

A COMPARATIVE STUDY OF THE RESULTS OF
THREE TRAINING TECHNIQUES ON GRIP STRENGTH

A Thesis

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Master of Science

by

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The Problem:

This investigation sought to determine the effectiveness of the exer-grip as a grip strength developing device, and to determine the effects of three different training techniques using the exer-grip.

The groups were defined as:

Constant Maximum Contraction

Interval Maximum Contraction

Alternate Session-Constant and Interval

Scope and Method of Study:

The testing apparatus used was a Narragansett grip dynamometer with no width adjustment. The average score from three test scores was used for the pre and post grip strength test. The training device was a rubber exer-grip which is manufactured by the Voit Rubber Company. The subjects used for this research were enrolled in two volleyball classes during the third quarter at Stout State University. Fifty-four out of the seventy-eight men enrolled were randomly assigned and used for this study. The age range was from seventeen to twenty one years.

All subjects used were non-varsity athletes during the training period.

Five general hypotheses were statistically tested. The first and second stated that using the analysis of variance test there would be a significant difference on the pre-test and post-test scores at the .05 per cent level. The third stated that using the analysis of covariance there will be a significant difference at the .05 per cent level between the adjusted means on the pre and post-test. The fourth and fifth hypotheses that were tested used the "t" test of significant difference between two means. It was stated that there would be a difference at the .05 per cent level of confidence between two means of the pre and post-test.

One general factor concerning the mean gain in grip strength of all fifty-four subjects was observed. No specific mean gain standards were pre determined for this study.

Findings:

All five hypotheses that were statistically tested yielded no significant difference. The mean gain in grip strength of all fifty-four subjects was 9.94 pounds.

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CHAPTER I

INTRODUCTION

Interscholastic and collegiate wrestling has grown in popularity at a fast rate in the past fifteen years. Wisconsin has had an outstanding growth in the number of schools that now sponsor interscholastic wrestling. Mr. John Roberts, the executive secretary of the Wisconsin Interscholastic Athletic Association reported, "In 1951 and 1952 Wisconsin had twenty schools sponsoring interscholastic wrestling and now in 1968 we had 311 schools start out in our tournament series."¹ This rapid expansion has created a demand for ways to improve strength with a minimum amount of time spent on formal strength training.

"Human strength, the ability to exert force, has been of interest since antiquity."² A champion wrestler must have muscular strength, especially gripping strength. Strength is needed in wrestling to execute explosive and aggressive moves and to get out of precarious situations. The ability to grasp the opponent's wrist or ankle and control it for a period of time is a start towards an offensive move which could result in a pin for the offensive wrestler. It is very difficult for the bottom wrestler to initiate a wrestling maneuver when his wrist and ankle are controlled by a strong grip.

¹John E. Roberts, from a presentation at the Wisconsin Interscholastic Athletic Association State Wrestling Tournament, February 23, 1968.

²Richard Berger, "Effect of Varied Weight Training Programs on Strength," Research Quarterly, 33:168, May, 1922.

Other sports such as track, golf, gymnastics, bowling, and baseball also demand gripping strength. The exer-grip is a device for developing grip strength and can be used to gain the strength needed in all sports but especially in wrestling. It seems logical to experiment with different techniques to determine whether or not the exer-grip is a useful grip strength developing device.

I. THE PROBLEM

Statement of the problem. The problem is to test the effectiveness of the exer-grip as a grip strength developing device, and to determine the effects of three different training techniques using the exer-grip. The three techniques are:

1. Constant-Maximum Contraction
2. Interval-Maximum Contraction
3. Alternate Session-Constant and Interval

A description of the three training techniques is given on page eight under the heading of Definition of Terms used.

Purpose of the study. The purpose of this study is to investigate three different training techniques, using the exer-grip to determine which tends to yield the most gain in grip strength over a period of nine weeks.

The exer-grip is a relatively new piece of equipment that people squeeze.

Need for the study. In recent years college athletes have been

experiencing an increase in academic pressure. This pressure demands full utilization of in-classroom and out-of-classroom time and effort. In addition to greater utilization of the athletes time, better methods and tools to accomplish these goals are necessary.

Research indicates that substantial gains in strength can be made through well-organized weight training programs. In 1964 Hawley reported that, "Sixty-six per cent of the group of subjects that trained with weights and calisthenics showed significant increase in strength, whereas, only sixteen per cent of the calisthenic group made any significant gain."³

The typical weight training program demands much time, discipline, motivation, and equipment. It is questionable whether the average athlete in high school or college has the time to work that hard for athletic achievement. The exer-grip is a very inconspicuous and inexpensive piece of equipment that can be used any time and most any place. Because of the exer-grips flat shape it can be carried in a pocket easily.

