired squat position and return
      upward to starting position.
   e. Inhale at the beginning of the exercise and exhale
      when the squat has been completed.

5. <u>Wrist Curl</u> (sitting position)

    a. Grasp bar bell with hands supinated and arms on thighs.
    b. Using primarily the wrists roll bar upward toward head off thigh in an arc. Return to thighs and continue.
    c. Inhale as the exercise is started, exhale as the bar returns to thigh position.

6. <u>Reverse Curl</u>

    a. Grasp the bar bell with the palms turned inward, have the bar resting on the thighs.
    b. Curl the bar upward to neck height keeping the elbows close to sides. Return the bar to the thigh position.
    c. Inhale at the beginning of the exercise and exhale as the exercise is completed.

7. <u>Lateral Raise</u>

    a. Grasp the dumbbells with the knuckles outward and the dumbbells resting against the side of the thigh.
    b. Raise the dumbbells from the sides in an arc meeting overhead. Return the dumbbells to the original position.
    c. Keep the feet about shoulder width and have the toes pointed slightly outward to maintain balance.
    d. Inhale at the start of the exercise and exhale as the exercise is completed.

8. <u>Alternate Press</u>

    a. Start with moderately heavy dumbbells at shoulder level.
    b. Push dumbbells overhead in an alternate seesaw manner.
    c. Keep feet about shoulder width with the toes slightly outward to maintain balance.
    d. Inhale and exhale as normally as possible during the exercise.

9. <u>Bent Arm Lateral Raise</u>

    a. Lay supine on the floor with the arms abducted to the sides.
    b. Grasp dumbbells, palms up, and with the bending of the arms at the elbow raise the weights to a position over the chest. Lower weights to the side and continue.
    c. Inhale as the exercise is started and exhale as the weights are returned to the sides.

DESCRIPTION OF THE ISOMETRIC TRAINING EXERCISES

1. Left Arm Resistance Exercise

    a. Assume golf position (closed stance).
    b. Abduct left arm with the back of hand against stationary object.
    c. Transfer weight strongly to left rotating hips slightly.
    d. Force the left hand and arm against resistance and hold for twelve seconds.

2. Right Hand Resistance Exercise

    a. Assume the same position as above.
    b. Use the right palm as the resistance to backward movement of the left hand.
    c. Keep elbow (right) tucked tightly into side.
    d. Try to force left hand backward and hold for twelve seconds.

3. Dead Lift

    a. Place bar approximately four rungs from bottom of rack.
    b. Grasp bar in curling position, bend at waist, and bend arms.
    c. Attempt to pull bar toward chest and hold for twelve seconds.

4. Body Hand

    a. Jump and grasp chinning bar.
    b. Hang until forced to release.

INITIAL TEST AND RETEST FOR DRIVING DISTANCE

	Initial Test	Retest	Sum of Difference	Difference Squared
1.	605	660	55	3,025
2.	615	600	− 15	225
3.	610	620	10	100
4.	600	620	20	400
5.	580	600	20	400
6.	580	640	60	3,600
7.	500	680	180	32,400
8.	640	600	− 40	1,600
9.	650	680	30	900
10.	550	660	110	12,100
11.	640	660	20	400
12.	590	720	130	16,900
13.	560	660	100	10,000
14.	610	700	90	8,100
15.	650	700	50	2,500
16.	590	580	− 10	100
17.	640	580	− 60	3,600
18.	530	540	10	100
19.	560	580	20	400
20.	530	640	110	12,100
21.	630	640	10	100
22.	600	660	60	3,600
23.	600	620	20	400

INITIAL TEST AND RETEST FOR DRIVING DISTANCE—Continued

	Initial Test	Retest	Sum of Difference	Difference Squared
24.	650	620	– 30	900
25.	625	700	75	5,625
26.	600	580	– 20	400
27.	590	560	– 30	900
28.	560	600	40	1,600
29.	580	580	00	00
30.	530	600	70	4,900
31.	630	640	10	100
32.	590	640	50	2,500
33.	580	640	60	3,600
34.	560	680	120	14,400
35.	600	620	20	400
36.	600	580	– 20	400
37.	560	640	80	6,400
38.	610	620	10	100
39.	570	600	30	900
40.	430	620	190	36,100
41.	650	660	10	100
42.	590	700	110	12,100
43.	700	640	– 60	3,600
44.	690	640	– 50	2,500
45.	650	660	10	100
46.	640	640	00	00

