

THE VALUE OF ISOMETRIC EXERCISE FOR  
THE DEVELOPMENT OF STRENGTH  
IN NINTH GRADE GIRLS

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class time and space are needed to perform the exercises used? Which areas of the body tested show the greatest increase in strength? Are the results from these exercises worth the time required to administer them?

Hypothesis to be tested. The hypothesis for this study is that girls who perform the isometric exercises will improve in strength to a greater degree than will the girls who participate only in regular physical education activity.

Limitations of the study. This study is concerned with three exercises using isometric contraction, which is a sampling of the field of isometric contraction. It can only be assumed that conclusions drawn from this study could pertain to other isometric exercises.

Ninth grade girls ranging in age from thirteen to sixteen were used, and findings of this study should be applied to this age group, and not to girls of different ages.

When the isometric contraction was performed, only the girl who was participating knew if she were performing to maximum capacity. It was assumed that those doing the exercises did so to the best of their ability. Likewise, it was assumed that those in the control group, who were not shown the exercises, did not attempt any of them at any time during the experiment. The girls in both groups were told



of the importance of doing only what was asked of them concerning the exercises. In the case of the control group, this meant not doing any of the exercises that were being performed by the experimental group.

## II. DEFINITIONS OF TERMS USED

Strength. The ability of a muscle to work against resistance.<sup>1</sup>

Isometric contraction. Tension developed in a muscle without causing it to shorten, and muscular effort which does not result in movement.

## III. METHOD OF PROCEDURE

A good physical education program will contain activities that encompass elements of strength building. It was the purpose of this study to determine whether the addition of three isometric exercises would improve the strength of girls to a greater degree than would the regular program of physical education.

Ninety-two girls who were enrolled in five physical education periods a week at Mayberry Junior High School, Wichita, Kansas, were selected and divided into two equated

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<sup>1</sup>Hugh Thompson, "Values of Isometric Training," Scholastic Coach, 32:38, September, 1962.

groups. The equating was done through the use of the Neilsen-Cozens Classification Index and three strength tests, which included: (1) hanging,<sup>2</sup> (2) sit-ups,<sup>3</sup> (3) Jump and reach.<sup>4</sup> These three tests indicated the degree of strength in the arms, abdomen, and legs, respectively, of each girl.

The experimental group, in addition to participating in regular physical education activities, took part in a program of isometric contraction three times weekly. The control group took part in physical education classes without the addition of isometric contraction exercises.

The exercises were designed to strengthen muscles of the arms, abdomen, and legs. Their selection was based upon available literature and upon the recommendation of men who teach physical education and had used them in their athletic programs. These particular exercises were also considered because of the ease in handling a large group quickly.

At the end of nine weeks, the girls repeated the three tests, and any change in their scores was noted. The scores were tabulated for each group as a whole, and the two groups were then compared with each other to determine

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<sup>2</sup>Gladys M. Scott and Esther French, Measurement and Evaluation in Physical Education (Dubuque, Iowa: Wm. C. Brown Company Publishers, 1959), p. 297.

<sup>3</sup>Ibid., p. 299.

<sup>4</sup>Ibid., p. 360.

whether there was any appreciable difference in strength increase between them.

Comparison was made by finding the mean score of each test for each group. The mean scores of the initial testing period were compared with the mean scores of the final testing period to determine any change in performance.

## CHAPTER II

### REVIEW OF LITERATURE

This study is concerned with the value of certain isometric contraction exercises when incorporated in a physical education program for ninth grade girls. There are many people in the field of physical education who use this method of strength training and recommend it highly, calling it a new innovation. Actually, the subject is not new at all, for as early as 1928, Siebert was experimenting with the leg muscles of a frog to see if isometric contraction caused the muscles to grow.<sup>1</sup>

#### 1. NEED FOR STRENGTH TRAINING

Although strength is only a part of total physical fitness, it is an important factor in an individual's performance, not only in athletic contests, but in every day living. A muscle grows larger and stronger only when it is required to work against a taxing load; this is known as the overload principle.<sup>2</sup>

An individual has strength only in the muscles he

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<sup>1</sup>Arthur H. Steinhaus, "Training for Strength," Physical Education Newsletter, 6:2, February 12, 1962.

