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THE EFFECTS OF PROGRESSIVE RESISTANCE
EXERCISE ON THE UPPER EXTREMITIES AND
ITS EFFECTS ON 100 YARD SWIMMING
PERFORMANCE

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY
Allyn Lehr McCormie
1956

THE EFFECTS OF PROGRESSIVE RESISTANCE EXERCISE
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by

Allyn Lohr McCormic

A THESIS

Submitted to the College of Education of Michigan
State University of Agriculture and Applied
Science in partial fulfillment of the
requirements for the degree of

MASTER OF ARTS

Department of Health, Physical Education and Recreation

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ACKNOWLEDGMENTS

The writer wishes to express his grateful acknowledgment to his advisor, Dr. W. D. Van Huss, for his professional guidance, criticisms, and valuable suggestions rendered in this study.

Thanks are extended to the subjects who cooperated in this study to the fullest extent.

The author is deeply indebted to his wife, Janet, for her valuable cooperation in the final preparation of the study.

A. L. Mc.

DEDICATION

This thesis is respectfully dedicated to my wife,
Janet.

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Approved

Wayne L. Lawrence

ABSTRACT

Title of Study. The Effects of Progressive Resistance Exercise on the Upper Extremities and Its Effects on 100 Yard Swimming Performance.

Statement of the Problem. To evaluate the influence of progressive resistance exercise on the upper extremities and its effects on 100 yard crawl stroke performance.

Methodology. Two groups of five subjects each, were matched on total times for the 100 yard crawl stroke. On each group there were four freshman swimming team candidates and one varsity swimming team candidate. The experimental group only participated in a weight training program. Both groups had identical swimming training programs to go by.

The timing program consisted of meeting each week and being timed in the following events: start 50, start 100, and start 440 yard swims, also the dead start 20 yard legs alone, arms alone, and whole stroke, there were times also gathered for the push off 25 and 75 yard distances.

The data were presented graphically and tested statistically by the small sample "t" and analysis of variance of several matched groups.

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Conclusions. The following conclusions are drawn on the basis of the data presented. Any interpretation of these conclusions should be made in the light of the limitations of the study.

1. Weight training has no deleterious effects on sprint swimming times either in the 100 yard distance or the 50 yard distance.

2. There was no significant results found as to whether weight training is beneficial to speed in swimming. Although there was a significant "t" value [$t = 2.43$ with 9 df] in the 50 yard start swim there was no significance noted in the 25 yard swim, 75 yard swim, and 100 yards swims. This then possibly was just a chance happening in the 50 yard distance.

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CHAPTER I

INTRODUCTION

(It has long been thought by most coaches and trainers that a vigorous program of weight training is detrimental to their swimmers.) (It is believed that such a program produces "muscle boundness" or "muscle tightness" and therefore decreases the range of motion and flexibility in the muscles involved.) (Massey and Chaudet¹, however, state that weight training increases range of movement in joints exercised while it may actually restrict movement in areas not exercised.) (Davis² investigating the effect of weight training on speed in swimming found the subjects increased in speed in a weight training program.) The data in this work, however, were inconclusive as to whether they improved solely due to the weight training. They might possibly have improved in spite of the weight program.

¹B. H. Massey and N. L. Chaudet, "Effects of Systematic, Heavy Resistive Exercise on Range of Joint Movement in Young Male Adults," Research Quarterly, 27:41-51, March, 1956.

²J. F. Davis, "The Effect of Weight Training on Speed in Swimming," Physical Educator, 12:28-29, March, 1955.

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As a follow up to Davis'³ work this experimental study was set up as a controlled experiment to give us insight into the effects of weight training programs on swimmers.

Statement of the Problem. To evaluate the influence of progressive resistance exercise on the upper extremities and its effects on 100 yard crawl stroke performance.

Need for the Study. The effect of progressive resistance exercise on sprint swimming has not been established. This investigation hopes to answer one of the most pressing questions being asked by the coaches, trainers, and swimmers today.

Limitations of the Study. 1. Size of samples. This study was performed with five experimental and five control subjects. The groups were matched on total times for 100 yard swimming performances.

2. Psychological factor. It is difficult to determine whether the subjects are performing maximum lifts or swimming maximum speed. It was not possible to check in this study whether the subjects were handling maximal weight

³
Ibid.

or not as a bias exists among swimmers against this. The weights reported are accurate and were checked. A very close check was maintained on the swimming times and it is felt minimal times were obtained.

3. Control group. It was felt that a sense of boredom may have influenced their performances because they had nothing to do but swim.

Definitions. The following are defined briefly for use in this study.

Progressive Resistance Exercise--For use in this study, the term progressive resistance exercise refers to load-resisting arm exercises.

Load-Resisting Exercises--"This term [load-resisting exercise] refers to those in which the exercise load resists the muscle."⁴

Maximum Load--The amount of weight that can be lifted for a given amount of repetitions.

Repetitions or Six Repetitions--Doing one exercise six times under maximum load.

Cycle or Three Cycles--Doing all five exercises in the order that they are given on the exercise sheet. Three cycles is doing these in order, three times.

⁴T. L. DeLorme and A. L. Watkins, Progressive Resistance Exercise (New York: Appleton-Century-Crofts, Inc., 1951), p. 23.

Push Off Times--Pushing off from the side of the pool while in the water. Times were recorded when the feet left the wall.

Start Times--A regular racing start was used, times were then recorded from the command "go," to the completion of the distance.

Dead Start--The subject lies prone in the water with his feet just touching the end of the pool. Times were recorded from the command "go."

CHAPTER II

RELATED LITERATURE

(Bob Kiphuth is primarily a body builder. His record as a coach merely serves to lift him out of the class of quack muscle-builders. He worked on the theory that his body building could be applied to any sport because he developed the correct "mechanics of muscle and movement": in swimming, the muscles that enable you to bring your arms down fast through the water and put power into the beat of your kick.¹)

Introduction and Background to Progressive Resistance Exercise. (DeLorme and Watkins² pointed out that progressive resistance exercise principles and techniques as they are now employed therapeutically had their inception in World War II.) Due to the urgent need for hospital beds and speedier rehabilitation of the wounded, this type of exercise was developed in Gardiner General Hospital, Chicago, Illinois, in the spring of 1944.

¹R. J. H. Kiphuth, "Yale's Body Builder," Literary Digest, 117:28, February 3, 1934.

²T. L. DeLorme and A. L. Watkins, Progressive Resistance Exercise (New York: Appleton-Century-Crofts, Inc., 1951), p. 1.

The scope of progressive resistance exercise has steadily widened since its inception with rehabilitation of veterans of World War II.³

(The age limits of progressive resistance exercise applications have been extended to include, not only the army age group, but the very young and the aged.⁴)

There were many false interpretations of the old term heavy resistance exercise as found by DeLorme and Watkins.⁵ (Some of the interpretations were, that only great poundage was used and that a muscle initially must have nearly normal power. (This then led to the change in name to progressive resistance exercise.))

The Need for Progressive Resistance Exercise. The use of progressive resistance exercise is primarily that of increasing strength. (This exercise is based on the physiological principle that in order to rapidly improve muscular

³T. L. DeLorme, "Recent Developments in Progressive Resistance Exercise," American Academy of Orthopedic Surgeons Instructional Course Lectures (Chapter VIII, Progressive Resistance Exercise, Ann Arbor, Michigan: J. W. Edwards, 1950), p. 225.

⁴Ibid.