INITIAL TEST AND RETEST FOR DRIVING DISTANCE--Continued

	Initial Test	Retest	Sum of Difference	Difference Squared
47.	610	580	− 30	900
48.	650	600	− 50	2,500
49.	600	660	60	3,600
50.	600	650	50	2,500
	29,905	31,590	1,685	220,175

Mean Score of Initial Test   598.10

Mean Score of Retest   631.80

Sum of Differences   1,685

Sum of Differences Squared   220,175

Note: The first five scores represent Subject 1, subsequently each five scores identifies the scores of the other nine subjects.

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED

FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST   Drive Distance

N =   50

D =   1,685

D^2 =   220,175

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

$$\frac{\sqrt{\Sigma D^2 - \dfrac{(D)^2}{N}}}{\sqrt{N-1}} \Bigg/ \sqrt{N} \qquad\qquad \frac{\sqrt{220,175 - \dfrac{(1,685)^2}{50}}}{\sqrt{49}} \Bigg/ \sqrt{50}$$

$S_{\overline{D}}$ =   8.084

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{1685}{50}$ = 33.70

$t = \dfrac{\overline{D}}{S_{\overline{D}}}$ $\dfrac{33.70}{8.084}$ =   4.169

$df = N - 1 = 49$

"t" at .01 level = 2.5758

Significant at the .01 level

INITIAL TEST AND RETEST FOR DRIVING DEVIATION

	Initial Test	Retest	Sum of Difference	Difference Squared
1.	0.5	2.5	– 2.0	4.00
2.	2.5	8.0	– 5.5	30.25
3.	9.0	8.5	0.5	0.25
4.	5.0	9.5	– 4.5	20.50
5.	2.0	10.0	– 8.0	64.00
6.	13.5	8.5	5.0	25.00
7.	7.5	2.0	5.5	30.25
8.	6.5	10.0	– 3.5	12.25
9.	3.0	4.5	– 1.5	2.25
10.	9.0	2.5	6.5	42.25
11.	4.5	4.0	0.5	0.25
12.	4.5	0.0	4.5	20.25
13.	9.0	4.0	5.0	25.00
14.	2.0	2.5	– 0.5	0.25
15.	7.5	2.5	5.0	25.00
16.	2.0	9.0	– 7.0	49.00
17.	4.0	1.0	3.0	9.00
18.	8.0	5.0	3.0	9.00
19.	2.5	6.0	– 3.5	12.25
20.	4.5	3.0	1.5	2.25
21.	3.5	1.0	2.5	6.25
22.	3.5	7.0	– 3.5	12.25
23.	7.0	2.5	4.5	20.25

INITIAL TEST AND RETEST FOR DRIVING DEVIATION--Continued

	Initial Test	Retest	Sum of Difference	Difference Squared
24.	6.5	4.0	2.5	6.25
25.	4.0	3.0	1.0	1.00
26.	0.5	2.0	- 1.5	2.25
27.	2.5	2.0	0.5	0.25
28.	12.5	10.0	2.5	6.25
29.	9.0	1.5	7.5	56.25
30.	7.0	4.5	2.5	6.25
31.	4.5	8.0	- 3.5	12.25
32.	2.5	10.0	- 7.5	56.25
33.	1.5	2.0	- 0.5	0.25
34.	6.5	1.5	5.0	25.00
35.	0.5	2.5	- 2.0	4.00
36.	1.0	2.5	- 1.5	2.25
37.	7.0	2.5	4.5	20.25
38.	3.0	1.0	2.0	4.00
39.	4.0	2.5	1.5	2.25
40.	11.0	0.5	10.5	110.25
41.	5.0	1.0	4.0	16.00
42.	2.0	12.0	-10.0	100.00
43.	7.5	1.5	6.0	36.00
44.	12.0	8.5	3.5	12.25
45.	6.5	2.5	4.0	16.00
46.	4.5	8.0	- 3.5	12.25

INITIAL TEST AND RETEST FOR DRIVING DEVIATION--Continued

	Initial Test	Retest	Sum of Difference	Difference Squared
47.	9.0	2.0	7.0	49.00
48.	6.5	8.5	- 2.0	4.00
49.	4.0	7.0	- 3.0	9.00
50.	7.0	10.0	- 3.0	9.00
	268.5	234.5	34.0	1,000.75

Mean Score of Initial Test   5.37

Mean Score of Retest   4.69

Sum of the Differences   34.0

Sum of the Differences Squared   1,000.75

Note: The first five scores represent Subject 1, subsequently each
five scores identifies the scores of the other nine subjects.