<sup>2</sup>Hugh Thompson, "Values of Isometric Training," Scholastic Coach, 32:38, September, 1962.

uses, and will remain weak in any muscles that are not often used. Many girls, when tested, have shown decided weaknesses in certain muscle groups. Because of these weaknesses, a method of training which would satisfactorily increase the strength of girls would seem to be of value. This study was conducted to determine whether isometric contraction was an activity which led to an increase in strength.

## II. RELATED STUDIES

In a study completed by Larsen, a comparison was made in strength-building effectiveness of a single six-second daily exercise bout with that of progressively greater numbers of six-second daily bouts. The experiment was based on study of wrist flexors of fifty-seven boys, and the exercises involved static muscular response. Five exercise sessions were held each week with each experimental subject over a period of four weeks. Significant gains in strength were shown by both groups. Slightly greater gains were shown by the progressive exercise group over the six-second group.<sup>3</sup>

Several studies make reference to results obtained from experiments performed in E. A. Muller's laboratory in

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<sup>3</sup>Eugene Larsen, "A Study of Two Methods of Building Static Muscular Strength," (unpublished Master's thesis, University of Wisconsin, Madison, Wisconsin, 1957).

Germany. Karpovich states:

Reports coming from E. A. Muller's laboratory in Germany have made a great impact upon methods of muscular training. These reports indicate that a single daily isometric contraction continued for six seconds and utilizing only two-thirds of maximum strength will give the best results in gaining muscular strength . . . . It seems that . . . oxygen deficit is an important factor in the acquisition of muscular strength.<sup>4</sup>

One study that obtained results contradictory to the reports from Muller was made by Rasch and Morehouse, who reported that insignificant gains in strength of elbow flexion were made following a six week's training program which used one daily fifteen-second isometric exercise bout using two-thirds maximum strength.<sup>5</sup> It should be noted that this study employed only three training sessions a week, whereas Muller's experiment used five training sessions a week.

Wolbers used two groups of students, one of which was given exercises requiring static muscle contractions, to see if isometric exercises helped the students to make significant gains in four tests of strength. The members of the experimental group did make gains significantly greater

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<sup>4</sup>Peter V. Karpovich, Physiology of Muscular Activity (fifth edition; Philadelphia: W. B. Saunders Company, 1959), pp. 35-36.

<sup>5</sup>G. Lawrence Rarick and Gene L. Larsen, "Observations on Frequency and Intensity of Isometric Muscular Effort in Developing Static Muscular Strength in Post-Pubescent Males," Research Quarterly, 29:338, October, 1958.

than those of the control group in the back lift, the leg lift, and the combined hand grip tests. The test in which no significant gains were made was the Sargent Jump. The boys doing the isometric exercises performed them five days a week and held each one for six seconds, once a day.<sup>6</sup>

A different type of experiment was conducted by Howell, Kimoto, and Morford,<sup>7</sup> in which three groups of subjects were equated. One group did weight training, the second used the Commander Set series of isometric contractions, and the third group participated in the usual required physical education program. All subjects were retested after an eight-week experimental period. Both of the experimental groups showed statistically significant improvements in the tests, and there were no significant differences between the initial and final scores of the two experimental groups. From this experiment, it was hypothesized that increases in muscular endurance can be gained by certain programs of isometric contractions and by isotonic exercises, isotonic meaning that the muscle is shortened during contraction while the load remains the same, as in weight training.

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<sup>6</sup> Charles P. Wolbers and Frank S. Sills, "Development of Strength in High School Boys by Static Muscle Contractions," Research Quarterly, 27:446, December, 1956.

<sup>7</sup> Maxwell Howell, Ray Kimoto, and W. R. Morford, "Effect of Isometric and Isotonic Exercise Programs Upon Muscular Endurance," Research Quarterly, 33:536, December, 1962.

As has been cited, most studies point out the fact that isometric exercises can be beneficial in strength training. Thompson claims that, "A carefully planned program of resistive exercises . . . can do more to develop strength and power than any training method yet devised."<sup>8</sup>

### III. SUMMARY

The subject of isometric training is not a new one, for as early as 1928, experiments were being made with the leg muscles of frogs to see if isometric contraction caused muscles to grow.

Many girls, when tested, show decided weaknesses in certain muscle groups; and, because of this, a system of strength training would seem to be of value.