⁵T. L. DeLorme and A. L. Watkins, "Techniques of Progressive Resistance Exercise," Archives of Physical Medicine, 29:263, May, 1948.

strength, one must contract against a resistance that will bring about near maximal voluntary effort.) Then, the resistance must also be progressively increased.⁶

Cureton⁷ states that sprint swimmers are forceful, testing high in arm strength. Also that all are average or above in strength.

(As a rule the practice of the sport itself is not sufficient to develop the muscles to their greatest strength, necessitating the addition of strength building exercises.) (In sports which emphasize skill rather than strength, athletes may benefit by strength exercises consisting of slow work with heavy weights and pulleys.) (In many instances athletes reach a peak in their play that represents only the skill side of the activity.) (Further improvement is impeded by their limitations in strength.⁸)

⁶A. L. Watkins, "Practical Applications of Progressive Resistance Exercise," Journal of American Medical Association, 148:443, February, 1952.

⁷T. K. Cureton, Physical Fitness Appraisal and Guidance (St. Louis: The C. V. Mosby Company, 1947), pp. 107-108.

⁸L. E. Morehouse, "The Physiology of Athletics," Scholastic Coach, 10:1:25, September, 1940.

(DeLorme⁹ found exercise to be essential in restoring function to muscles, which were weakened and atrophied as a result of injury as well as disease.)

Effects of Exercise on Muscle. (As Wakim¹⁰ points out, exercises which are regular and systematic, and of heavy nature will tend to thicken and toughen the sarcolemma of muscle fibers and increase the amount of connective tissue within the muscle.) (There is an increase in muscle size, but not an increase in the number of muscle fibers.) DeLorme and Watkins¹¹ further emphasize that there is an increase in the number of capillaries, and the content of muscle hemoglobin, phosphocreatine, and glycogen.

(Systematic progressive resistance exercise carried on for sufficiently long period of time augments the ability to do work.) (If the exercise is carried on against gradually increasing resistance, the most outstanding effect is increase in strength.) It is further determined that when

⁹T. L. DeLorme, "Restoration of Muscle Power by Heavy Resistance Exercise," The Journal of Bone and Joint Surgery, 27:645, October, 1945.

¹⁰K. G. Wakim, "The Physiologic Aspects of Therapeutic Physical Exercise," The Journal of the American Medical Association, 142:2:104-105, January 14, 1950.

¹¹T. L. DeLorme and A. L. Watkins, Progressive Resistance Exercise (New York: Appleton-Century-Crofts, Inc., 1951), p. 14.

graphed against time, the slope gradient of the training curve will vary from individual to individual as will also vary the peak development attainable.¹²

Studies Related to Weight Training. (Capen¹³ ran an experiment in which he compared a weight training group to a required physical education group. The weight training group showed greater general improvement in muscular strength, although there were no statistically significant differences between the two groups in muscular strength) (McCloy's Revision), muscular endurance [chin-ups, push-ups, sit-ups, and squat jumps], and circulo-endurance [300 yard shuttle run] or in athletic power. The weight training group did, however, excel the required physical education group in all final scores, though not significantly due to the difference in initial scores. Capen concluded that the weight training group improved more in speed events than the required physical education group.

Chui¹⁴ studied twenty-three subjects engaged in weight training and compared these with twenty-two subjects

¹²Ibid.

¹³E. K. Capen, "The Effects of Systematic Weight Training on Power, Strength, and Endurance," Research Quarterly, 21:83-93, May, 1950.

¹⁴E. Chui, "The Effect of Systematic Weight Training on Athletic Power," Research Quarterly, 21:188-194, October, 1950.

participating in a required physical education program. The weight training group engaged in their program two to three times weekly for one hour. The study hoped to ascertain some pertinent facts covering the effects systematic weight training had on athletic power. The weight training subjects showed a slight improvement over the required physical education group in body weight, the Sargent jump, the eight and twelve-pound shot put, and sixty yard dash. In the twelve pound shot the weight training group improved 2.37 feet. The mean improved from 27.18 to 29.5 feet. There was no reported losses. The physical education group's distance improved 1.41 feet. Their mean improved only from 25.12 to 25.7 feet. The mean of those that lost was 10.34 inches. There were similar results in the eight-pound shot but not as much improvement between the two groups. (Chui concluded that the subjects engaged in weight training improved over the control group and that results indicated that probability of increasing power through systematic weight training,) although no statistical significance was shown.

Zorbas and Karpovich¹⁵ studied six hundred men, age 18 to 30 years, in an effort to determine the effects of

¹⁵W. S. Zorbas and P. V. Karpovich, "The Effect of Weight Lifting upon the Speed of Muscular Contractions," Research Quarterly, 22:145-148, May, 1951.

training with weights on speed of muscular contraction. Two groups were used, the control group consisted of 300 men who never indulged in weight training, the experimental group consisted of 300 men who had participated in weight training for a minimum of six months and still were engaged in this activity.

A specially constructed apparatus for recording speed of rotary movements of the arm was used for measurement. Each group had two trials with three minutes of rest between tests. The lowest recorded time in seconds was used. The weight lifting group was concluded to be faster in speed than the non-lifters, although no statistical significance was shown in the study.

DeLorme, Ferris, and Gallagher¹⁶ studied the effects of progressive resistance exercise on muscular contraction time. Elbow flexion and knee extension were studied using ten adolescent boys for subjects. Two groups consisting of five boys in an exercise group and five boys in a control group were used. The exercise group was given progressive resistance exercise four times a week for four months.

¹⁶ T. L. DeLorme, B. G. Ferris, and J. R. Gallagher, "Effects of Progressive Resistance Exercise on Muscular Contraction Time," Archives of Physical Medicine, 33:86-92. February, 1952.

Elbow flexion and knee extension was measured on an electric clock calibrated in and accurate to within one/one-hundreths seconds. One R. M. 's were determined for biceps, knee extension, and hip-knee extension, while circumferential upper arm and thigh measurements at the beginning and end of the experimental period were taken. It was concluded that following the progressive resistance exercise period there was an increase in circumferential measures and a considerable increase in elbow flexion and knee extension one R. M. The results of the post-exercise contraction time tests showed no evidence of slower times for the exercise group. No statistical significance was shown in this study.

Masley, Hairbedian, and Donaldson¹⁷ working with three groups; a beginning weight lifting class, a volley ball class, and a sports lecture class, studied the effect of systematic weight training on coordination and speed of movement. Speed was determined by twenty-four clockwise revolutions of the arm in a frontal plane in seconds. The apparatus used was similar to the hand crank of Zorbas and Karpovich.¹⁸ The coordination test consisted of a foil test at a copper disc for speed and accuracy. Strength was

¹⁷J. W. Masley, A. Hairabedian, and D. N. Donaldson, "Weight Training in Relation to Strength, Speed, and Coordination," Research Quarterly, 24:308-315, October, 1953.

¹⁸Zorbas and Karpovich, op. cit., pp. 146-147.

tested by McCloy's revision of Roger's Strength Index. The weight training class improved in strength, speed, and coordination over the two other groups, although no statistical significance was shown. It was concluded that weight training had no apparent deleterious effect on the subjects.

Wilkins¹⁹ tested three groups as a means of finding the effects of weight training on speed of movements. The first group consisted of an elementary weight lifting class with no previous experience; the second group was made up of chronic weight lifters with an average of two and a half years experience; the third group, a control group, was taken from an elementary swimming class and a golf class.

All groups were tested on an arm movement recording apparatus. A bicycle crank with a radius of 7-1/4 inches was mounted on a frame and attached to the wall. The axis of the crank was 58 inches from the floor. There was no resistance other than the ball bearings used. Hand grips were made from the taped pedal sleeves. An electric counter set at fifteen second intervals was used to count the number of revolutions the subjects made. Both hands were used. The elementary weight lifters and the control group improved

¹⁹B. M. Wilkins, "The Effects of Weight Training on Speed of Movement," Research Quarterly, 23:361-369, October, 1952.

the same from the first test to the retest. The trend of the data appears to be toward weight training improving speed.

