THE EFFECTS OF SELECTED ISOTONIC AND ISOMETRIC EXERCISES FOR DEVELOPING STRENGTH FOR THE IRON CROSS

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THE EFFECTS OF SELECTED ISOTONIC AND ISOMETRIC EXERCISES FOR DEVELOPING STRENGTH FOR THE IRON CROSS

By

Robert Louis Harris

AN ABSTRACT OF A THESIS

Submitted to
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Approved Gale Mikles

ABSTRACT

THE EFFECTS OF SELECTED ISOTONIC AND ISOMETRIC EXERCISES FOR DEVELOPING STRENGTH FOR THE IRON CROSS

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Statement of the Problem

This study was undertaken to determine the effectiveness of six selected exercises on the strength required for performing the iron cross on the still rings. Three of the exercises were isotonic, and the other three were isometric. The amount of strength developed and the time spent acquiring it were the deciding criteria.

Methodology

Seventy-eight subjects were selected from the required freshman Physical Education classes at Michigan State University. They were weighed and ranked according to body weight, then divided into six groups, with the means of each group as near equal as possible. Each group was then randomly assigned to an exercise, and, using a cable tensiometer, measured for arm adduction strength.

The six different exercises consisted of the following: GROUP A (Isometric: Testing Apparatus Exercise): Pressing

down maximally on the testing apparatus for three bouts, each of six seconds duration, with a two-minute rest period between bouts.

GROUP B (Isotonic: Regular Cross Attempt Exercise): Lowering down from a support position on the low still ring setup, attempting to hold the iron cross, and jumping up to regain the support position again (one attempt). The exercise involved three bouts, each bout consisting of six attempts, with a two-minute rest period between the bouts.

GROUP C (Isotonic: Inner-Tube Exercise): Starting from a support position with an inner-tube cut and the ends attached to the rings, and with the tube placed under the feet, lowering down to the iron cross position, and pressing back up with the help of the inner-tube. The exercise involved three bouts, each bout consisting of ten repetitions, with a two-minute rest period between the bouts.

GROUP D (Isometric: Arms Through Straps Exercise): Placing the arms through the straps to a point where maximal exertion was needed to hold the iron cross position for the designated length of time. The exercise involved two bouts, each bout of six seconds of duration, with a two-minute rest period between the bouts.

GROUP E (Isotonic: Inner-Tube Exercise): This exercise was similar to that of GROUP C, except that the requirements

were two bouts, each bout consisting of ten repetitions, with a two-minute rest period between the bouts.

GROUP F (Isometric: Arms Through Straps Exercise): This exercise was similar to that of GROUP D, except that the requirements were three bouts, each bout of six seconds duration, with a two-minute rest period between the bouts.

Individuals in each group were instructed to exert maximally throughout the entire exercise.

The exercises were done once a day, five days per week, for approximately six weeks. Each subject was tested for arm strength improvement before his exercise on Friday of each week. A final strength test was taken at the end of the training period, and the data were statistically treated using the Analysis of Variance method to determine the significance of the difference between the initial and final arm strength recordings of each group.

Conclusions

Within the confines of the study, and subject to the usual limitations of sample and type of training program, the following principle conclusion may be drawn.

1. At the termination of the six weeks training period, none of the six selected exercises elicited a significant improvement in the arm strength required to perform the iron cross on the still rings.

However, other secondary conclusions warrant mentioning.

2. Each of the groups showed improved arm strength means at the end of the six weeks period.

3. The groups performing isometric exercises generally tended to produce better results when tested on the isometric testing apparatus. Such was not the case for the isotonic-exercising groups.

4. The isometric groups generally showed slower or negligible improvement until the second or third week of training, as compared to the more rapid improvement of the isotonic groups.

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The writer wishes to express his appreciation to all the subjects who were connected with the study. Their cooperation and enthusiasm was of great benefit to the completion of the experiment.

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R.L.H.

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CHAPTER I

INTRODUCTION

In gymnastics, there are certain basic elements that are looked for in judging a routine. On the still rings, the iron cross is regarded as being one of the more difficult (in regards to strength) and time-consuming skills to learn, yet one of the more basic elements that should be included in a gymnast's routine.

Several years ago, a technique apparently used by some European gymnasts was brought back to the United States by an American gymnast who competed in the 1962 World Games, in Prague, Czeckoslovakia. This technique involved the use of a bicycle inner-tube as a means of exercising the muscles involved in performing the iron cross. When cut and attached to both rings, and used as a means of support, the gymnast could repetitively go through the full range of motion of the skill, as well as hold himself in the desired iron cross position, with as much or as little muscular tension as he desired.

The writer has observed and experienced the use of such a device, with positive results, and in a relatively short period of time. However, there are many coaches and gymnasts who differ in their opinion as to the better

method for exercising the muscles required to perform the iron cross. One of the most prevalent means used today of exercising for this skill, is repetitively attempting the skill itself. There appears to be much wasted energy and time in this case, since the gymnast has to regain a support position each time, before attempting the skill again. Since an inner-tube is inexpensive and more convenient than wall pulleys or weights, it may prove to be an efficient and productive strengthening device.

Due to the varied opinions of coaches and gymnasts as to the better method of exercising for the iron cross, the selected isotonic and isometric exercises for this study were those that were felt to be the more commonly used methods.

Purpose of the Study

This study was undertaken to determine the effectiveness of six selected exercises on the strength required for performing the iron cross on the still rings. Three of the exercises were isotonic, and the other three were isometric.

Since none of the subjects were on an exercise program of their own, or trying out for a varsity sport, and since the experimental design was too short in duration to develop the strength needed to hold the correct iron cross position as it is held in gymnastics competition, the actual

success of the subjects for performing the skill at the completion of the study was not a deciding criterion. The aim was to determine which exercise was most effective for strength development, in regards to amount of strength developed and the time spent acquiring it.

Need for the Study

There is a definite need for more knowledge of training and teaching techniques in gymnastics. It is an individual sport that is beginning to expand in popularity in America; therefore, much needs to be known for prospective coaches to teach or coach it.