New records of all types and in all sports are being threatened or broken every day. This is possibly due to new training techniques and training devices. Too often new devices and training techniques are used without an objective evaluation of their effectiveness. If properly

³Hawley, Dennis, "Comparitive Study of the Effect of Calisthenics and Calisthenics and Weights on Strength and Endurance," Seminar Report, August, 1964, Wisconsin State University, La Crosse, Wisconsin.

used, the exer-grip could be a valuable supplement to grip strength developing devices, and because of its size, expense, and compactness it can be used out of class and will not take up as much formal class or practice time as many techniques currently being used. To date no research has been applied to the Voit Exer-Grip.

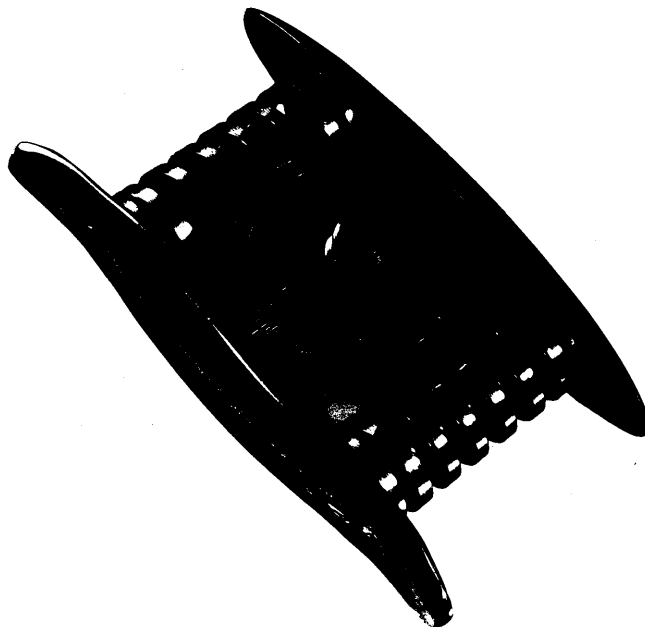
Delimitations. This study included fifty-four male students at Stout State University, Menomonie, Wisconsin. All subjects used for the experiment were non-varsity participants. The age range of the subjects was from seventeen to twenty-one years. Only the dominant hand of each subject was tested and trained. The height and weight of each subject were not considered in this study.

Limitations. Since all subjects are non-varsity performers, this study applies to physical education students rather than to the highly trained athlete. The grip strength output of the subjects was assumed to be a maximum effort. Free time activities, motivation, nuisance injuries, and sickness during testing and training sessions are variables that this researcher could not completely control.

II. DEFINITION OF TERMS USED

Dynamometer. This is an instrument which measures strength of the grip (finger flexors). It consists of two heavy springs mounted between steel bars. The scale is from zero to two hundred pounds.

FIGURE I

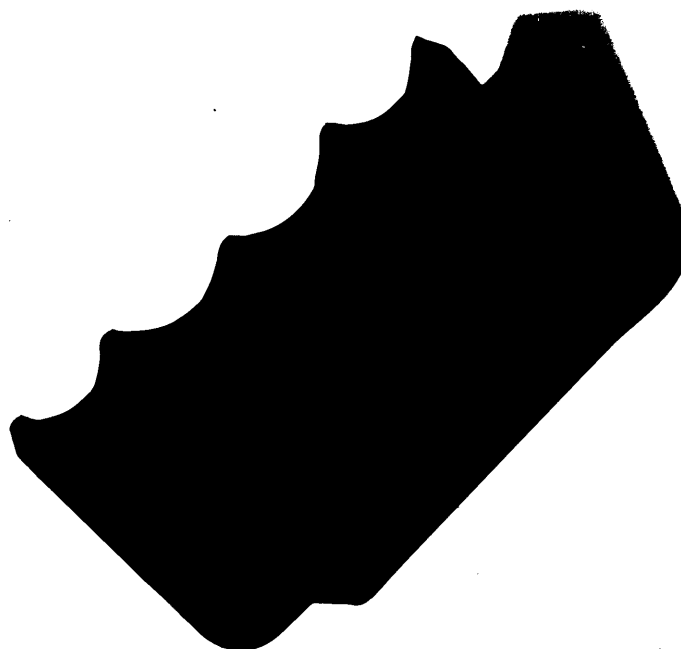


Offensive wrestler. The man on top or in complete control of his opponent. The offensive man is the most aggressive and initiates the action.

Defensive wrestler. The man down on the mat in the bottom position. He is in a position of disadvantage because the top man is awarded control of him before the whistle sounds. When in neutral or standing position the defensive man will hold back and wait for the action to come to him.

Exer-Grip. A flat piece of live rubber used for grip strength development and manufactured by the Voit Rubber Company. Its dimensions are: Three and one-half inches, by two inches, by one-half inch.

FIGURE II



Ready Position. This is the position assumed by the subjects for testing with the dynamometer and for training with the exer-grip. The trunk, knees, and dominant arm are comfortably flexed a few degrees. The back is straight before the actual contraction begins.

FIGURE III



Dominant arm. The natural arm used for every day activities, such as writing, dining, and throwing.

Constant Maximum Contraction. A maximal contraction that is not relaxed until the completion of the time lapse that was predetermined for each training session. A progression at eight, ten, and twelve seconds was used in this study. (See table number one.)