(Davis²⁰ studied the effect of weight training upon speed in swimming the crawl stroke. He used seventeen subjects who previous to college had participated in competitive swimming or had equal ability. A period of ten weeks was devoted to experimentation. During the first week two one-half hour workouts were conducted in the pool. Upon completion of these workouts, times were taken for the start twenty-five and fifty yard swims. The weight training program was carried from the second to the ninth week and during this period they were allowed in the pool only once a week. The program consisted of three workouts a week during which the subjects did the following exercises: supine press with bar bell, single straight arm pull down with wall pulley weights, two arm curl with bar bell, deep knee squats with bar bell, stiff leg dead lift with bar bell, supine arm circulating with dumbbells, bent over rowing with bar bell, and situps on an inclined board. Each exercise was done under maximum load using eight to eleven

²⁰ J. F. Davis, "The Effect of Weight Training on Speed in Swimming," Physical Educator, 12:28-29, March, 1955.

repetitions. After each exercise the subject was to rest for at least three minutes. The subject then repeated each exercise using the same weights and doing as many repetitions as possible. The tenth week each subject was timed as he was in the first week of the experiment. Statistics were then used on the mean differences between the initial and final times for the twenty-five yard swim. Here there was a decrease of .57 seconds. In the fifty yard swim there was a drop of 1.08 seconds. The "t" values for the differences in the twenty-five yard swim was 7.35 and the fifty yard distance was 5.07. Both of these were well above the requirement for significance at the one per cent level of confidence. All subjects showed an increase in speed in swimming the crawl stroke. This information would seem to indicate that weight training is not detrimental to swimming, but highly beneficial.)

CHAPTER III

RESEARCH METHODS

This study was designed to determine the effect of progressive resistance exercise on the upper extremities and its effects on 100 yard crawl stroke performance. In addition to determining the effect of progressive resistance exercises on crawl stroke swimming, it was hoped that some determination could be made of the amount of weight training that could be done by swimmers who were dependent on swimming speed, without slowing them down.

I. SOURCE OF DATA

Method. The experimental method of research was used as shown:

Experimental group	T_1 _____ T_2
Control group	T_1 _____ T_2

The subjects were matched in two groups on the basis of their total times for the 100 yards.

Selection of Distances and Exercises. Times were taken in the start fifty, and four hundred forty as well as the start one hundred yard swim. These were used to gain further insight into the effects the weight training might

have in speed in swimming. Three other measures given were the arms alone, legs alone, and whole stroke tests as described by Wilson.¹ These tests were used to gain insight into the different components that make up the crawl stroke.

A swimming program was outlined for both groups. This covered the entire experimental period and was utilized to standardize the program for both groups.²

A weight training program was outlined for the experimental group. This program consists, primarily of exercises for the upper extremities.³

Selection of Subjects. A large number of subjects were tested at the beginning of the experiment. The subjects finally selected consisted of Michigan State University freshman and varsity swimming team candidates. Two matched groups in the start one hundred yard swim were selected from the trials given.

The experimental and control groups consisted of four freshman swimming team candidates and one varsity

¹C. T. Wilson, "Coordination Tests in Swimming," Research Quarterly, 5:81-88, December, 1934.

²See Appendix A.

³See Appendix B.

swimming team candidate. All subjects participated in a swimming program that was set up for them.

The Experimental Factor. A progressive resistance exercise program for the upper extremities was set up for each subject in the experimental group. The program consisted of the experimental group meeting five days a week and doing a series of five exercises for increasing the strength of the upper extremities. The exercises were accomplished by each subject determining his maximum load in each exercise as prescribed. [Three cycles of six repetitions with a slight rest in between if desired.]

The control group did not participate in any weight training program but merely performed in the swimming training program.

Testing Procedure. All subjects met on Tuesdays of each week for timing in the start one hundred yard swim. On Wednesdays the subjects were timed in the following distances as prescribed by Wilson.⁴

Twenty Yard Swim Arms Alone. This test measures the time it takes a subject to swim twenty yards with his arms alone. The feet are supported in the water by a bouyance tube with the legs strapped together.⁵

⁴Wilson, loc. cit.

⁵Ibid.

Twenty Yard Swim Legs Alone. In this test the time was recorded for each subject swimming twenty yards using his legs alone. The arms are supported by a kick board held with the arms extended forward.⁶

Twenty Yard Swim Whole Stroke. In this test the subject swims the crawl stroke twenty yards as fast as possible from a dead start in the water. Time is recorded on these tests by a stop watch when the command "go" was given.⁷

On Thursday of the third week the second and final times were taken for the start four hundred forty yard swim.

During the course of the swimming program times were taken for the push off twenty-five and seventy-five yard swims.

Times were also taken for other distances as just part of their daily routine.⁸

The tabulation sheets for the experimental group were handed in at the end of each week. New sheets were handed out on Monday of the following week with the weights recorded on them which were done on the previous Friday.

The experiment was conducted for seven complete weeks. The initial times were taken during the week preceding the first week and the final times were taken during the week following the seventh week.

⁶Ibid.

⁷Ibid.

⁸See Appendix A.

II. TIMING TECHNIQUES

Fifty, One hundred, and Four hundred forty Yard Start Swims. A regular racing start was taken in each of these distances. Time was recorded by means of a stop watch from the command "go" until the distance was completed.

All Twenty Yard Swims. These times were dead start times. The subjects were placed in the water in a horizontal prone position. The feet were supported and brought up flat on the end of the pool. Time was recorded on the command "go" until the head crossed the twenty yard mark.

Twenty-five and Seventy-five Yard Push Off Swims. Times in these distances were push off times. Time was recorded from the command "go" until the distances had been completed.

The other times taken during the swimming program⁹ were taken using the push off method.

Timing Device. The timing device was a stop watch with a split second hand. This watch was accurate to the nearest tenth of a second and was read as such. All times were taken by the same person to assure consistent timing.

⁹

See Appendix A.

III. STATISTICAL TECHNIQUES

The statistical techniques used in comparing groups were the analysis of variance of several matched groups as described by Edwards¹⁰ and Student's "t" for matched groups also as described by Edwards.¹¹

¹⁰A. L. Edwards, Statistical Analysis (New York: Rinehart and Company, 1946), pp. 225-232.

¹¹Ibid., pp. 174-176.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The preceding chapters have discussed the statement of the problem, needs for the study, related studies, and the methods used in collecting the data. This chapter will give the results of the study indicated in the procedure described in Chapter III.

The purpose of this study was to evaluate the influence of progressive resistance exercise on the upper extremities and its effects on one hundred yard crawl stroke performance. Because many believe that weight training is deleterious to speed, this study also hoped to determine the amount of progressive resistance exercise which may be given swimmers dependent on speed for their performances.

The subjects used in this study were divided into experimental and control groups. Five subjects were placed in each group, matched on total times in the one hundred yard crawl stroke.

The experimental group only, participated in a weight training program of the upper extremities. Both groups participated in the identical swimming programs. The swimming performance data consisted of collecting the following times: [1] Fifty yard start swim, [2] one hundred

yard start swim, [3] four hundred forty yard start swim, [4] twenty yard arms alone swim, [5] twenty yard legs alone swim, [6] twenty yard whole stroke swim, and [7] twenty-five and seventy-five yard push off swims.