The iron cross is one gymnastics skill that is acquired in a number of ways, and with varying degrees of success. In order to lessen the time spent on the development of strength, and to increase the success in performance of this skill, we need to know which type of exercise to give our gymnasts to produce maximum results.

Such an exercise would be an invaluable asset to a gymnast as a pre-season and during-season conditioning exercise as an aid to better performance.

Definition of Terms

Still Rings. A piece of gymnastics apparatus that consists of two wooden rings, each suspended from the ceiling by a steel cable and a leather strap. The

measurements of the apparatus for competition are: eighteen feet from the floor to the top of the cables; eight feet from the floor to the bottom of the rings; and two feet between the two cables.

Iron Cross. A gymnastic skill, whereby the body is held suspended between the rings, solely supported by the arms, which are held in a horizontal position. The person is facing straight forward.

Isotonic Exercise. An exercise which takes into account the full range of motion of the skill, and where the muscles in action are continually contracting (shortening) and expanding (lengthening).

Isometric Exercise. An exercise which is done statically, without movement. The subject holds himself in the iron cross position for a specified period of time.

Limitations of the Study

The study was limited by the following factors.

1. The number of subjects available for selection was small.
2. The study did not take into account the endurance of the subjects.
3. No attempt was made to measure the subjects for maximum effort.

4. There was no control over the sleep, diet, or daily living habits of the subjects. However, they were instructed to remain as near as possible to their weight at the time of the initial test, and to avoid exercise that would affect the same muscles as those affected by the selected exercises.

CHAPTER II

REVIEW OF THE LITERATURE

Even though strength development methods and muscle-building techniques have been practiced since earliest times, there is still disagreement among researchers as to the BEST method for strength development, namely, isometric or isotonic exercises. The principle remains the same, that of exercising the muscles against gradually increasing resistance, but the methods employed create the controversy and varied results. In this connection, the rapidity and the ultimate degree of development in individuals will be different. This can be attributed to such individual differences as body weight, body type, motivation, age, neuromuscular conditioning, and physiological mechanisms.[1]

Since 1953, there have been investigations of the value of strengthening the muscles by the use of isometric contractions.[2]

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[1]Peter V. Karpovich, Physiology of Muscular Activity (fifth edition; Philadelphia: W. B. Saunders Company, 1959), pp. 34-36; Paul Hunsicker and George Greey, "Studies in Human Strength," Research Quarterly, 28:109-119, 1957, Lucien Brouha, "Training," in Science and Medicine of Exercise and Sports, ed. Warren Johnson (New York: Harper and Brothers, 1960), pp. 414-416.

[2]Layton R. Sutton and Edward M. Krusen, "Variations in Increment for Different Muscles With Brief Maximal Exercise," Physical Medicine and Rehabilitation, 43(8):426-431, August, 1962.

Hettinger and Muller[3] reported that a single daily static contraction of six seconds duration and at two-thirds maximum effort, produces the best results in gaining strength. However, Asa[4] conducted experiments where he used repetitive isometric contractions, and found gains to be greater, as compared to those received when a single daily contraction was used.

Morehouse,[5] in his study of a single voluntary brief maximal exertion against an isometric resistance, found, with periodic repetitions, a very rapid improvement in strength. He also states that these repetitions need not be many, frequent, or maximum in effort.

Muller[6] believes that the key to strength development is tension. In connection with this, Hellebrandt and

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[3]T. Hettinger and E. A. Muller, "Muskelleistung and Muskeltraining," Arbeitsphysiologie, 15:111-126, 1953, in Peter V. Karpovich, Physiology of Muscular Activity (fifth edition; Philadelphia: W. B. Saunders Company, 1959), p. 36.

[4]M. Asa, "Effect of Isotonic and Isometric Exercises Upon the Strength of Muscle" (unpublished Doctor's Dissertation, Springfield College, 1958), in Peter V. Karpovich, Physiology of Muscular Activity (fifth edition; Philadelphia: W. B. Saunders Company, 1959), p. 36.

[5]Lawrence E. Morehouse, "Physiological Basis of Strength Development," in Exercise and Fitness (Chicago: The Athletic Institute, 1960), pp. 193-199.

[6]E. A. Muller, "Training Muscle Strength," Ergonomics, 2:216, 1959.

Houtz[7] experimentally demonstrated the overload principle, and came up with the following conclusions:

1. Strength and endurance increase when repetitive exercise is performed against heavy resistance.
2. It is not the amount of work done which constitutes the training stimulus. The amount of work done per unit of time is the critical variable.
3. Rate of improvement depends on the degree to which a person is willing to overload.

The subject's ability to overcome inhibition and thus allowing himself to exert to a greater capacity is of major importance. Through repetition and experience, the subject learns to adapt to temporary discomfort, and in this manner overcome inhibition and permit an increase in strength of performance.

Rarick and Larsen[8] conducted a study to compare the relative effectiveness of single daily isometric exercise bouts maintained at two-thirds maximum tension, with a program of static exercises in which the frequency of the

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[7]F. A. Hellebrandt and S. J. Houtz, "Mechanisms of Muscle Training in Man: Experimental Demonstration of the Overload Principle," Physical Therapy Review, 36(6):371, June, 1956.

[8]G. L. Rarick and G. L. Larsen, "Observations on Frequency and Intensity of Isometric Muscular Effort in Developing Static Muscular Strength in Post-Pubescent Males," Research Quarterly, 29(3):333-342, October, 1958.

six-second bouts was progressively increased with tension levels at 80% of maximum static strength. Thirty post-pubescent males, divided into two experimental groups and one control group, served as subjects. Within group and between group comparisons of strength scores were made at the conclusion of the four weeks period of training, and again four weeks after the termination of the program.

The following summarizes the findings of this investigation:

1. Both experimental groups elicited gains during the study. However, the strength increase achieved by the 80% maximum tension group was slightly greater at the end of the four weeks period, and the decline in strength was less during the post-training period than for the six-second, two-thirds maximum tension group.