Interval Maximum Contraction. A maximal contraction which is released every one second until the completion of the time lapse is predetermined for each training session.

Overload Principle. This pertains to the concept that a muscle does not increase in strength unless it contracts against resistance.

Isometric Contraction. A hard steady muscular contraction applied to an immovable object at a predetermined angle and duration of time.

Isotonic Contraction. A hard steady muscular contraction that allows movement of the muscle and a steady change of the angle of the body part being exercised. The weight factor against the muscle group changes during the exercises due to the movement of the body part.

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CHAPTER II

REVIEW OF RELATED LITERATURE

Because of the importance of strength, physical educators have conducted a large amount of research in the area of strength development. Almost all the strength research involves the use of weights, immovable bars, and calisthenics. Isometric and isotonic muscle contractions are two methods of muscle development being applied at the present time. Isotonic contractions refer to working with barbells and weights, while isometric contractions pertain to work against an immovable object at a predetermined angle.

Researchers often disagree with each other as to the value of one technique or concept compared to another. E. J. Thompson in his article, "Weight Training Versus Isometric Training," pointed out that E. A. Mullers and Peter V. Karpovich disagree on the value of weight training and isometric training. Thompson further found that Mathews and others reported a significant increase in the strength of both arms when using both weight training and isometric training. He also stated that Mathews and Krause concluded that, "isometric training resulted in greater strength gains."¹

Wolbers and Sills, in an attempt to measure whether a static contraction of forty-five seconds developed more gripping strength than a static contraction of six seconds, found that, "a six second

¹Thompson, E. J. "Weight Training Versus Isometric Training," Scholastic Coach, 32:42-7, October, 1962.

contraction developed as much gripping strength as a forty-five second fatiguing contraction."²

Slater reported increases of fifty-two to eighty-eight per cent in strength as a result of training isometrically with thirty maximum isometric contractions in twenty-five days.³

In a study concerning the frequency and intensity of isometric muscular effort, Rarick and Larson concluded "that strength increase is greater when a progressive addition of sets of muscular contractions was added rather than just one set at a six second contraction."⁴

Dynamic or isotonic training has been used for many years. The barbells and the overload principle, which is the theory that muscle does not gain in strength unless it is worked to near maximum capacity, are well established in dynamic training sessions.

E. K. Capen tested four programs of heavy resistance weight training, which is similar to the overload principle. He compared the strength gains of four different groups using four training techniques. Each subject in group one selected the heaviest weight with which he

²Welber, Charles P. and Frank D. Sills. "Development of Strength in High School Boys by Static Contraction," Research Quarterly, 27:446-450, December, 1956.

³Slater, M. "The Effect of Muscle Strength of Maximum Isometric and Isotonic Contractions at Different Repetition Rates," Journal of Physiology, 130:109-13, 1955.

⁴Rarick, Lawrence G. and Larson, Gene L. "Observations on Frequency and Intensity of Isometric Muscular Effort in Developing Static Muscular Strength in Post Pubescent Males," Research Quarterly, 29:33-41, October, 1958.

could perform a maximum of eight executions or repetitions. Over a period of time, the repetitions were increased to fifteen. At this point more weight was added and the number of the repetitions reduced to eight. The training continued until the subject could again reach fifteen repetitions.

Each subject in group two selected the heaviest weight with which he could perform a maximum of five repetitions. The subjects increased the weight as the number of repetitions increased.

Each subject in group three selected the heaviest weight with which he could perform a maximum of five repetitions. The subjects trained using three sets of five repetitions. When they reached the point where they could perform five repetitions during the second and third set, more weight was added.

Each subject in group four selected the heaviest weight with which he could perform one repetition. The subjects trained using three sets per session. The weight was slightly decreased for set two and three. The number of repetitions was increased to three. At the conclusion of his study Capen reported, "all four groups gained about the same amount of strength." He also, indicated that Group Four's gain was slightly higher but not significantly so. Capen further stated that, "more attention should be applied to methods of motivating individuals to train."⁵

⁵Capen, E. K. "Study of Four Programs of Heavy Resistance Exercises for Development of Muscular Strength," Research Quarterly, 27:132-42, May, 1956.

As the isometric contraction theory began to gain popularity, researchers were concerned with the relative merits of isotonic and isometric contractions for the development of strength.

Robert Berger, one of the accepted authorities in strength research concluded on a comparative study of static and dynamic strength, that dynamic and static strength improved significantly when they were dynamically and statically trained. However, when attempting to train his subjects statically to improve dynamic strength, there was no significant difference.⁶

Berger conducted another study in 1962 that compared resistance load and strength improvement. He reported that, "training at ninety per cent of maximum effort produced just as much strength increase as one hundred per cent maximum effort."⁷

In still another study concerning the optimum repetitions needed for maximum strength development, Berger concluded that three sets of four, six and eight repetitions developed the greatest strength increase. As the strength of the subjects increased more repetitions were added to the training session. This is called progressive training.⁸

Gardner conducted a study concerning the specifics of strength

⁶Berger, R. A. "Comparison of Static and Dynamic Strength Increases," Research Quarterly, 33:329-33, October, 1962.