Treatment of Data. All results were tabulated and differences between the groups from T_1 through T_2 were evaluated using the analysis of variance of several matched groups.¹ The small sample "t" test was utilized for comparison of difference between T_1 and T_2 of the experimental group versus the differences between T_1 and T_2 of the control group.²

Presentation of Data. The data are presented graphically and discussed as to the trends, findings, and statistical significance. The presentation is divided into two categories, [I] the testing results and discussion, and [II] general discussion.

I. TESTING RESULTS AND DISCUSSION

One hundred yard swim results. The results of the one hundred yard swim are shown in Chart I.

¹A. L. Edward, Statistical Analysis (New York: Rinehart and Company, 1954), pp. 225-230.

²Ibid., pp. 174-176.

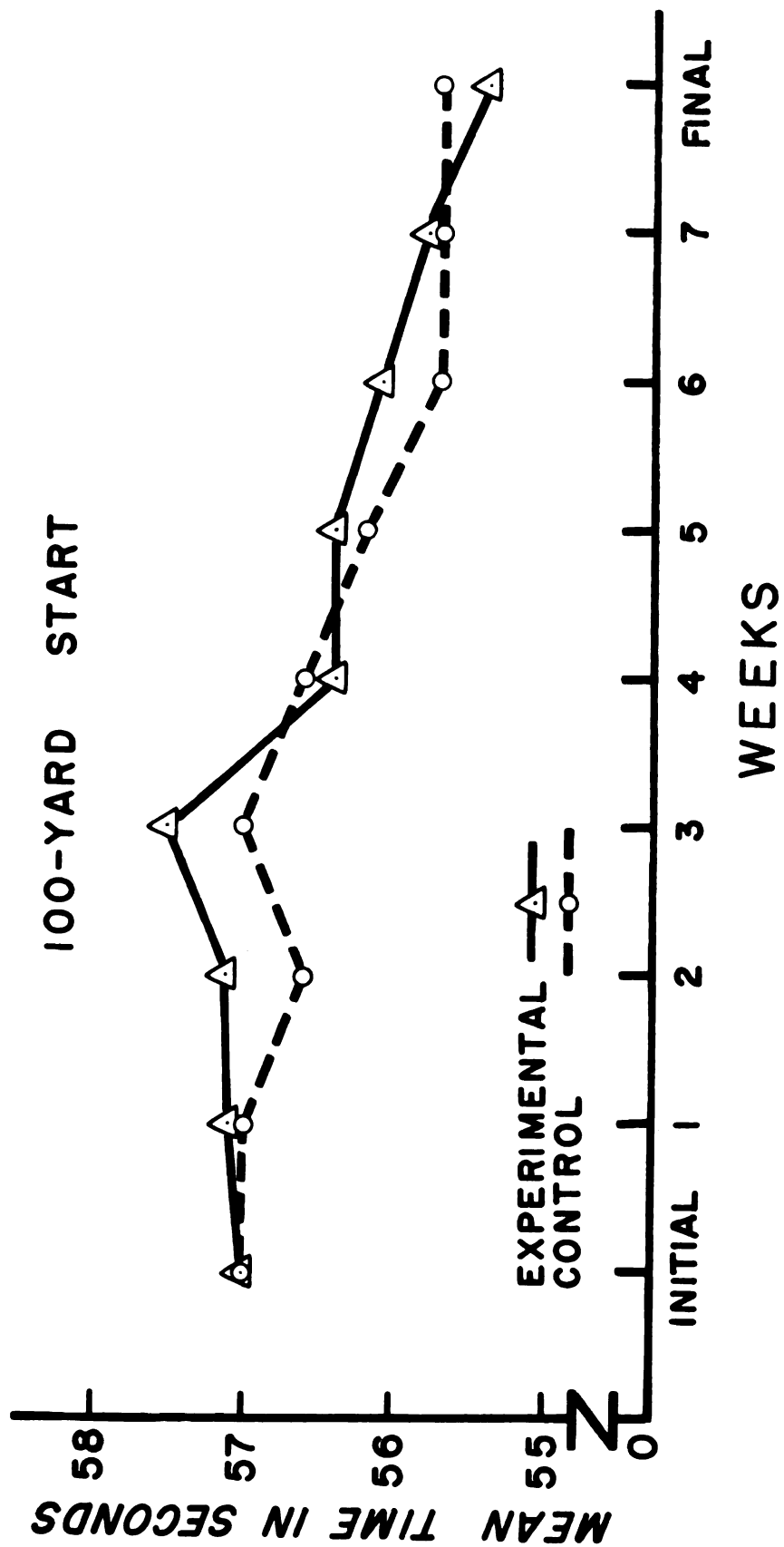


CHART I

The differences from T_1 to T_2 were analyzed using the "F" test and were found to be highly significant [$F = 6.77$, significant at the 1% level with 8 and 32 df] in the experimental group columns. The control group also showed significance [$F = 3.20$, significant at the 1% level with 8 and 32 df] though not as great. From these results we may infer that the longitudinal differences are indicative of real differences and are not due to chance.

The T_1 to T_2 times for the experimental group were 285.2 to 277.3 respectively. Thus we have a group drop of 7.9 seconds. The T_1 to T_2 times for the control group were 285.0 to 278.4 or a group drop of 6.6 seconds. Thus we find that the experimental group dropped 1.3 seconds more than the control group.

The "t" value of .45 [9 df], however, indicates there was no significant difference found in analyzing the improvements between the two groups.

It is important to remember that even though both groups showed statistical significance at the one per cent level of improvement in the one hundred yard swim, the experimental group was found to have improved the most. Therefore, we could conclude that the effects of progressive resistance exercise were not deleterious to them. The trends, in fact, are in the opposite direction [faster times] but are not significantly greater for the experimental group in this study.



Twenty yard arm stroke alone results. The results of the twenty yard arm stroke alone are shown in Chart II.

The differences from T_1 to T_2 were compared using the "F" test and were found to be significant [$F = 5.48$, significant at the 1% level with 6 and 24 df] in the experimental group columns. The control group value of "F" was more significant [$F = 7.92$, significant at the 1% level with 6 and 24 df] than the experimental group.

The small sample "t" test was used to compare the differences of T_1 and T_2 of the experimental group with that of the T_1 and T_2 of the control group. It was found that there was no significant [$t = .88$ with 9 df] difference between the two groups in the twenty yard arm stroke alone.

The actual group times for the experimental subjects from T_1 to T_2 decreased 2.5 seconds as compared to the T_1 to T_2 drop of only 2.0 seconds for the control group over the seven week study period. It is felt at this time that the study was stopped too early to see the complete results of the experimental group. As can be seen in Chart II the times for the experimental group data were still decreasing at the conclusion of the study and the times for the control group had already leveled off. It is felt at this time that the effects of progressive resistance exercise in the arms alone test is not harmful to the experimental group but possibly could have helped them improve more than the control group.