In several studies of isometric contraction, significant gains were made by subjects who performed exercises five times weekly. In a study by Rasch and Morehouse, insignificant gains were made by subjects who performed the exercises only three times weekly.

The fact that more strength training experiments are needed is shown by comments of Slater-Hammel, in which he states:

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<sup>8</sup>Hugh Thompson, "Weight Training vs. Isometric Training," Scholastic Coach, 32:42, October, 1962.



Our researchers in physical education have become concerned with 'quantitative information' on muscle development . . . ; they are exploring the relationships between muscle development and such variables as type of muscle contraction (isometric vs. isotonic) . . . . This work has exciting possibilities. Its importance cannot be overestimated because it offers the promise of improving our understanding and of providing us with basic information for development of the most efficient exercise and activity programs.<sup>9</sup>

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<sup>9</sup>A. T. Slater-Hammel, "Research on Muscle Development," Research Quarterly, 31:236, May, 1960.

## CHAPTER III

### METHODS AND PROCEDURES OF THE STUDY

#### I. METHOD OF GROUPING

In order to determine whether three isometric exercises supplement a regular physical education program to a significant degree, it seemed necessary to use students who would participate in the same number of physical education classes each week. For that reason, the ninety-eight ninth grade girls who were scheduled for daily physical education classes were selected for the study. The number was reduced to ninety-two because of excessive absences or injuries.

Since height, weight, and age might have a bearing on a girl's performance, the Neilsen-Cozens Classification Index was used to equate the two groups that were used for the study. The three strength tests chosen were: (1) hanging,<sup>1</sup> (2) sit-ups,<sup>2</sup> (3) jump and reach,<sup>3</sup> which indicate a girl's arm strength, abdominal strength, and leg strength, respectively.

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<sup>1</sup>Gladys M. Scott and Esther French, Measurement and Evaluation in Physical Education (Dubuque, Iowa: Wm. C. Brown Company Publishers, 1959), p. 297.

<sup>2</sup>Ibid., p. 299.

<sup>3</sup>Ibid., p. 360.

The instructions for the tests were read to each class of ninth graders. Complete instructions may be found in the Appendix. Each test was demonstrated to the girls by the instructor, and the students were reminded of the importance of doing their best. The researcher did all of the timing and scoring.

When doing the hanging test, the instructor made sure the girl's hands were placed properly and then told the girl to go when she was ready. Time was recorded from the instant the girl jumped into position until she lowered herself so that her chin reached the level of the doorway bar.

In the sit-up test, two girls who were not involved in the testing assisted the instructor. One held the participant's feet in place, while the other counted each sit-up out loud.

The jump and reach test was done with the help of a jumping board attached to the wall. The board was marked in inches by white lines and in half-inches by yellow lines. The instructor stood six feet away from the board in order to see clearly where each girl touched.

The girls were given only one test during a class period. The hanging test was given on Monday, the sit-ups on Wednesday, and the jump and reach test on Friday of the same week.

Because an individual might score much higher on one test than on another, it was not possible to equate the two groups exactly when using the raw scores. The three test scores were converted to T-scores and averaged in order to equate the groups. The Neilsen-Cozens Classification Index was used in the equating process, also. The Index is a means of grouping students according to height, weight, and age. The final score for each girl is in letter form ranging, in this study, from E to H. The younger, smaller, lighter girls are in the E group; the average girls are in the F and G groups; and the larger, older girls are in the H group. Table I reports the means and standard deviations of both groups in the three tests. Table II indicates the Neilsen-Cozens Classification Index scores. The raw scores for each test are included in the Appendix.

## II. METHODS OF PRESENTING THE EXERCISES

### Control Group

The girls who were placed in the control group were assured that their part of the experiment was as important as that of the experimental group, and were asked to refrain from questioning the other group concerning the exercises.

### Experimental Group

The girls selected for the experimental group were taken into the locker room for instructions. All of the

TABLE I  
 MEANS AND STANDARD DEVIATIONS OF SCORES FROM  
 INITIAL TESTING PERIOD

Test Score	Mean	Standard Deviation
<b>Hanging Test</b>		
Control	21.9	11.58
Experimental	22.1	13.15
<b>Sit-ups</b>		
Control	30.8	5.37
Experimental	31.0	5.82
<b>Jump and Reach</b>		
Control	11.8	2.1
Experimental	12.0	1.97

TABLE II  
 EQUATED GROUPS ACCORDING TO NEILSEN - COZENS  
 CLASSIFICATION INDEX

Letter Score	Control Group	Experimental Group
E	10*	10
F	18	18
G	12	12
H	6	6

\*Number of girls in each classification.

exercises were performed in the locker room so that the girls in the control group could not observe the procedures. The experiment was explained to them and they were cautioned against telling girls in the control group about the exercises.