⁷Berger, R. A. "Comparison Between Resistance Load and Strength Improvement," Research Quarterly, 33:637, December, 1962.

⁸Berger, R. A. "Optimum Repetitions for the Development of Strength," Research Quarterly, 33:334-8, October, 1962.

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changes following isometric training. He found that isotonic exercises strengthen muscles throughout a long movement. Gardner also concluded that isometric training develops the ballistic type movement at angles less than twenty degrees.⁹

Robert Berger conducted a comparative study of static and dynamic strength training and reported that training statically six to eight seconds in two positions is not as effective as three sets of six repetitions dynamically.¹⁰

A number of observations have been made by researchers that supplement primary strength research. In a study to determine if the strength testers need to be thoroughly trained, Cousins found that both a trained and untrained tester could administer a grip test with no apparent loss of validity.¹¹

Cotten performed a study using a Collins closed circuit respirometer to determine endurance or oxygen consumption. He reported that an increase in duration of a sustained voluntary isometric contraction at percentages of fifty per cent of a maximum voluntary contraction or greater is due to strength. However, results indicated that endurance

⁹Gardner, G. "Specificity of Strength Changes of the Exercised and Non-exercised Limb Following Isometric Training," Research Quarterly, 34:98-101, March, 1963.

¹⁰Berger, R. A. "Comparison Between Static Training and Various Dynamic Training Programs," Research Quarterly, 34:131-35, May 1963.

¹¹Cousins, George F. "Effect of Trained and Untrained Testers Upon Administration of Grip Strength Tests," Research Quarterly, 26:273-76, October, 1955.

is a factor responsible for the increase in duration of a twenty-five per cent contraction.¹²

In further support of strength training, Mathews and Krause concluded that, "strength gains are an individual phenomena." They stated that this is due primarily to the variations in the amount of effort that each individual puts forth.¹³

Tuttle and others found that the development of grip strength endurance is not directly proportional to the development of maximum grip strength.¹⁴

In 1951 Hunsicker surveyed studies of human strength. On the basis of his survey, he reported that strength increase is the greatest from nine to nineteen years. The increase of strength is not as great from age nineteen to thirty. Hunsicker further reported that Isikawa found that the left hand was ninety per cent as strong as the right. He also stated that Erb and Rabinowitsch concluded that subjects could squeeze more with their arm extended rather than in a flexed position. Hunsicker also stated that Slater and Hamel reported that by exercising

¹²Cotten, Doyice. "Relationship of the Duration of Sustained Voluntary Isometric Contraction to Changes in Strength and Endurance," Research Quarterly, 38:366-74, October, 1967.

¹³Mathews, Donald, and Robert Krause. "Effect of Isometric and Isotonic Exercises on Elbow Flexor Muscle Groups," Research Quarterly, 28:26-37, 1957.

¹⁴Tuttle, W. W., C. D. Jannen, and C. W. Thompson. "Relation of Maximum Grip Strength to Grip Strength Endurance," Journal of Applied Physiology, 2:663-70, 1950.

one arm, the other also gains in strength.¹⁵

Morehouse has reported on the development of strength of subjects with diverse initial strengths. He found that subjects with different beginning strength levels make about the same absolute gains in strength at about the same rate. He also concluded that the intensity of the contraction seems of greater importance in strength development than the frequency of contractions.¹⁶

Everett and Sills conducted a study of the relationship of grip strength to stature, somatotype components, and anthropometric measurement of the hand. He concluded that weight correlated the highest with hand grip strength and that hand width was second. Everett and Sills also observed that age had very little influence upon grip strength. They concluded their study by recommending an adjustable grip dynamometer for testing purposes.¹⁷

Wright conducted a study concerning temperature factors and strength performance. He concluded that, "a rise in temperature of 2° F. above normal increased grip strength." He also stated that a rise in temperature higher than 2° F. decreased grip strength

¹⁵Hansicker, Paul. "Studies in Human Strength," Research Quarterly, 28:109-22, May, 1951.

¹⁶Morehouse, Chauncey A. "Development and Maintenance of Isometric Strength of Subjects with Diverse Initial Strengths," Research Quarterly, 38:449-56, October, 1967.

¹⁷Everett, Peter W. and Frank D. Sills, "The Relationship of Grip Strength to Stature, Somatotype Components, and Anthropometric Measurements of the Hand," Research Quarterly, 23:161-66, 1952.

output.¹⁸

Mathews in his book, Measurement in Physical Education, gave the following instructions for the use of the grip testing dynamometer. He stated, "the subjects hands should be first chalked. Place the concave edge of the dynamometer between the first and second joints of the finger with the dial toward the palm. The subject is allowed any movement while squeezing the instrument providing he does not hit any object with his fist. The right grip is tested first."¹⁹

J. D. Whitely conducted a study concerning strength scores and correlations. He reported, "larger correlation will be obtained when the average strength score is used rather than the highest score." Whitely did point out, however, that if there is an extremely high score in comparison with the other scores, that the high score should be used.²⁰ On the basis of Whitely's research, this researcher chose to use the average score.