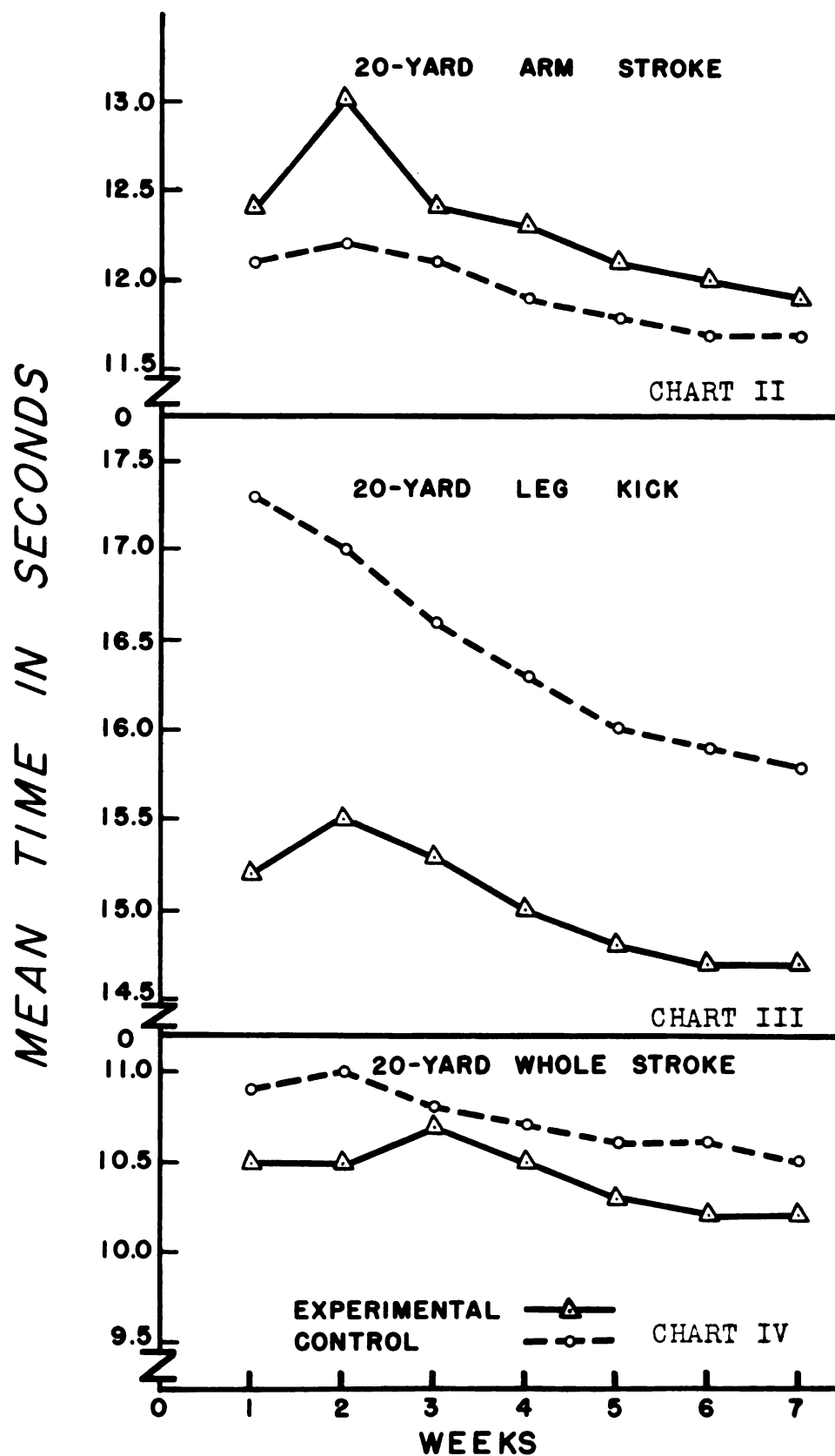
Twenty yard legs alone results. The results of the twenty yard legs alone test are shown in Chart III.

The "F" value for the differences in T_1 to T_2 for the experimental group was not significant [$F = .97$, not significant at the 5% level with 6 and 24 df] in this test. However, significant [$F = 11.38$, significant at the 1% level with 6 and 24 df] results were found in the control group. The results of this test does not give us insight on the effects of progressive resistance exercise on the upper extremities and its effects on the leg kick which we had hoped it would do.

The small sample "t" test was employed and found that there was a negative significance [$t = 4.17$ at the 1% level with 9df] in this test. According to this test there was a significant difference in the two groups in kicking ability at the start. The poorer control group improved more, therefore, than the experimental. This difference was due to chance as the groups were matched on the basis of start one hundred yard times and nothing else.

As can be seen there is a great difference between the T_1 of the control group and the T_1 of the experimental group. Only a slight difference remains at the T_2 level for both groups.

The experimental group possibly had greater leg strength to start with than the control group. This could



be possible but it is not known as no measurement other than the twenty yard legs alone test was taken on the legs separately.

Twenty yard whole stroke results. The results of the twenty yard whole stroke are shown in Chart IV.

The "F" value for the difference in T_1 to T_2 were not significant [$F = .10$, not significant at the 5% level with 6 and 24 df] in the experimental group. However, in the control group there is a highly significant [$F = 9.06$, significant at the 1% level with 6 and 24 df] figure.

The "t" test was also computed for the difference between the two groups and found that there was no significant [$t = .79$ with 9 df] difference between the two groups. There, however, was a negative number showing that the control group possibly had the heaviest sway in the differences of the two groups.

There is a possibility in this test that the dead start that was used might have been unfamiliar to the subjects as compared to the regular racing start normally employed. It is also possible that for the twenty yard distance the leg strength would enter in and cause some bias on this test. This might explain why the experimental group is faster at both the T_1 and T_2 levels.

Fifty yard start time results. The results of the Fifty yard start times are shown in Table I.

TABLE I
50 YARD START TIMES

Experimental Group				Control Group			
Group	Initial Times	Final Times	Difference	Group	Initial Times	Final Times	Difference
H.H.	25.6	25.3	.3	M.F.	26.0	26.1	- .1
J.K.	27.5	26.8	.7	J.G.	26.1	25.6	.5
J.L.	24.0	22.5	1.5	W.H.	25.5	25.4	.1
C.M.	25.7	25.2	.5	D.P.	24.0	22.6	1.4
D.T.	24.8	24.2	.6	T.R.	23.7	23.4	.3
Means	25.52	24.8	.72	Means	25.06	24.62	.44

The small sample "t" was used to find the differences between the two groups. Significance [$t = 2.43$, significant at the 5% level with 9 df] was found that these groups differed in their T_1 to T_2 relation.

The experimental group mean times for T_1 and T_2 were 25.52 to 24.80 seconds respectively. The control group mean times were 25.06 and 24.62 seconds respectively.

Although the control group started out and ended up the study period faster than the experimental group, the experimental subjects decreased their times more than the control subjects. Several factors could be taken into consideration here which we know nothing about.

The experimental subjects possibly could have greater leg strength which would enable them to get a better start

than the control group and also receive a better push off on their turn for the short fifty yard distance.

Four hundred forty yard start time results. The results of the four hundred forty yard start times are shown in Table II.

TABLE II
440 YARD START TIMES

Experimental Group				Control Group			
Group	Initial Times	Final Times	Difference	Group	Initial Times	Final Times	Difference
H.H.	5:57.6	5:54.0	3.6	M.F.	6:11.0	6:04.0	7.0
J.K.	5:27.2	5:24.4	2.8	J.G.	5:33.9	5:24.5	9.4
J.L.	5:50.5	5:31.2	19.3	W.H.	5:37.0	5:34.1	2.9
C.M.	5:30.7	5:21.4	9.3	D.P.	5:52.8	5:33.6	11.2
D.T.	5:29.6	5:19.3	10.3	T.R.	5:39.1	5:36.3	2.8
Means	5:39.12	5:30.6	9.06	Means	5:46.76	5:38.50	6.66

The small sample "t" test was used to analyze the differences between the T_1 and T_2 times of the experimental group and the T_1 and T_2 times of the control group. The value found was not significant [$t = .16$ with 9 df] at the five per cent level.

These data were included to see if there was any difference in the two groups as well as to give us some insight into whether the progressive resistance exercise affected the

longer distances. Due to the erratic performance at this distance the data are of little value.