2. The two experimental groups showed significantly higher strength scores than the control group, but the differences between the two former groups was not significant.

3. The 80% maximum tension group was significantly superior to the control group, regarding strength retention. However, such was not the case between the two-thirds maximum tension group and the control group. The difference between the two experimental groups in strength retention, while not significant, favored the group employing the higher tension level for longer periods of time.

The findings of this study generally support the Hettinger-Muller hypothesis of static strength development. Although the two methods used were not significantly different in strength improvement results, the 80% maximum tension group tended to be slightly more effective in terms of developing qualities of strength retention.

As a result of all this relatively recent research, we have been given some significant proof as to the values of isometric exercising, but Bender, Kaplan and Johnson sum up the current belief that, "Isometric exercises are not the whole answer to the conditioning needs of the individual. . .(They) are extremely effective for the development of strength, but their effectiveness is increased if they are used with proper adjunctive isotonic and stretching exercises."[9]

McDonald,[10] also of the same opinion, mentions that many athletes play safe and use a combination of the two types plus a good deal of stretching, and in this way show much wisdom, as both isometric and isotonic contractions are operative in the functional situation.

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[9]J. A. Bender, H. M. Kaplan and A. J. Johnson, "ISOMETRICS. . .A Critique of Faddism versus Facts," Journal of Health, Physical Education and Recreation, 34(5):22, May, 1963.

[10]A. McDonald, "Modern Training and Sports Medicine," Physical Education Journal, 55(165):35-38, July, 1963.

It is the opinion of some researchers, though, that isometric training does not enhance performance of movements involving isotonic contractions, and vice-versa.

Berger,[11] in a study to determine the changes in dynamic strength produced by static training and, conversely, the changes in static strength produced by dynamic training, concluded the following:

1. Improvement in static and dynamic strength was significant.
2. An increase in dynamic strength did not result in a corresponding increase in static strength, as shown by the insignificant coefficients of correlation.
3. Dynamic strength changes also did not result in a corresponding increase in static strength.

Rasch and Morehouse[12] conducted a study, using 24 subjects performing isotonic exercises and 25 performing isometric exercises. All of the subjects were near equal in weight and height. The results of the six-week experiment were that the isotonic group showed greater strength gains and hypertrophy than did the isometric group, and

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[11]R. A. Berger, "Comparison of Static and Dynamic Strength Increases," Research Quarterly, 33(3):329-333, October, 1962.

[12]P. J. Rasch and L. E. Morehouse, "Effect of Static and and Dynamic Exercises on Muscular Strength and Hypertrophy," Journal of Applied Physiology, II(I):29-34, 1957.

whereas subjects showed strength gains in the tests when muscles were employed in a familiar way, little or no gain in strength was observed when unfamiliar procedures were employed. This reflected largely the acquisition of skill. It was suggested also that isotonic exercises probably produce better results from the psychological as well as the physiological aspects. Subjects in both groups expressed a dislike for isometric effort because it was boring.

However, Mathews and Kruse[13] compared the effects of isotonic exercise of the elbow flexor muscles on the ergograph, and isometric exercise of the same muscles by three consecutive six-second maximum pulls on a strap, and could not obtain valid differences of improvement between the two methods. A significant difference between the means of the two groups was not obtained, and they concluded that strength changes were peculiar to the individual. This supports the findings of Karpovich, Hunsicker and Greey, and Brouha[14] in regards to the importance of individual differences in developing strength.

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[13]D. K. Mathews and R. Kruse, "Effects of Isometric and Isotonic Exercises on Elbow Flexor Muscle Groups," Research Quarterly, 28(1):26-37, March, 1957.

[14]Karpovich, Hunsicker and Greey, Brouha, loc. cit.

Berger,[15] comparing the effects of static and dynamic training, trained 57 male college students three times weekly, for 12 weeks, using two positions of the bench press lift at 6-8 seconds maximum exertion, and 9 groups dynamically performing the bench press lift at 2 R.M. and 6 R.M. He found that the static group was significantly stronger than the group trained dynamically with 2 R.M. for two bouts, but significantly weaker than the group trained with 6 R.M. for three bouts. However, he concluded that there is a negligible fatigue problem involved with static training, probably owing to the fact that more exercise sessions could be tolerated.

In regards to isometric and isotonic exercising, Darcus and Salter[16] found that both forms lead to an increase in muscular strength, but that dynamic training causes a greater percentage improvement. Also, this method usually resulted in an immediate and rapid improvement; whereas static activity produced no consistent upward trend until the second week of training.

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[15] R. A. Berger, "Comparison Between Static Training and Various Dynamic Training Programs," Research Quarterly, 34(2):131-135, May, 1963.

[16] H. D. Darcus and N. Salter, "The Effect of Repeated Muscular Exertion on Muscular Strength," Journal of Physiology, 129:325-336, August, 1955.

As evidenced by the literature, the conclusions drawn from research on isotonic and isometric exercising are varied and many times contradictory, even when experiments are carried out in a similar fashion.

From the preceding review of literature, we can draw some reasonably valid conclusions regarding isotonic and isometric exercising.

1. Both isometric and isotonic exercises tend to produce an improvement in strength, but there still exists differences of opinions, and varied results of experiments carried out in a similar fashion, as to which is more effective.

2. Such individual differences as body weight, body type, motivation, age, neuromuscular conditioning, and physiological mechanisms are important factors in strength development.

3. Periodic repetition of isometric exercises produces more favorable gains than a single daily static contraction.

4. Tension and/or overload appear to play an all-important role in improvement. The ability to overcome inhibition and go "all out" is an important factor here.

5. Isometric exercises should be combined with some adjunctive dynamic or stretching exercises, since both usually exist in the functional situation.

6. Isometric exercises are more valuable for static strength requirements, and isotonic exercises are more valuable for improving dynamic strength for dynamic strength requirements.