Regardless of the amount of strength developing research that has been completed, it is evident that a clear need exists to continue to determine the validity of new equipment and to determine the training technique that yields the greatest increase in strength. The reviewed

¹⁸ Wright, V. "Factors Influencing Diurnal Variation of Grip Strength," Research Quarterly, 30:110-16, March, 1959.

¹⁹ Mathews, Donald K., Measure in Physical Education (Philadelphia: W. B. Saunders Company, 1958), p. 61.

²⁰ Whitely, J. D. "Larger Correlations Obtained by Using Average Rather Than 'Best' Strength Scores," Research Quarterly, 34:248-49, May, 1963.

research has been an excellent supplement in aiding this project. The conclusions provided by these previous studies guided this experimental study.

The exer-grip closely relates to actual human flesh, thus making the strength training in wrestling more realistic. Regardless of the way that muscle strength is studied, the important need is for better understanding of old and new techniques.

CHAPTER III

PROCEDURE

Previous to the study a brief pilot study was conducted. From this came the methodology which was employed in this research.

Fifty-four out of seventy-eight men from two volleyball classes were selected for this study. None of these men was competing in varsity sports during this study, and their participation was voluntary. The subjects were divided into three groups by random selection. The groups were then classified as, (1) constant maximum contraction, (2) interval maximum contraction, and (3) alternate training session. The classes met twice a week for nine weeks. The nine week testing and training period was divided into three week sessions. The training began with eight second contractions and after five training sessions two seconds were added to the muscular contraction phase of the training session. Two more seconds were added at the end of ten training sessions as shown on Table I.

A record book with the name and scores of each subject was kept to insure attendance. Class roll call was taken each day and checked in the book. If the subjects missed more than three training sessions or two in a row, they were dropped from the study.

General Orientation. A thorough plan for the research project was introduced at the first session. The value of this type of study to physical education and athletics was discussed. The hand dynamometer and the exer-grip were briefly shown and demonstrated to the subjects.

TABLE I

ARRANGEMENT OF NINE WEEK SESSIONS FOR RESEARCH WORK

Week and Number	Session	Time
I Week of January 22	1. Orientation	
	2. Pre-test	
II Week of January 29	1. Training Session	
	2. Training Session	
III Week of February 5	3. Training Session	8 second contraction
	4. Training Session	
	5. Training Session	
IV Week of February 12	1. Training Session	
	2. Training Session	
V Week of February 19	3. Training Session	10 second contraction
	4. Training Session	
VI Week of February 26	5. Training Session	
VII Week of March 4	1. Training Session	
	2. Training Session	
VIII Week of March 11	3. Training Session	12 second contraction
	4. Training Session	
IX Week of March 18	5. Training Session	
	1. Post-test	

After the demonstration the researcher discussed the three training groups that this study would involve. Constant maximum contraction, interval maximum contraction, and the alternate session constant and interval maximum contraction were explained to give the subjects a better understanding of the research project.

They were told that the purpose of this study was to test the exer-grip as a strength developing device as well as attempt to determine a training technique that shows the greatest gain in strength. Further explanation to the subjects indicated the importance of class attendance and the willingness to work hard during each session. They were told that if they missed three training sessions or two in succession they would be dropped from the study. The subjects were also told that the results of the study would be shared with them and that they were not being graded on their performance. The hand dynamometer and the exer-grips were passed around to the subjects for personal investigation.

The test retest correlation for reliability of the testing device was omitted in this study. From an examination of the literature and specifically Whitely's study, reviewed on page 16, this researcher decided that averaging three test scores would be sufficient for this study.²¹

Pre-test. The pre-test established the strength index of each subject prior to the training period. The instrument for testing was a

²¹Whitely, J. D. "Larger Correlations Obtained by Using Average Rather Than 'Best' Strength Scores," Research Quarterly, 34:248-49, May, 1963.

new Narragansett hand dynamometer without the width adjustment. The researcher demonstrated the use of the dynamometer step by step. The subjects were instructed to apply magnesium chalk to their hand to prevent any slipping during the contraction phase of the test. They were then told to place the dynamometer in their hand with the dial facing towards the palm, so that the concave edge fit their first and second fingers. They were then instructed to assume the ready position as defined in Chapter I, and not to touch anything with the testing hand during the maximum contraction. At this point the subjects were given an opportunity to ask any questions concerning the use of the testing instrument. Emphasis was placed on the value of sound technique, correct posture, and proper grip on the instrument. The subjects were also told that total effort and cooperation was necessary if the study was to be reliable.