Twenty-five yard push off time results. The results of the twenty-five yard push off times are shown in Chart V.

The small sample "t" test was used to analyze the differences between the T_1 and T_2 times of the experimental group and the T_1 and T_2 times of the control group. The value [$t = .73$ with 9df] was not significant.

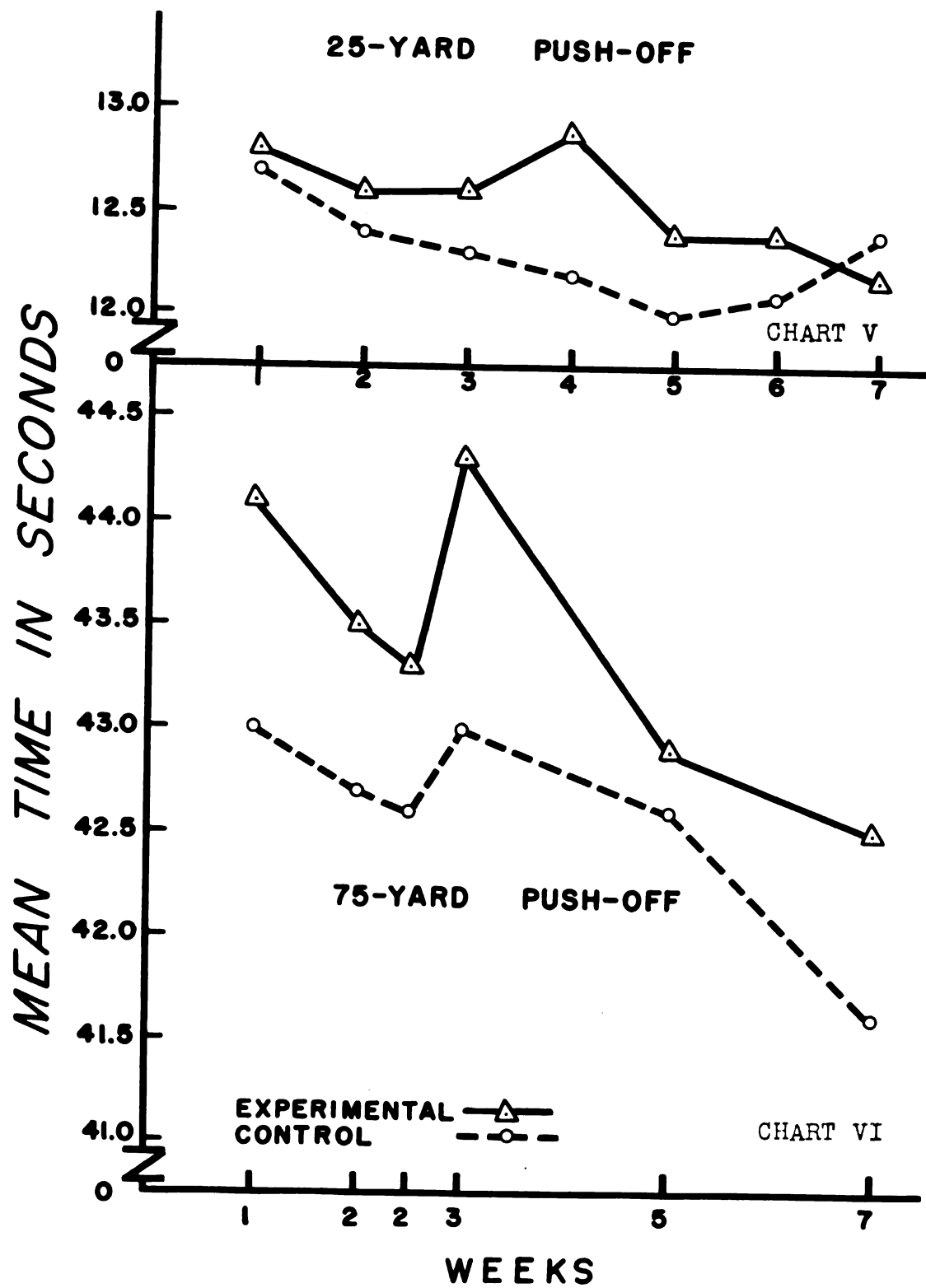
Seventy-five yard push off time results. The results of the seventy-five yard push off times are shown in Chart VI.

The small sample "t" test was used to analyze the difference between the experimental group T_1 and T_2 and the control group T_1 and T_2 times. The value of "t" at the five per cent level was [$t = 1.49$ with 9 df] not significant.

II. GENERAL DISCUSSION

The general trends in this study were toward faster time in the experimental group who were working with a weight training program.

The fifty yard swim results indicate that weight training had a beneficial effect on speed in swimming the crawl stroke. The "t" value of 2.43 [9 df] shows a significant difference between the two groups in their initial to



final times. Due to the insignificant results in the one hundred yard, twenty-five yard, and seventy-five yard data it is quite possible the fifty yard results were due to chance alone.

In the twenty yard leg kick alone there was a significance [$t = -4.17$ with 9df] in the opposite direction. This possibly could have been due to differences in leg strengths or coordination at the beginning of the study. It is felt that these differences have confused the data somewhat. The groups were matched on one hundred yard times only and the differences obtained were strictly chance differences.

In all other tests the small sample "t" value was not significant. Although these tests proved insignificant differences there was a decrease in the times of the experimental group in the other distances.

It is possible that this insignificance was due to the bias swimmers have regarding weight training. Although the subjects voiced that they were performing maximum lifts and swimming minimal times, it was felt by the writer that there may have been insufficient motivation to obtain maximum performance in the weight training program. The improvement records in loads lifted tend to indicate the experimental subjects were not lifting maximally. With this bias in the exercise program it is felt that this possibly influenced the performance in the swimming program as well. Regardless

of the thoughts behind the exercise program by the individuals the experimental group did improve in time over the control group in all distances except the twenty yard leg kick and the twenty yard whole stroke. It is possible that the timing techniques and leg strength were factors in producing this result. However, it is felt that these differences were due to chance alone as evidenced by the twenty yard leg kick differences because of the way in which this study was set up at the start by matching only on one hundred yard times.

Probably the most important point is that although the experimental group was using progressive resistance exercise for the upper extremities, the effect was not deleterious. The trends, in fact even at the loads being used were towards faster not slower time. These results are similar to those obtained in the earlier weight lifting studies on the effects of weight training on athletic performance.^{3,4,5,6,7}

³Edward Chui, "The Effect of Systematic Weight Training on Athletic Power," Research Quarterly, 21:188-194, October, 1950.

⁴E. K. Capen, "The Effect of Systematic Weight Training on Power, Strength, and Endurance," Research Quarterly, 21:83-93, May, 1950.

⁵J. F. Davis, "The Effect of Weight Training on Speed in Swimming," Physical Educator, 12:28-29, March, 1955.

⁶B. M. Wilkins, "The Effect of Weight Training on Speed of Movement," Research Quarterly, 23:361-369, October, 1952.

⁷W. S. Zorbas and P. V. Karpovich, "The Effect of Weight Lifting Upon the Speed of Muscular Contractions," Research Quarterly, 22:145-148, May, 1951.

Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains. The *Agrobacterium* strains were grown in the YEA medium for 24 h at 28 °C. The cell concentration of the *Agrobacterium* strains was adjusted to 1.0 × 10⁸ cells/ml. The cell suspension was then mixed with the plant tissue and the transformation efficiency was determined. The results are shown as the mean ± SD of three independent experiments. The asterisk indicates a significant difference between the two strains (*p* < 0.05).

1. *Journal of the American Medical Association*, 1997; 277: 1001-1005.