7. Isotonic exercising usually produces immediate improvement, whereas gains in strength with isometric exercising do not usually appear until the second week of training.

In a re-evaluation of isometric training methods carried out by Muller and Rohmert, Royce sums up the findings found to be prevalent by these men and others, by stating, "It is theorized that the amount and duration of stretch (resulting from the contraction itself) of the elastic muscle elements provides the stimulus for strength increase."[17] This holds true for both isotonic and isometric exercising.

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[17]J. Royce, "Re-Evaluation of Isometric Training Methods and Results, A Must," Research Quarterly, 35(2):215, May, 1964.

CHAPTER III

METHODOLOGY

This study was undertaken to determine the effectiveness of six selected isotonic and isometric exercises upon the development of strength for performing the iron cross on the still rings. In analyzing the effectiveness, an initial test of arm strength was taken at the beginning of the study, and every week thereafter. There were five tests for improvement taken within the approximate six-week period. Due to a Thanksgiving recess, an improvement test could not be taken between the twentieth of November and the fourth of December.

Individual testing consisted of exerting maximally on a simulated still ring set-up, and using a calibrated cable tensiometer for measuring arm strength (Appendix A).

Equipment

The equipment used for exercising consisted of two regular sets of still rings apparatus; one set with the rings attached and one without (Illustrations III and IV). The height of both sets from the floor was approximately five feet. The other piece of equipment, used for both exercising and testing (Illustration II), consisted of a fixed 1/4 inch steel cable passing over a pulley and attaching to a 1/16 inch steel cable (400 pounds maximum tension), which was attached to a 1 inch solid steel bar. On each end of this bar, a 27 inch long

leather strap was attached, supporting a regular sized ring. The distance between the straps at the bar was comparable to the distance between the straps (at a height of 27 inches from the top of the rings), of an average sized individual within the college freshman age group (established from national height norms), extending his arms as though he was holding an iron cross.

Subjects

Seventy-eight male freshmen were selected from the required Physical Education classes at Michigan State University. None of the subjects had previous gymnastics experience, and none of them were on an exercise program of their own, or trying out for a varsity sport. All subjects lived in University dormitories and, for the most part, ate the same type of food.

Experimental Procedure

The seventy-eight subjects were ranked according to body weight, and divided into six groups so as to make the means of the six groups equal. Following this, each group was randomly assigned to an exercise. They then were measured for arm adduction strength, and these initial arm strength means, along with the arm strength means of subsequent testing periods, were recorded for analysis and observation of improvement.

They began their controlled exercising programs the same day as they were measured for initial arm strength. There was no training period, but all were given demonstrations and instructions concerning their individual exercising regimes, and they were under constant observation the first week of exercising to insure that correct training procedures were followed. The exercises were done every Monday, Tuesday, Wednesday, Thursday, and Friday, with Friday being the day for improvement testing. On this day, they performed their exercise after the strength measurement had been taken.

Exercise Programs

Subjects in all groups were given basic instructions that pertained to all six exercises, such as: keeping the arms horizontal and straight while doing the exercise, exerting maximally, and maintaining the initial body weight throughout the training program.

The six different exercises consisted of the following:

GROUP A (Isometric: Testing Apparatus Exercise): Refer to Illustration II: Pressing down maximally for three bouts, each bout of six seconds duration, with a two-minute rest period between the bouts.

Illustration II
Testing Apparatus Exercise

GROUP B (Isotonic: Regular Cross Attempt Exercise): Lowering down from a support position, attempting to hold the iron cross, and jumping up to regain the support position again (one attempt). This exercise involved three bouts, each bout consisting of six attempts, with a two-minute rest period between the bouts.

GROUP C (Isotonic: Inner-Tube Exercise): Refer to Illustration III: Starting from a support position with an inner-tube cut and attached to both rings, and with the tube placed under the feet, lowering down to the iron cross position, and pressing back up with the help of the inner-tube. This exercise involved three bouts, each bout consisting of ten repetitions, with a two-minute rest period between the bouts.

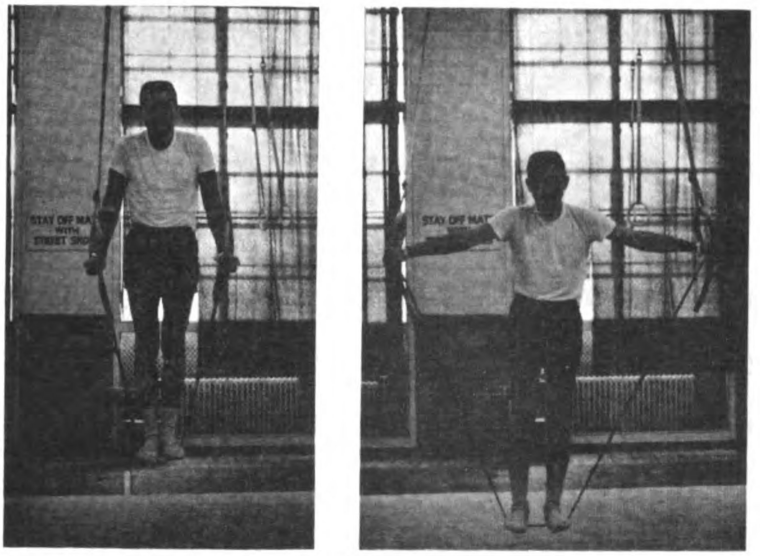


Illustration III

Inner-Tube Exercise

The subjects in this group, as well as those in GROUP E, were instructed to use only as much tension as necessary to perform the bouts and exercise with maximum effort.

GROUP D (Isometric: Arms Through Straps Exercise):

Refer to Illustration IV: This exercise was done on the still rings apparatus that did not have the rings attached. The exercise involved placing the arms through the straps to a point where maximal exertion was needed to hold the iron cross position for the designated length of time. The

Illustration IV

Arms Through Straps Exercise

requirements were two bouts, each bout of six seconds duration, with a two-minute rest period between the bouts.