For the purpose of warming up prior to the test, six exercises were demonstrated and explained by the researcher. They were: (1) side straddle hop, (2) trunk rotation, (3) toe touches, (4) squat thrusts, (5) sit-ups, (6) running in place for ten seconds. The subjects were told that ten repetitions of each exercise would be executed in the same order every day prior to a testing or training session. Each subject then spent a moment thinking about any part of the pre-test procedure. All were given a chance to ask any questions about the pre-test.

In setting the stage for the actual pre-test the subjects were once again encouraged to get themselves emotionally ready to perform. The researcher suggested that they try to simulate a life or death situation in their mind. The subjects then executed the series of six

exercises previously mentioned in this chapter. Because there was only one testing instrument available the subjects who were not being tested were asked to participate in some passive activity with the volleyball to maintain their warmed up condition. The subjects were called up in alphabetical order to begin the actual grip strength test. The subject, with no command from the researcher, would compress the dynamometer for approximately one full second and release. He would repeat the test three times with a thirty second rest between each test. While one subject was testing, another was alert and ready to go, and still another on deck as it was defined. The subject on deck was asked to exercise briefly, while the subject in the alert position was asked to rest, put magnesium chalk on his hands, and think seriously about the test. The subjects were called up on deck until they were all tested. Three scores for each man were recorded in the record book.

Training Session. A portion of the first training session was used to explain the timing involved with this study and to incorporate a motivating contest of achievement between each group of subjects. The instruction for training was as follows: The constant maximum contraction group was instructed to squeeze the exer-grip on the first "crush" command they heard from the researcher and to release on the command "release." The interval maximum contraction group was instructed to squeeze the exer-grip on the command "crush," and release on the call of the number. The command and count was then, "crush" one, "crush" two, "crush" three, and up to the numbers eight, ten, or twelve depending on

what training period they were engaged in. The alternate group of subjects had to learn both techniques. When the explanation was completed and there were no further questions, the subjects engaged in the six warm-up exercises discussed earlier in this chapter.

Upon completion of the exercises, each group was given an exerciser grip, asked to spread out around the gymnasium floor, and instructed to assume the "ready position." On the command, "ready crush one," the training session would begin. During the first five training sessions, the groups trained using three sets of eight second contractions with a ten second rest between each set. After the first five sessions the time factor progressed to ten and then twelve seconds as shown in Table I. The alternate group started out training using the constant maximum contraction technique and then alternated to the interval technique the next session. This group also finished their training using the constant technique.

The researcher spent some time synchronizing the verbal commands with each second on an Aristo stop watch. The reliability of the procedure was acceptable to the researcher for this study.

Post-test. The post-test using the grip dynamometer was conducted after completion of the fifteenth training session. As previously discussed in this chapter under the heading pre-test, the subjects were instructed again on the use of the grip dynamometer. The series of six exercises were executed and the subjects again were called up alphabetically to begin retesting their grip strength. Emphasis was again placed

on correct posture, proper grip of the instrument, and the need for a maximum effort from everyone. The concept of personal pride was stressed to the whole group in an effort by the researcher to get maximum performance. As each subject completed the post-test the three test scores were recorded in the record book along with his pre-test score. To increase the reliability coefficient of the test, the average score was calculated from the three raw post-test scores. These data were now ready for thorough statistical treatment.

Statistical design of the study. The analysis of variance and covariance were used to test for differences among the groups. Separate analysis of variance test were computed for the pre-test and post-test. Correlation coefficients between the means of the groups and within groups were also computed. Finally, small "t" test of the significance of the differences between two means was applied to the data of this project.

The raw data was transferred to IBM cards at Wisconsin State University, La Crosse, Wisconsin, and the facilities of the center were used to test for difference among the groups.

Statement of Hypothesis: The following hypotheses were tested in order to check for differences among the groups sampled:

Using the analysis of variance statistical treatment, there will be a significant difference at the .05 per cent level between:

- a. The groups on the pre-test scores.
- b. The groups on the post-test scores.

Using the analysis of covariance statistical treatment there will be a significant difference at the .05 per cent level between the adjusted means on the pre and post test.

Using the "t" test of significant differences between two means there will be a significant difference at the .05 per cent level of confidence between the means of:

PRE-TEST

- a. The constant and interval maximum contraction group.
- b. The interval and alternate maximum contraction group.
- c. The constant and alternate maximum contraction group.

POST TEST

- a. The constant and interval maximum contraction group.
- b. The interval and alternate maximum contraction group.
- c. The constant and alternate maximum contraction group.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

In order to determine whether the exer-grip is a useful strength developing device and which training technique more closely relates to the increase of strength, the effects of the training program were examined.

Previously it was indicated that the analysis of variance,²² analysis of covariance,²³ and "t" tests²⁴ would be used for this problem. The .05 per cent level of confidence was used in accepting or rejecting the hypothesis. This section outlines the process and results involved in analyzing the data using these procedures.

The pre-test scores for this study were equated. Equated pre-test groups is a basic assumption when applying the analysis of variance statistical technique.²⁵ All collected data were processed by the computer centers at Wisconsin State University, La Crosse, Wisconsin and Stout State University, Menomonie, Wisconsin. A Monroe calculator number 1220 was used for parts of the statistical treatment.