1. The first step in the process is to identify the problem or issue that needs to be addressed. This involves gathering information and understanding the context of the problem.

...the fact that the *Journal* is not a journal of the American Psychological Association, but of the American Psychological Society, which is a much smaller organization.

Age Group	Gender	Percentage of respondents who believe the U.S. should take action
18-29	Male	75
	Female	88
30-49	Male	78
	Female	85
50-69	Male	72
	Female	82
70+	Male	65
	Female	75

• • •

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary. The purpose of this study was to determine the influence of progressive resistance exercise on the upper extremities and its effects on one hundred yard crawl stroke performance.

Two groups of five subjects each, matched on total times for the one hundred yard swim were used. The experimental group consisted of four freshman swimming team candidates and one varsity swimming team candidate. The experimental group participated in a progressive resistance exercise program.¹ This program consisted of meeting five days a week and performing the exercises perscribed.

The control group consisted of four freshman swimming team candidates and one varsity swimming team candidate. This group did not participate in the weight training program. All subjects participated in an identical swimming program that was outlined for them.² All subjects were timed on Tuesdays, Wednesdays, and Thursdays of each week for seven complete weeks.

¹See Appendix B.

²See Appendix A.

The timing program consisted of all subjects meeting on Tuesdays of each week for timing in the start one hundred yard swim. On Wednesdays the subjects were timed in the twenty yard arms alone, twenty yard legs alone, and twenty yard whole stroke tests as described by Wilson.³ On Thursday of the third week the second and final times were taken for the start four hundred forty yard swim.

During the course of the swimming program times were taken for the push off twenty-five and seventy-five yard swims.

The data are presented graphically and tested statistically using the analysis of variance of several matched groups and the small sample "t" tests.

The limitations of this study may have added some bias to the data because of the psychological factor involved in doing maximum lifts and swimming maximum speed.

Conclusions. The following conclusions are drawn on the basis of the data presented. Any interpretation of these conclusions should be in light of the limitations of the study.

³
C. W. Wilson, "Coordination Tests in Swimming,"
Research Quarterly, 5:81-88, December, 1934.

1. Weight training has no deleterious effects on sprint swimming times either in the one hundred yard distance or the fifty yard distance.)

2. There was no significant results found as to whether weight training is beneficial to speed in swimming. Although there was a significant "t" value [$t = 2.43$ with 9 df] in the fifty yard start swim there was no significance noted in the twenty-five yard swim, seventy-five yard swim, and one hundred yard swims. This then possibly was just a chance happening in the fifty yard distance.)

Recommendations. The recommendations of this study are as follows:

1. Due to the small number of subjects used in this study, it is recommended that the same study should be repeated with more subjects.

2. It is recommended that a similar study be extended for a greater length of time.

3. Due to the possible variation in the timing techniques used, a standard technique is recommended to be used in all of the distances to be tested.

4. It is recommended that there be more than one criteria used for matching the groups. If possible the arms alone test as well as the legs alone test should be considered in setting up the two groups.

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BIBLIOGRAPHY

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2. The second part of the report deals with the specific details of the work, including the methods used, the results obtained, and the conclusions reached. It also mentions the various difficulties encountered and the ways in which they were overcome.

3. The third part of the report discusses the future prospects of the work and the steps that should be taken to further the research. It also mentions the various organizations and individuals who have assisted in the work and the ways in which they have contributed to it.

4. The fourth part of the report discusses the various problems that have arisen in the course of the work and the ways in which they have been solved. It also mentions the various suggestions that have been made for the improvement of the work and the ways in which they have been adopted.

5. The fifth part of the report discusses the various results of the work and the ways in which they have been used. It also mentions the various conclusions that have been drawn from the results and the ways in which they have been applied.

6. The sixth part of the report discusses the various methods used in the work and the ways in which they have been improved. It also mentions the various results of the improvements and the ways in which they have been used.

7. The seventh part of the report discusses the various conclusions reached in the work and the ways in which they have been applied. It also mentions the various suggestions that have been made for the improvement of the work and the ways in which they have been adopted.

8. The eighth part of the report discusses the various future prospects of the work and the steps that should be taken to further the research. It also mentions the various organizations and individuals who have assisted in the work and the ways in which they have contributed to it.

9. The ninth part of the report discusses the various difficulties encountered in the course of the work and the ways in which they have been overcome. It also mentions the various suggestions that have been made for the improvement of the work and the ways in which they have been adopted.

10. The tenth part of the report discusses the various results of the work and the ways in which they have been used. It also mentions the various conclusions that have been drawn from the results and the ways in which they have been applied.

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APPENDIXES

APPENDIX A

TIMING SCHEDULE SHEET

WE WILL TRY TO DO ALL OF OUR TIMING ON TUESDAYS AND THURSDAYS
IF YOU ARE UNABLE TO ATTEND ON THESE TWO DAYS PLEASE LET ME
KNOW ABOUT IT THE DAY BEFORE IF POSSIBLE.

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
JANUARY 23 20 kick 20 stroke 20 swim	24	25 START GROUPS ON THEIR PROGRAMS	26	27
30 30 kick 30 stroke 30 swim	31 TIME St. 100 yds. P.O. 50 - 2 P.O. 25 - 2	1 FEBRUARY Time 20 yds. arms 20 yds. kick 20 yds. swim	2 TIME P.O. 125 - 1 P.O. 75 - 2	3
6 30 kick 30 stroke 30 swim	7 TIME St. 100 yds. P.O. 75 - 2 P.O. 25 - 4	8 Time 20 yds. arms 20 yds. kick 20 yds. swim	9 TIME P.O. 125 - 1 P.O. 75 - 2	10
13 30 kick 30 stroke 30 swim	14 TIME St. 100 yds. P.O. 25 - 4 P.O. 75 - 2	15 TIME 20 yds. arms 20 yds. kick 20 yds. swim	16 TIME St. 440 yds.	17
20 36 kick 36 stroke 36 swim	21 TIME St. 100 yds. P.O. 25 - 4 P.O. 50 - 2	22 TIME 20 yds. arms 20 yds. kick 20 yds. swim	23 TIME P.O. 200 - 1 P.O. 50 - 2	24
27 36 kick 36 stroke 36 swim	28 TIME St. 100 yds. P.O. 25 - 2 P.O. 50 - 2	29 TIME 20 yds. arms 20 yds. kick 20 yds. swim	1 MARCH TIME P.O. 200 - 1 P.O. 75 - 2	2
5 36 kick 36 stroke 36 swim	6 TIME St. 100 yds. P.O. 50 - 2 P.O. 150 - 1	7 TIME 20 yds. arms 20 yds. kick 20 yds. swim	8 TIME P.O. 25 - 2 P.O. 50 - 2 P.O. 25 - 2	10
12 40 kick 40 stroke 40 swim	13 TIME St. 100 yds. P.O. 150 - 1 P.O. 50 - 2	14 TIME 20 yds. arms 20 yds. kick 20 yds. swim	15 TIME P.O. 125 - 1 P.O. 75 - 1 P.O. 25 - 4	16
19 TIME FINAL START 50's	20 TIME FINAL START 100's	21 TIME FINAL START 440's	22 FINISH ANYTHING THAT NEEDS TO BE DONE	

APPENDIX B

EXERCISES

INSTRUCTIONS--Please read these carefully and carry out to each exercise that is listed.

These exercises are based upon maximum load. This is the load that we can lift or move six (6) complete repetitions. This will be a little difficult to locate at first but, with a little effort on your part this can be accomplished quite readily. The first few times you will find that you are a little to light or maybe a little to heavy. Whatever the case maybe continue on at this session with that weight. The next day do what is necessary to make the weight where you want them to get the six (6) repetitions the first time through.