The subjects in this group, as well as those in GROUP F, were instructed to use only as much tension as necessary to perform the bouts and exercise with maximum effort, and, when they felt that they could tolerate more tension, to slightly move the straps outward.

GROUP E (Isotonic: Inner-Tube Exercise):

Refer to Illustration III: This exercise was similar to that of GROUP C, except that the requirements were two bouts, each bout consisting of ten repetitions, with a two-minute rest period between the bouts.

GROUP F (Isometric: Arms Through Straps Exercise):

Refer to Illustration IV: This exercise was similar to that of GROUP D, except that the requirements were three bouts, each bout of six seconds duration, with a two-minute rest period between the bouts.

In a regular exercise day, each subject was advised to warm-up with light calisthenics and/or stretching exercises before proceeding on to the training exercise. On Friday, they were also told to go through a mild warm-up before being measured, so as to avoid muscular injury.

Method of Analysis

The results of the research were graphically illustrated (Table 1), showing the mean or average data collected on each of the six groups from the beginning to the end of the study. The data were statistically treated using the analysis of variance method, to determine and compare the difference between the initial and final arm strength means of each of the six groups.

CHAPTER IV

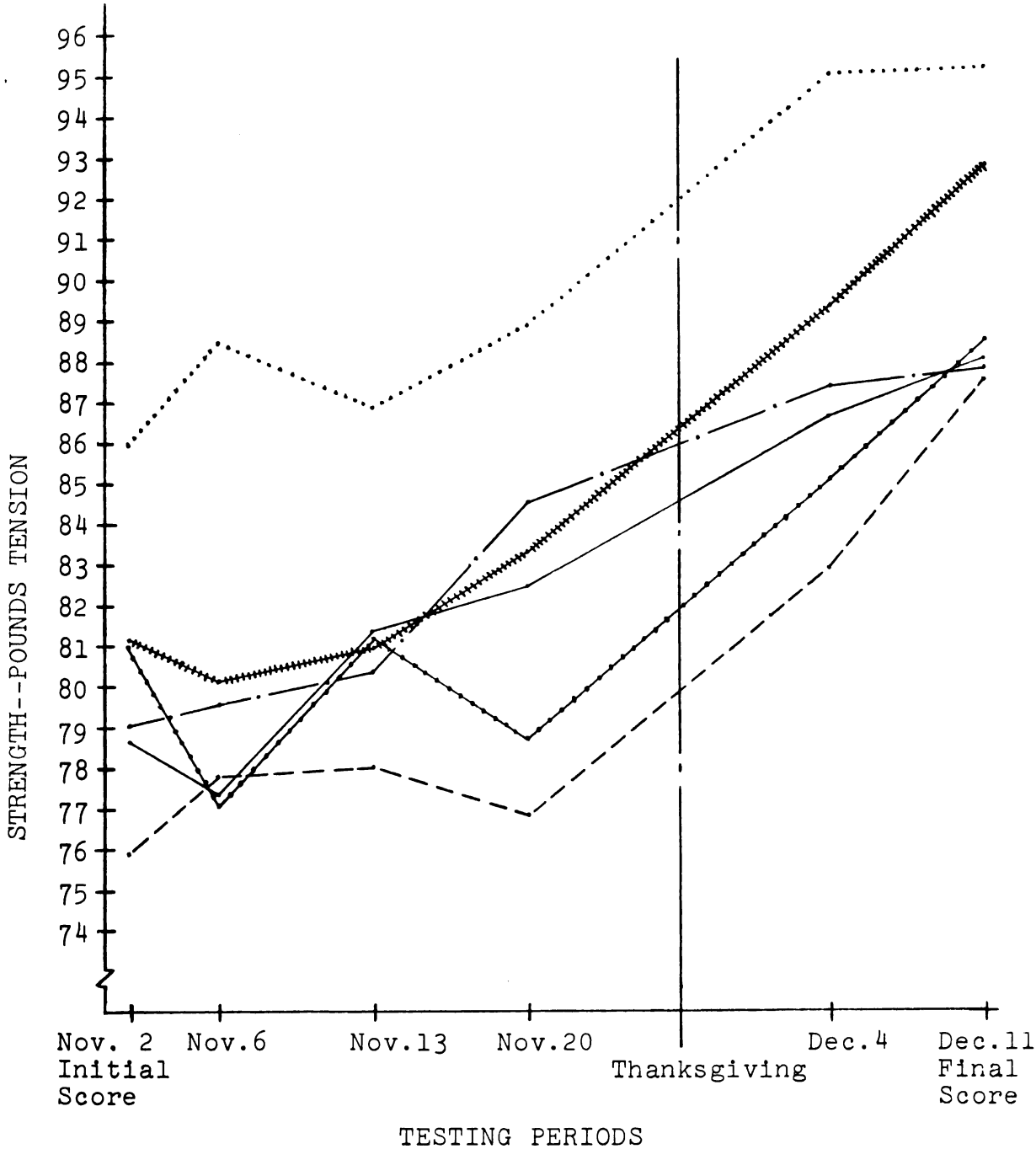
RESULTS AND ANALYSIS OF DATA

This study was undertaken to determine the effectiveness of six selected exercises on the strength required for performing the iron cross on the still rings. Three of the exercises were isotonic, and the other three were isometric. All subjects were freshmen enrolled in the required Physical Education classes at Michigan State University. An initial arm strength recording was taken, and subsequent measurements taken every week thereafter, for six weeks.

The statistics used to analyze the data was the analysis of variance, comparing the significance of each group's performance. Only the difference between each group's initial and final arm strength recordings was used in the analysis.

Table 1 shows the group mean scores for each week throughout the six weeks training program. It can be readily seen that an improvement at the conclusion of the program existed for each group; however, the analysis of variance results, illustrated in Table 2., points to the fact that, although each group elicited improved scores after six weeks of training, the improvement of any one group was not significant at the .05 level of confidence.