²² N. M. Downie, and R. W. Heath, Basic Statistical Methods (New York: Harper and Row Publishers, 1965), p. 176.

²³ Allen L. Edwards, Experimental Design in Psychological Research (New York: Rinehart and Company, Inc., 1950), p. 333.

²⁴ Downie, loc. cit., p. 140.

²⁵ Statement by E. Wayne Courtney, personal interview.

PRE-TEST DATA

In development of the analysis of variance for the X and Y variable and the sum of the products, the usual procedure was followed in determining the sum of squares and mean squares. The F-test was made following this procedure.²⁶ The results for the analysis of variance of the pre-test (X) are shown in the following table.

TABLE II

ANALYSIS OF VARIANCE FOR THE PRE-TEST (X)

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between groups	2	5.37	2.68	
Within groups	51	18640.62	365.50	0.00
Total	53	18646.00		

As shown in Table II, the F score was 0.00 which is not significant at the five per cent level of confidence with degrees of freedom of two between groups and fifty-one within groups. See appendix for a complete outline of data used and procedures followed.

Due to the fact that these data were correlated the Pearson product-moment correlation coefficient was established prior to

²⁶Ibid.

applying the "t" test statistical treatment. "If data are correlated, such correlations have to be taken into account when tests of significance are being made; because the condition of independent samples no longer exists."²⁷ The formula used was as follows:

$$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}}$$

$$r = \frac{54(846228) - 6426 \times 6962}{\sqrt{[54(783340) - (6426)^2][54(918458) - (6962)^2]}}$$

$$r = \frac{958500}{1065386.4}$$

$$r = .90$$

A correlation coefficient of .90 is a very high correlation.

The relationship between pre-test (X) and post-test (Y) is very dependable.

At this point the "t" test of the significance of the difference between the means was applied to the pre-test (X) data. The results are shown on Table III.

²⁷Downie, op. cit., p. 134.

TABLE III

NUMBERS, MEANS, STANDARD DEVIATION, STANDARD ERROR
THE MEAN, AND "t" RATIOS FOR THE PRE-TEST (X) DATA

GROUP						
Constant	18	118.72	19.31	4.68	$X_1 X_2$.05
Interval	18	118.83	18.65	4.52	$X_2 X_3$.31
Alternate	18	119.44	17.75	4.30	$X_1 X_3$.43

None of the above "t" ratios is significant at the five per cent level of confidence.

POST-TEST (Y)

The analysis of variance for the post-test was determined in the same manner as that for the pre-test variable. Table IV summarizes these data.

TABLE IV

ANALYSIS OF VARIANCE FOR THE POST-TEST (Y)

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between Groups	2	64.98	32.49	
Within Groups	51	20810.87	408.05	0.07
Total	53	20875.86		

The F value was 0.07 for the analysis of variance for the post-test (Y) data. This was not significant at the five per cent level of confidence.

The "t" test was applied to the means of the post-test (Y). The results of this application are shown in Table V.

TABLE V

NUMBER, MEANS, STANDARD DEVIATION, STANDARD ERROR OF
THE MEANS, AND "t" RATIOS FOR THE POST-TEST (Y) DATA

GROUP	N	MEAN	S.D.	S.E.M.	T
Constant	18	127.50	22.08	5.35 $Y_1 Y_2$	1.51
Interval	18	130.17	19.25	4.67 $Y_2 Y_3$.52
Alternate	18	129.11	17.27	4.19 $Y_1 Y_3$.30

There is no significant difference at the five per cent level of confidence between any two "t" values listed in Table V.

ANALYSIS OF COVARIANCE

For the analysis of covariance, means obtained in the initial analysis had to be adjusted for differences which might have occurred in the scores used for the study. The computer center at Wisconsin State University, La Crosse, Wisconsin, computed the Analysis of Covariance for this study.

Table VI summarizes these adjusted data and shows the F-test ratio.

TABLE VI

ANALYSIS OF COVARIANCE FOR X AND Y DATA

ADJUSTED ADJUSTED				
Source of Variance	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between groups	2	60.91	30.45532	0.388
Within groups	50	3917.89	78.36	
Total	52	3978.80		

(Note: One degree of freedom is lost because of covariance treatment.)

Tabular F at the five per cent level of confidence with two and fifty degrees of freedom equals 19.47. The computed F for this study equals 0.38. Hence, the positive hypothesis is rejected. There were no significant differences among methods (treatments).

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The central problem of this study was to test the effectiveness of the exer-grip as a grip strength developing device, and to determine the effects of three different training techniques using the exer-grip. The problem had four parts:

- A. The selection of a grip strength testing instrument.
- B. The administration of the testing instrument to the subjects during the Pre and Post-test.
- C. The organization necessary to administer the training session.
- D. The statistical analysis of the data to determine the presence or lack of significant differences between the means of the three training techniques and formulate conclusions regarding the use of the exer-grip.

The covariant factor in this study was the pre-test score which was established immediately prior to the training period. The dependent variable was the post-test score determined immediately following the training session.