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED

FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST _____Drive Deviation_____

N = _____50_____

D = _____34.0_____

D^2 = _____1,000.75_____

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

$$\frac{\sqrt{\dfrac{\Sigma D^2 - \dfrac{(D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{1,000.75 - \dfrac{(34.0)^2}{50}}{49}}}{\sqrt{50}}$$

$S_{\overline{D}}$ = .6253

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{34.0}{50}$ = .68

$t = \dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{.68}{.6253}$ = 1.088

df = N - 1 = 49

"t" at .01 level = 2.5758

Not significant at the .01 level

INITIAL TEST AND RETEST FOR CHIPPING DISTANCE

	Initial Test	Retest	Sum of Difference	Difference Squared
1.	16.08	01.58	14.50	210.25
2.	07.17	04.92	2.25	5.06
3.	04.33	07.00	- 2.67	7.13
4.	07.08	06.75	0.33	.11
5.	07.17	09.33	- 2.16	4.67
6.	12.83	04.25	8.58	73.62
7.	19.00	04.83	14.17	200.79
8.	16.50	09.08	7.42	55.06
9.	19.75	02.83	16.92	286.29
10.	08.58	04.75	3.83	14.67
11.	24.58	05.67	18.91	357.59
12.	13.08	07.17	5.91	34.93
13.	06.00	05.67	0.33	.11
14.	13.00	06.50	6.50	42.25
15.	02.33	05.33	- 3.00	9.00
16.	07.75	02.00	5.75	33.06
17.	04.00	10.58	- 6.58	43.30
18.	08.08	06.00	2.08	4.33
19.	10.00	09.00	1.00	1.00
20.	23.08	09.75	13.33	177.69
21.	15.67	09.00	6.67	44.49
22.	14.75	02.50	12.25	150.06
23	15.25	05.25	10.00	100.00

INITIAL TEST AND RETEST FOR CHIPPING DISTANCE—Continued

	Initial Test	Retest	Sum of Difference	Difference Squared
24.	06.83	05.67	1.16	1.35
25.	15.08	03.50	11.58	134.10
26.	09.50	05.67	3.83	14.67
27.	19.83	06.17	13.66	186.60
28.	07.00	06.92	0.08	.01
29.	20.00	05.75	14.25	203.06
30.	05.17	05.83	− 0.66	.44
31.	06.50	04.33	2.17	4.71
32.	11.50	01.08	10.42	108.58
33.	03.83	02.33	1.50	2.25
34.	06.00	06.92	− 0.92	.85
35.	32.50	07.50	25.00	625.00
36.	04.08	06.25	− 2.17	4.71
37.	05.75	05.83	− 0.08	.01
38.	12.75	04.42	8.33	69.39
39.	18.42	04.17	14.25	203.06
40.	18.00	01.17	16.83	283.25
41.	16.33	12.75	3.58	12.82
42.	04.75	15.00	−10.25	105.06
43.	08.50	10.00	− 1.50	2.25
44.	09.92	07.58	2.34	5.48
45.	26.42	05.42	21.00	441.00
46.	16.50	10.58	5.92	35.05

INITIAL TEST AND RETEST FOR CHIPPING DISTANCE--Continued.

	Initial Test	Retest	Sum of Difference	Difference Squared
47.	08.08	05.83	2.25	5.06
48.	07.00	06.92	0.08	.01
49.	19.00	05.83	13.17	173.45
50.	13.42	07.58	5.84	34.11
	608.72	310.74	297.98	4,511.79

Mean Score of Initial Test   12.17

Mean Score of Retest   6.21

Sum of Differences   297.98

Sum of Differences Squared   4,511.79

Note: The first five scores represent Subject 1, subsequently each
five scores identifies the scores of the other nine subjects.