TABLE 1: GROUP MEAN PROGRESSION CHART



Group A – – – – – Testing Apparatus Exercise
Group B ———— Regular Cross Attempt Exercise
Group C —·—·— Inner-Tube Exercise (3 bouts)
Group D . . . . . Arms Through Rings Exercise (2 bouts)
Group E ●———●——● Inner-Tube Exercise (2 bouts)
Group F ▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪ Arms Through Rings Exercise (3 bouts)

TABLE 2

ANALYSIS OF VARIANCE RESULTS:
ARM STRENGTH IMPROVEMENT

Source	S. S.	d. f.	M. S.	F
Between	168.53	5	33.71	-
Within	6991.15	71	98.47	-
TOTAL	7159.68	76	-	.34

p = .05

A brief study of the group results in Table 1 will show that some of the results obtained generally support the findings of other researchers. In regards to the findings of Darcus and Salter,[18] the three isotonic groups (with the exception of Group E) showed an immediate improvement, whereas the isometric groups did not elicit any consistent upward trend until the second or third week of training.

It has been previously mentioned that some researchers do not believe that isotonic exercising enhances performance of those movements involving isometric contractions, and vice-versa. From the results in Appendix B, it can be seen that the groups generally showing the highest gain in strength were the isometric groups. This is a significant

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[18]Darcus and Salter, loc. cit., pp. 325-336.

finding, since the testing device was of a static or isometric nature. Although a correlation analysis was not performed on this finding, the results generally agree with Berger's[19] conclusions, and the observations made by Rasch and Morehouse.[20]

Also of interest, is the fact that the two groups showing the highest gains in strength were still rapidly improving at the termination of the six weeks training period.

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[19]Berger, loc. cit., pp. 329-333.

[20]Rasch and Morehouse, loc. cit., pp. 29-34.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study was undertaken to determine the effectiveness of six selected exercises on the strength required for performing the iron cross on the still rings. Three of the exercises were isotonic, and the other three were isometric. The amount of strength developed and the time spent acquiring it were the deciding criteria.

Summary

Seventy-eight subjects were selected from the required freshman Physical Education classes at Michigan State University. They were weighed and ranked according to body weight, then divided into six groups, with the means of each group as near equal as possible. Each group was then randomly assigned to an exercise, and measured for arm adduction strength.

The six exercises performed were: three isometric six-second bouts on the testing apparatus; three isotonic six-attempt bouts of a regular iron cross; three isotonic ten-repetition bouts with the aid of an inner-tube; two isometric six-second bouts with the arms through the straps; two isotonic ten-repetition bouts with the aid of an inner-tube; and, three isometric six-second bouts with the arms through the straps.

Individuals in each group were instructed to exert maximally throughout the entire exercise.

The exercises were done once a day, five days per week, for approximately six weeks. Each subject was tested for arm strength improvement before his exercise on Friday of each week. A final strength test was taken at the end of the training period, and the data were statistically treated using the analysis of variance method, to determine the significance of the difference between the initial and final arm strength recordings of each group.

Conclusions

Within the confines of the study, and subject to the usual limitations of sample and type of training program, the following principle conclusion may be drawn.

1. At the termination of the six weeks training period, none of the six selected exercises elicited a significant improvement in the arm strength required to perform the iron cross on the still rings.

However, other secondary conclusions warrant mentioning.

2. Each of the groups showed improved arm strength means at the end of the six weeks period.
3. The groups performing isometric exercises generally tended to produce better results when

tested on the isometric testing apparatus. Such was not the case for the isotonic-exercising groups.

4. The isometric groups generally showed slower or negligible improvement until the second or third week of training, as compared to the more rapid improvement of the isotonic groups.

Recommendations

At the conclusion of this study, it is recommended that some thought be given to the following problems:

1. A similar study, if undertaken, should be carried on for a longer period of time, since two of the groups showing the greater gains in strength were still rapidly improving at the termination of the experiment.
2. Conduct a training session of short duration before the actual training program begins, to familiarize the subjects with proper exercising techniques and assuring desirable levels of capability for performing the exercises. The absence of this in the study was detrimental to some of the subjects' early performances.
3. Compare the exercises performed in this study with identical or similar exercises, but of a higher and/or longer level of intensity.

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APPENDICES

APPENDIX A

CABLE TENSIOMETER CALIBRATION SCALE

Dial Units	Tension (lbs.)	Dial Units	Tension (lbs.)
3	7	32	81
4	9	33	84
5	11	34	88
6	13	35	92
7	15	36	94
8	17	37	98
9	19	38	101
10	21	39	104
*11	*24	40	108
12	26	41	111
13	28	42	114
14	30	43	118
15	32	44	122
16	35	45	126
17	37	46	130
18	39	47	133
19	42	48	136
20	44	49	140
21	46	50	144
22	49	51	148
23	51	52	152
24	54	53	156
25	58	54	160
26	61	55	164
27	64	56	169
28	68	57	174
29	71	58	180
30	74	59	188
31	78		

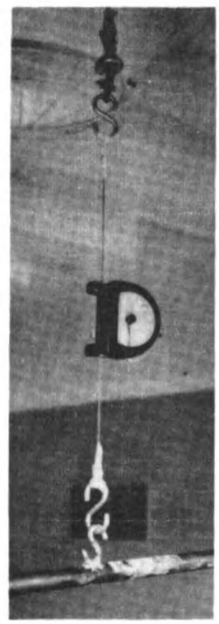

Illustration V
Testing Device

NOTE: *Weight of the testing apparatus

The weight of the testing apparatus exerted a tension of twenty-four pounds, or eleven dial units, on the 1/16 inch

steel cable. Therefore, once the subjects had been measured, these two readings had to be subtracted from their scores. The scores shown in the Appendices are the proper strength measurements, minus the tension exerted by the weight of the apparatus.