The exercises were performed on Monday, Wednesday, and Friday after roll call was taken and announcements were made.

Isometric contraction for the arms. The exercise for the arms utilized short jumping ropes with the ends tied together, forming a ring. Each rope was numbered, and each girl knew which rope belonged to her and used the rope with the number that had been assigned to her. A tall girl would need a longer rope than would a short girl, so it was necessary for each girl to use the same rope every time the exercise was performed. The girls stood on the ropes with feet slightly apart. The hands were placed on the rope a little less than shoulder width apart. Hands were open and palms were up. Arms were bent at a little more than a ninety-degree angle. When the instructor said, "Go," the girls pulled toward the ceiling as hard as possible. This position was held for six seconds, at which time the instructor gave the command to stop. Figure 1 illustrates the proper position of the girl while performing the exercise.

Isometric contraction for the legs. The girls were asked to work in partners for the isometric exercise for the legs, but after a week of the exercise, they were unable to hold each other, so two doorway bars were used for the remaining eight weeks. Figure 2 illustrates the proper position of the girls while performing the exercise.

The girls lay on their backs underneath the bar, with one foot placed against the bar. The girl and the bar were positioned in such a manner that there was an approximate 145 degree angle at the knee and the upper leg was at a right angle to the hip. On the signal, "Go," the performer pushed as hard as possible against the bar. The other leg was exercised in the same manner for a second six-second period.

Isometric contraction for the abdomen. For the isometric exercise using abdominal muscles, the girls stood erect and on the signal, "Go," they contracted the muscles of the abdomen for six seconds, at which time they were asked to stop. It was suggested that contracting the muscles should be done by pulling in the muscles and making them hard, as if someone were about to hit them in the abdomen with a fist.

These exercises were selected because of the ease in handling a large group. All except the leg exercise went very rapidly. Because only two girls could use one bar at the same time, more time was consumed in doing the exercise for



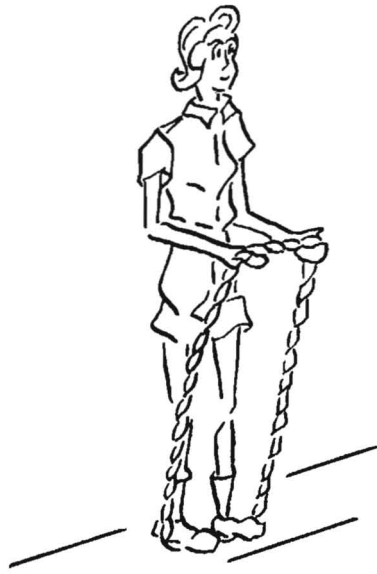


FIGURE 1

ISOMETRIC EXERCISE FOR THE ARMS

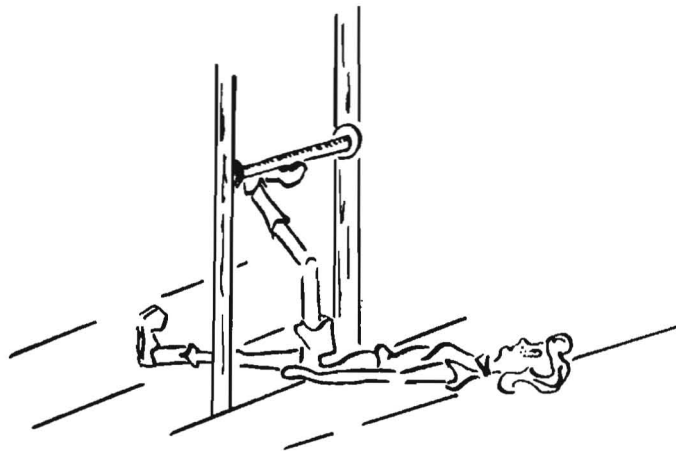


FIGURE 2

ISOMETRIC EXERCISE FOR THE LEGS

the legs than was necessary for the other exercises. The three exercises were completed in approximately four minutes.