There are a total of five (5) exercises and these should be done in the order that they are listed. When you have completed six (6) repetitions of exercise number one go on to exercise number two and do six (6) repetitions of this one and so on until you have completed all of the exercises. When all exercises have been completed then do the same thing over the second time and then again the third. After completing the exercises for the cycle then go to the swimming pool for your swimming workout.

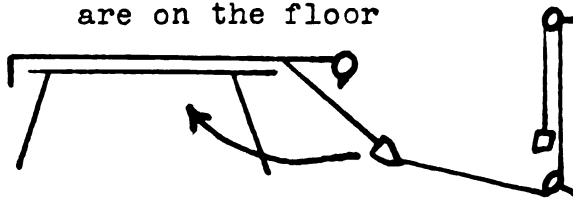
On the exercise workout sheet please record the amount of weight and the number of repetitions that you have in each cycle.

These weights and swimming exercises are set up on a certain schedule and any deviation from this schedule will throw the entire experiment off. So please adhere to these instructions.

EXERCISE NO. 1

WALL PULLEY WEIGHTS

Equipment -- Ironing board and wall weights
Position -- Lie on your stomach and face the wall weights. Use handles on the hooks that are on the floor



EXERCISE NO. 2 PRONE BARBELL

Equipment -- Bench and barbells
 Position -- Lie on your stomach with arms hanging down to the floor



EXERCISE NO. 3 SUPINE BARBELL

Equipment -- Bench or mat and barbell
 Position -- Lie on your back with hands over your head



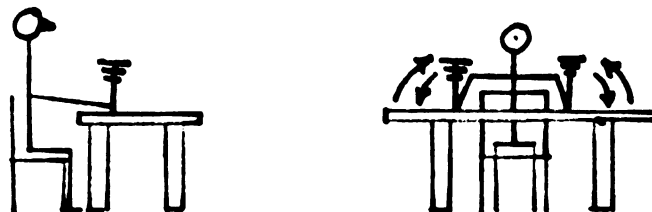
EXERCISE NO. 4 TWO ARM CURL

Equipment -- Barbell
 Position -- Standing arms extended down; flex at elbows, extend fully down



EXERCISE NO. 5 ARM ROTATOR

Equipment -- Table and chair and small barbells
Position -- Sitting at table hands rotated outward,
lift weights inward and then back out
again

DEFINITIONS OF TERMS

Cycle -- Five exercises done in the order prescribed
each six times and six (6) times only.

Repetition -- Doing these exercises over six times
in one cycle.

APPENDIX C -- RAW DATA

TABULATION SHEET

DATE OF TABULATION MARCH 25, 1956

TABULATED BY ALLEN L. MCCORMICK

GRADUATE STUDENTS OF PHYSICAL EDUCATION
THE EFFECTS OF PROGRESSIVE RESISTANCE EXERCISE ON THE UPPER
TOPIC EXTREMITIES AND ITS EFFECTS ON 100 YARD SWIMMING PERFORMANCE

	100 YARD TIMES (SECONDS)				Final Times	20 YARD LEE KICK TIMES (SECONDS)				YARD WHOLE STROKE TIMES (SECONDS)			
	Initial Times	1st week	2nd week	3rd week		1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
1 EXPERIMENTAL													
2 H. H.	59.1	59.2	59.6	60.1	58.7	58.2	57.8	57.1	57.0				
3 J. K.	61.3	59.6	60.2	60.4	59.3	60.0	59.7	59.5	59.3				
4 J. L.	53.4	53.8	53.1	52.9	52.2	52.5	52.4	52.1	52.1				
5 C. M.	56.4	58.6	57.1	57.9	57.3	57.4	57.1	56.8	55.7				
6 D. T.	55.0	54.2	55.6	56.3	54.3	53.8	53.7	53.2	53.2				
7 MEANS	57.04	57.08	57.12	57.52	56.36	56.38	56.14	55.84	55.16				
8													
9 CONTROLS													
10 M. P.	59.1	59.2	59.0	61.5	59.8	58.7	57.9	57.8	58.1				
11 J. G.	59.2	57.6	56.8	58.5	58.3	58.1	57.3	57.8	57.0				
12 W. H.	57.2	58.1	57.9	57.1	57.3	56.8	56.7	56.9	56.9				
13 D. P.	54.5	53.6	53.0	51.7	51.9	52.1	51.6	51.8	52.0				
14 T. R.	55.0	56.7	56.3	56.4	55.8	55.4	54.9	54.3	54.4				
15 MEANS	57.00	57.04	56.60	57.04	56.62	56.22	55.68	55.72	55.68				
16													
17													
18 EXPERIMENTAL													
19 H. H.	12.7	14.1	12.4	12.4	12.8	12.2	12.2	12.1					
20 J. K.	13.0	13.1	13.2	13.1	13.1	13.0	12.8	12.7					
21 J. L.	11.9	11.9	11.9	11.9	11.7	11.6	11.6	11.5					
22 C. M.	11.9	11.8	11.8	11.8	11.7	11.4	11.2	11.1					
23 D. T.	12.3	14.3	12.5	12.5	12.4	12.3	12.1	11.9					
24 MEANS	12.36	13.04	12.36	12.36	12.34	12.10	11.98	11.86					
25													
26 CONTROLS													
27 M. P.	12.4	12.3	11.9	11.9	11.9	11.9	11.8	11.9					
28 J. G.	12.2	12.1	12.4	12.0	11.8	11.8	11.9	11.7					
29 W. H.	12.5	12.8	12.6	12.4	12.1	12.3	12.3	12.1					
30 D. P.	12.1	12.7	12.2	12.1	12.0	11.9	11.8	11.8					
31 T. R.	11.2	11.0	11.2	11.1	11.0	10.8	10.9	10.9					
32 MEANS	12.08	12.18	12.06	11.90	11.76	11.74	11.68	11.68					
33													
34													
35													

APPENDIX C -- RAW DATA

MISSISSIPPI STATE COLLEGE
DEPARTMENT OF PHYSICAL EDUCATION, HEALTH
AND RECREATION FOR MEN

DATE OF TABULATION MARCH 25, 1956

TABULATED BY ALLEN L. MCCORMICK

GRANITE STONE AND RESIN
THE RESULTS OF PROPERLY SET 7 DISTANCE RECORDS OF THE UPPER
TONGUE EXERCISES AND ITS RECORDS OF 100 YARD SWIMMING PERFORMANCE

TABULATION SHEET																																		
DATE OF TABULATION MARCH 25, 1956																																		
TABULATED BY ALLYN L. MCCORMICK																																		
EXERCISE 1																																		
EXERCISE 2																																		
EXERCISE 3																																		
EXERCISE 4																																		
EXERCISE 5																																		
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EXERCISE 34																																		
EXERCISE 35																																		

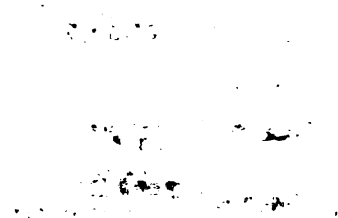
Date Due

ROOM USE ONLY

Dec 13 57			
Nov 17 58			
15 Jul 59			
27 Jul 59			
JUL 11 1961			
AUG 11 1961			
JAN 7 1963			
JAN 21 1963			
FEB 1 1963			
FEB 21 1963			
MAR 1 1963			
1075 APR 25 63			
8113 MAY 10 63			
APR 13 1964			
FEB 13 1968			
JAN 8 1970			
JAN 21 1970			
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