APPENDIX B

GROUP A: TESTING APPARATUS EXERCISE

Isometric Weekly Measurements, 3-6 Sec. Bouts

Subjects	Initial Body Wt.	Initial Score Nov. 2		Nov. 6		Nov. 13		Nov. 20		Dec. 4		Final Score Dec. 11		Diff. (lbs) Tension	Final Body Wt.
H. F.	128	24.5	69	26.5	75.5	30	87	27	77	26.5	75.5	28.5	82	+13	130
H. M.	137	27	77	27	77	27	77	28	80	31.5	92	34.5	104	+27	138
A. F.	138	25	70	24.5	69	22.5	62	25	70	26	74	25.5	72	+ 2	140
R. C.	140	24.5	69	25	70	24.5	69	24.5	69	23.5	66	25	70	+ 1	143
E. H.	145	25.5	72	29	84	24.5	69	28.5	82	32.5	96	32.5	96	+24	143
J. H.	150	28	80	29	84	28	80	25	70	30.5	88.5	31.5	92	+12	150
B. R.	170	28	80	29.5	85.5	30	87	29.5	85.5	31	90	31.5	92	+12	167
R. K.	157	32	94	27	77	28.5	82	30	87	31	90	35	106	+12	158
J. R.	156	29	84	28.5	82	29	84	29.5	85.5	30	87	31.5	92	+ 8	158
R. K.	163	29	84	30	87	30	87	28	80	29	84	32	94	+10	163.5
N. G.	164	24	68	25.5	72	29	84	24	68	26.5	75.5	28	80	+12	166
J. C.	165	23	64	25	70	24	68	24	68	27	77	25	70	+ 6	165
R. C.	DROPPED OUT OF SCHOOL														
TOTAL	1813		911		933		936		922		995.5		1050	+139.0	1821.5
Mean Scores	151.08		75.92		77.75		78.00		76.83		82.96		87.50	+11.58	151.79

NOTE: Within each testing period column the figure to the left is the dial unit measurement taken off the cable tensiometer while the figure to the right is the dial unit reading converted to pounds tension.

GROUP B: REGULAR CROSS ATTEMPT EXERCISE

Isotonic Weekly Measurements, 3-6 Attempt Bouts

Subjects	Initial Body Wt.	Initial Score Nov. 2		Nov. 6		Nov. 13		Nov. 20		Dec. 4		Final Score Dec. 11		Diff. (lbs) Tension	Final Body Wt.
P. T.	134	25	70	23	64	27	77	28	80	30.5	88.5	29.5	85.5	+15.5	131.5
J. W.	137	27	77	26	74	26	74	29	84	31	90	29	84	+ 7	136
M. M.	140	30	87	25.5	72	25.5	72	28.5	82	28.5	82	29	84	- 3	137
R. D.	144	30	87	26	74	29.5	85.5	28.5	82	31	90	32.5	96	+ 9	144.5
R. M.	146	29	84	26.5	75.5	30	87	29	84	29	84	32	94	+10	146
R. G.	149	28	80	29	84	31.5	92	30.5	88.5	30.5	88.5	30.5	88.5	+ 8.5	149
P. V.	150	25.5	72	27	77	24.5	69	23.5	66	22	60	25	70	- 2	153
B. W.	155	24.5	69	30	87	28.5	82	27.5	78.5	31	90	30	87	+18	157
J. R.	156	28.5	82	29	84	25	70	28	80	30	87	30	87	+ 5	155
R. M.	165	29	84	29	84	31	90	32	94	30	87	28.5	82	- 2	161
O. O.	165	17	44	17	44	23	64	21	57	25	70	27.5	78.5	+34.5	164
A. B.	166	32	94	32.5	96	33	98	35	106	36	109	34.5	104	+10	172
J. H.	174	31.5	92	31	90	33	98	31	90	33.5	100	34.5	104	+12	172
TOTAL	1981		1022		1005.5		1058.5		1072		1126		1144.5	+122.5	1978
Mean Scores	152.38		78.62		77.35		81.42		82.46		86.62		88.04	+9.42	152.15

GROUP C: INNER-TUBE EXERCISE

Isotonic Weekly Measurements, 3 Bouts, 10 Reps.

Subjects	Initial Body Wt.	Initial Score Nov. 2		Nov. 6		Nov. 13		Nov. 20		Dec. 4		Final Score Dec. 11		Diff. (lbs) Tension	Final Body Wt.
J. O.	134	27	77	27	77	24.5	69	28	80	27	77	25.5	72	- 5	135
H. B.	138	31	90	31	90	32	94	33.5	100	23	102	36	109	+19	143
T. B.	140	24	68	23	64	21.5	58.5	23	64	23	64	26	74	+ 6	137
S. I.	142	25.5	72	23	64	25	70	25	70	28	80	27.5	78.5	+ 6.5	143
C. M.	150	22.5	62	20	54	24.5	69	25	70	25.5	72	24.5	69	+ 7	148
P. M.	150	23.5	66	24	68	23	64	26	74	27	77	28	80	+14	150
D. E.	152	31	90	32	94	31	90	31.5	92	35	106	36.5	110.5	+20.5	154
J. D.	155	24.5	69	28	80	31.5	92	29	84	29.5	85.5	31	90	+21	160
J. B.	155	30	87	30	87	33	98	30.5	88.5	33	98	31.5	92	+ 5	153
R. O.	162	31.5	92	31.5	92	33.5	100	33.5	100	36.5	110.5	32.5	96	+ 4	161
C. S.	165	25.5	72	31	90	28	80	33	98	26	74	27.5	78.5	+ 6.5	162
J. V.	165	29	84	30	87	28	80	31.5	92	32	94	33	98	+14	167
T. M.	170	33	98	30	87	28	80	29.5	85.5	32.5	96	32	94	- 4	176
TOTAL	1978		1027		1034		1044.5		1098		1136		1141.5	+114.5	1989
Mean Scores	152.15		79.00		79.54		80.35		84.46		87.38		87.81	+ 8.81	153.00