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

TEST   Chipping Distance

N = 50

D = 297.98

D^2 = 4,511.79

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

$$\dfrac{\sqrt{\dfrac{\Sigma D^2 - \dfrac{(D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{4,511.79 - \dfrac{(297.98)^2}{50}}{49}}}{\sqrt{50}}$$

$S_{\overline{D}}$ = 1.046

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{297.98}{50}$ = 5.9596

t = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{5.9596}{1.046}$ = 5.697

df = $N - 1$ = 49

"t" at .01 level = 2.5758

Significant at the .01 level

INITIAL TEST AND RETEST FOR CHIPPING DEVIATION

	Initial Test	Retest	Sum of Difference	Difference Squared
1.	3.0	2.5	0.5	.25
2.	10.0	4.0	6.0	36.0
3.	2.5	8.5	- 6.0	36.0
4.	2.5	3.0	- 0.5	.25
5.	2.0	4.5	- 2.5	6.25
6.	11.0	3.5	7.5	56.25
7.	5.0	4.5	0.5	.25
8.	16.5	8.0	8.5	72.25
9.	14.0	0.5	13.5	182.25
10.	2.0	4.0	- 2.0	4.00
11.	1.0	7.5	- 6.5	42.25
12.	2.5	1.5	1.0	1.00
13.	3.0	8.0	- 5.0	25.00
14.	7.0	8.5	- 1.5	2.25
15.	3.0	2.0	1.0	1.00
16.	10.5	0.5	10.0	100.00
17.	5.5	2.5	3.0	9.00
18.	7.0	1.0	6.0	36.00
19.	8.5	0.0	8.5	72.25
20.	7.0	5.0	2.0	4.00
21.	4.0	8.5	- 4.5	20.25
22.	7.0	3.0	4.0	16.00
23.	10.0	2.0	8.0	64.00

INITIAL TEST AND RETEST FOR CHIPPING DEVIATION—Continued

	Initial Test	Retest	Sum of Difference	Difference Squared
24.	7.0	7.5	– 0.5	.25
25.	3.0	4.0	– 1.0	1.00
26.	6.5	4.5	2.0	4.00
27.	4.0	4.0	0.0	.00
28.	1.0	7.0	– 6.0	36.00
29.	10.0	6.5	3.5	12.25
30.	1.0	7.5	– 6.5	42.25
31.	7.5	3.5	4.0	16.00
32.	14.5	0.5	14.0	196.00
33.	5.5	2.0	3.5	12.25
34.	5.5	9.5	– 4.0	16.00
35.	24.0	8.5	15.5	240.25
36.	1.0	4.5	– 3.5	12.25
37.	3.5	3.0	0.5	.25
38.	10.0	4.0	6.0	36.00
39.	4.0	4.5	– 0.5	.25
40.	1.0	0.5	0.5	.25
41.	4.0	1.5	2.5	6.25
42.	0.5	2.0	– 1.5	2.25
43.	7.0	0.5	6.5	42.25
44.	2.0	5.0	– 3.0	9.00
45.	33.0	1.0	32.0	1,024.00
46.	13.0	2.5	10.5	110.25

INITIAL TEST AND RETEST FOR CHIPPING DEVIATION---Continued

	Initial Test	Retest	Sum of Difference	Difference Squared
47.	6.5	6.5	0.0	.00
48.	0.5	3.0	- 2.5	6.25
49.	5.0	3.0	2.0	4.00
50.	7.0	1.5	5.5	30.25
	332.0	201.0	131.0	2,646.50

Mean Score of Initial Test   6.64

Mean Score of Retest   4.02

Sum of the Differences   131.0

Sum of Differences Squared   2,646.50

Note: The first five scores represent Subject 1, subsequently each five scores identifies the scores of the other nine subjects.

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

TEST ___Chipping Deviation___

N = ___50___

D = ___131.0___

D^2 = ___2,646.50___

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

$$\dfrac{\sqrt{\dfrac{\Sigma D^2 - \dfrac{(D)^2}{N-1}}{}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{2,646.50 - \dfrac{(131.0)^2}{50}}{49}}}{\sqrt{50}}$$

$S_{\overline{D}}$ = 9.696

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{131.0}{50}$ = 2.62

t = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{2.62}{.9696}$ = 2.702

df = N - 1 - 49

"t" at .01 level = 2.5758

Significant at the .01 level

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