Conclusions

The sampling procedure used in the study randomized from seventy

six students in two volleyball classes at Stout State University, Menomonie, Wisconsin. Fifty four subjects were selected from the two classes for this study. Using the pre-test grip strength scores the groups were equated.²⁸ Based on the results summarized in chapter four the following conclusions were drawn:

1. When the hypothesis that the pre-test scores were equal was tested by the analysis of variance the hypothesis was rejected at the .05 per cent level. This was primarily because the groups were equated.
2. Using the "t" test of significant differences between two means on the pre-test scores, the hypothesis was rejected. This again was primarily due to equated pre-test groups.
3. When the analysis of variance was applied to the post-test data, the computed F did not fall into the critical region; thus, the hypothesis was rejected. Therefore, it was concluded that significant differences were not present for the post-test factor.
4. When the t-test was applied to the post-test data, the "t" value did not fall into the critical region; thus, the hypothesis was again rejected.
5. Results of the Analysis of Covariance Test showed no significant difference of the adjusted means.

²⁸ See appendix for data used.

Each group tended to gain about the same amount of grip strength according to the raw score finding. However, statistically there was no significance at the five per cent level of confidence. This kind of results indicates that possibly the training techniques were quite close in the form and degree of muscle contraction. Another observation was that the weaker subjects in many cases did not make substantial gains in strength. There were also a number of negative performances which are quite difficult to explain. It could be concluded that these weaker subjects are not motivated to increase their muscular strength. Also, none of the subjects were physical education majors and so may have lost interest which could account for some of the poor and negative performances.

Further studies should be conducted using a combination of more sets, repetitions, and a larger training period. Also, the application of this test and training technique to a group of motivated varsity swimmers who do not necessarily train during swimming for grip strength but would put forth their best effort to the project, due to their competitive spirit. Another approach might be to group the subjects according to their weight index. And still another method could be to group the subjects by their performance on the pre-test so that all men that squeezed one hundred and thirty to one hundred and forty pounds would be in one group and so on by ten pound intervals. This procedure would allow the researcher to analyze the weak and strong separately.

By observing the means on the pre-test and post-test scores of all fifty-four subjects within the three groups, the exer-grip appeared to have value as a hand grip strengthening device. The mean gain in hand grip strength was 9.94 pounds. The lack of significant difference between the three training techniques indicates that the group of subjects might be too homogeneous.

In conclusion, this researcher feels that if further research would be conducted using another sequence of training methods the difference in techniques could be significant.

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C. UNPUBLISHED MATERIALS

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Roberts, John E. From a Presentation at the Wisconsin Interscholastic Athletic Association State Wrestling Tournament, February 23, 1968.

APPENDIX

CONSTANT MAXIMUM CONTRACTION

<u>Subject</u>	<u>Initial Score</u>	<u>Final Score</u>
1	157.	176.
2	146.	154.
3	136.	144.
4	135.	158.
5	133.	138.
6	132.	133.
7	128.	129.
8	127.	128.
9	120.	135.
10	115.	120.
11	112.	113.
12	110.	117.
13	107.	124.
14	106.	133.
15	104.	106.
16	100.	109.
17	90.	97.
18	79.	81.

INTERVAL MAXIMUM CONTRACTION

<u>Subject</u>	<u>Initial Score</u>	<u>Final Score</u>
19	154.	162.
20	147.	161.
21	136.	151.
22	133.	132.
23	133.	142.
24	130.	137.
25	129.	138.
26	125.	141.
27	121.	128.
28	117.	128.
29	113.	131.
30	109.	114.
31	108.	131.
32	106.	109.
33	103.	105.
34	102.	141.
35	97.	103.
36	76.	89.

ALTERNATE SESSION-CONSTANT AND INTERVAL

<u>Subject</u>	<u>Initial Score</u>	<u>Final Score</u>
37	155.	157.
38	144.	146.
39	138.	139.
40	133.	157.
41	132.	140.
42	131.	127.
43	130.	139.
44	127.	128.
45	121.	137.
46	118.	137.
47	112.	121.
48	111.	123.
49	108.	117.
50	107.	133.
51	102.	127.
52	101.	103.
53	93.	95.
54	87.	98.

COMPUTERIZED SCORES

Sum of Initial Tests	6426.
Sum of Final Tests	6962.
Sum of Squares-Initial	783340.
Sum of Squares-Final	918458.
Sum of Cross Products	846228.
Total Sum of Products	17750.00
Sum of Products for Methods	4.69
Sum of Products Within Groups	17745.30
Adjusted Sum of Squares Within Groups	3917.89
Adjusted Total Sum of Squares	3978.80
Reduced Sum of Squares for Methods	60.91
Reduced Variance for Methods	30.45532
Adjusted Error Variance	78.35

FORMULA FOR t-TEST

$$T = \frac{X_1 - X_2}{\sqrt{Sx_1^2 + Sx_2^2 - 2(r)(Sx_1)(Sx_2)}}$$