GROUP D: ARMS THROUGH STRAPS EXERCISE

Isometric Weekly Measurements, 2-6 Sec. Bouts

Subject	Initial Body Wt.	Initial Score Nov. 2		Nov. 6		Nov. 13		Nov. 20		Dec. 4		Final Score Dec. 11		Diff. (lbs) Tension	Final Body Wt.
L. C.	135	32	94	32	94	32.5	96	32.5	96	38.5	118	35	106	+12	136.5
E. M.	138	30	87	28	80	28	80	30	87	32	94	31.5	92	+ 5	137
R. K.	141	28.5	82	33	98	28.5*	82	30	87	33	98	31.5	92	+10	140
R. L.	142	24.5	69	28	80	24.5	69	26.5	75.5	28	80	30.5	88.5	+19.5	146
G. G.	145	34	102	33	98	33	98	33	98	36	109	36	109	+ 7	146
Z. L.	150	26.5	75.5	26.5	75.5	25.5	72	24.5	69	24.5	69	28	80	+ 4.5	156.5
R. C.	153	23.5	66	24	68	23.5	66	25	70	27	77	24.5	69	+ 3	154
C. G.	155	33.5	100	33	98	33.5	100	33	98	34	102	34	102	+ 2	154
R. Q.	158	25.5	72	30	87	34	102	34	102	34	102	36	109	+37	151
C. M.	162	34	102	33.5	100	34.5	104	32	94	34.5	104	35.5	107.5	+ 5.5	163
R. K.	165	31	90	31	90	31	90	30.5	88.5	32	94	29.5	85.5	- 4.5	172
R. S.	183	32	94	32	94	31.5	92	36	109	36.5	110.5	36	109	+15	180
T. N.	150	29	84	30	87	27.5	78.5	28.5	82	27.5	78.5	30.5	88.5	+ 4.5	146.5
TOTAL	1977		1117.5		1149.5		1129.5		1156		1236		1238	+120.5	1982.5
Mean Scores	152.08		85.96		88.42		86.88		88.92		95.08		95.23	+ 9.27	152.5

*Strained Shoulder

GROUP E: INNER-TUBE EXERCISE

Isotonic Weekly Measurements, 2 Bouts, 10 Reps.

Subject	Initial Body Wt.	Initial Score Nov. 2		Nov. 6		Nov. 13		Nov. 20		Dec. 4		Final Score Dec. 11		Diff. (lbs) Tension	Final Body Wt.
R. P.	128	25	70	23	64	26	74	24.5	69	25.5	72	25.5	72	+ 2	128.5
G. T.	138	21.5	58.5	22.5	62	20.5	55.5	20.5	55.5	21	57	23	64	+ 5.5	140
R. H.	140	27	77	28.5	82	31	90	30	87	32.5	96	32	94	+17	148
P. A.	143	28	80	24	68	25.5	72	28.5	82	24.5	69	28	80	+ 0	139.5
R. W.	147	34	102	31.5	92	31	90	31.5	92	34	102	36	109	+ 7	153
A. L.	150	23	64	23	64	24.5	69	23.5	66	23	64	23.5	66	+ 2	143
R. S.	154	26	74	23.5	66	25	70	26	74	24	68	25	70	- 4	149
W. V.	155	32	94	30	87	34	102	31	90	33	98	35	106	+12	152
C. D.	160	32	94	30.5	88.5	32.5	96	31.5	92	32.5	96	38	116	+22	150
G. H.	163	28.5	82	25.5	72	27	77	27.5	78.5	32	94	28	80	- 2	160
S. R.	162	27	77	30	87	27.5	78.5	23	64	31	90	30.5	88.5	+11.5	152
R. R.	167	29	84	26.5	75.5	28.5	82	26.5	75.5	29	84	33	98	+14	166.5
R. L.	170	32.5	96	32	94	33.5	100	33	98	38	116	35.5	107.5	+11.5	171
TOTAL	1977		1052.5		1002		1056		1023.5		1106		1151	+98.5	1952.5
Mean Scores	152.08		80.98		77.08		81.23		78.73		85.08		88.54	+ 7.58	150.19

GROUP F: ARMS THROUGH STRAPS EXERCISE

Isometric Weekly Measurements, 3-6 Sec. Bouts

Subjects	Initial Body Wt.	Initial Score Nov. 2		Nov. 6		Nov. 13		Nov. 20		Dec. 4		Final Score Dec. 11		Diff. (lbs) Tension	Final Body Wt.
J. B.	135	20.5	55.5	25	70	25	70	24	68	24	68	20.5	85.5	+30	134
J. C.	138	27	77	24	68	27	77	25.5	72	28.5	82	28.5	82	+ 5	131
B. G.	140	24	68	24	68	24	68	24	68	24	68	35.5	107.5	+39.5	140
T. S.	138	33	98	29	84	25*	70	28	80	31.5	92	32	94	- 4	134.5
B. Q.	146	30	87	30*	87	24.5	69	28	80	28.5	82	27.5	78.5	- 8.5	149.5
K. K.	146	30	87	30.5	88.5	30	87	29	84	31	90	31	90	+ 3	152.5
J. E.	154	28	80	28	80	31.5	92	32	94	32	94	34	102	+22	157
B. M.	156	26	74	23.5	66	24.5	69	25	70	29	84	28	80	+ 6	159
J. L.	160	26.5	75.5	27	77	28	80	30	87	31.5	92	33	98	+22.5	169
J. K.	161	31.5	92	32	94	30.5	88.5	33	98	34.5	104	36	109	+17	164
L. K.	164	24	68	27	77	29	84	28	80	32	94	29	84	+16	162
R. J.	168	32	94	30	87	32.5	96	33.5	100	35	106	32.5*	96	+ 2	164
T. V.	171	33	98	32	94	34	102	34	102	35	106	33.5	100	+ 2	174
TOTAL	1977		1054		1040.5		1052.5		1083		1162		1206.5	+152.5	1990.5
Mean Scores	152.08		81.08		80.04		80.96		83.31		89.38		92.81	+11.73	153.12

*Strained Shoulder