### III. FINAL TESTING PERIOD

Each exercise was performed three times weekly for nine weeks. At the end of the nine weeks, both the control and experimental groups were retested using the three tests administered at the beginning of the experiment.

The hanging test was given on the Monday after the exercises had been terminated; the sit-ups and jump and reach were administered on Tuesday and Wednesday, respectively. The same girls who had assisted during the first testing period were used again. Instructions for the tests were repeated and the same methods of administering the tests were employed.

Comparison of the two groups. The mean score for each test for each group was found and compared in order to determine whether any significant gain was made by the experimental group as compared to the control group. Since the two groups were equated by using the scores of the first testing period and there was no significant difference between the means of the two groups on any of the three tests, it would be assumed that any differences in the means of the final testing period might be due to the isometric exercises performed by the experimental group.

#### IV. SUMMARY

Ninety-two ninth grade girls were given three tests of strength, and from these tests and the Neilsen-Cozens Classification Index, two equated groups were formed.

The experimental group, in addition to regular physical education classes, participated in a nine week's session of three isometric exercises performed for six seconds each, three times weekly.

At the end of the nine weeks, girls in both groups were retested, and the mean scores for each test for each group were found and compared in order to determine whether there were any significant differences between the two groups in the final testing.

## CHAPTER IV

### RESULTS OF THE STUDY AND EVALUATION OF METHODS USED

#### I. METHOD OF COMPARING TEST SCORES

After all the girls repeated the three strength tests that each had performed at the beginning of the nine week's period, the mean and standard deviation were found for each group on each test.

By determining the standard error of the mean difference for each test, it was discovered whether the difference between the means of the experimental and control groups in the final testing were real or due to chance.

To determine whether or not the means of the final test scores of the experimental group were significantly different from the means of the final test scores of the control group, the "t" test involving the Fisher "t" value table was administered.<sup>1</sup> The "t" values necessary for significance were 2.63 or above for the 1 per cent level of confidence and 1.99 or above for the 5 per cent level of confidence.

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<sup>1</sup> Leonard A. Larson and Rachael Yocom, Measurement and Evaluation in Physical, Health, and Recreation Education (St. Louis: The C. V. Mosby Company, 1951), p. 344.

## II. ANALYSIS OF MEAN DIFFERENCES

Initial testing. When comparing the scores of the experimental and control groups after the initial testing, as shown in Table III, the "t" value for the hanging test was .076; the "t" value of the sit-ups was .169, and the "t" value for the jump and reach test was .628. None of these values is high enough to show a significant difference between the two groups in any of the three tests, so it would be assumed that any significant difference found after the final testing might be due to the isometric exercises performed by the experimental group.

Final testing. In comparing the scores of the experimental and control groups after the final testing, as shown in Table IV, the mean of the control group in the hanging test was 27.5; the mean of the experimental group in the hanging test was 28.9. The "t" value was .455.

The mean of the control group in the sit-ups was 33.1, and the mean of the experimental group in the sit-ups was 32.8. The "t" value was not computed for the sit-ups because there was less improvement in the experimental group than in the control group, making it obvious that there was no significant gain made by the experimental group.

The mean of the control group in the jump and reach test was 12.3, and the mean of the experimental group was 12.9.

TABLE III  
COMPARISON OF MEANS IN INITIAL TESTING

	Mean	Mean Diff.	S. E. of Diff.	t
Hanging Test				
Control	21.9			
Experimental	22.1	.2	2.637	.076
Sit-ups				
Control	30.8			
Experimental	31.0	.2	1.180	.169
Jump and Reach				
Control	11.8			
Experimental	12.1	.3	.429	.628

TABLE IV  
COMPARISON OF MEANS IN FINAL TESTING

	Mean	Mean Diff.	S. E. of Diff.	t evidence,
<b>Hanging Test</b>				
Control	27.5			
Experimental	28.9	1.4	3.085	.455
<b>Sit-ups</b>				
Control	33.1			
Experimental	32.8			
<b>Jump and Reach</b>				
Control	12.3			
Experimental	12.9	.6	.386	1.48

The "t" value for the jump and reach test was 1.48.

The "t" value of .455 in the hanging test was below the 1.99 or the 2.63 level of confidence; therefore, the difference in the scores of the two groups would not be significant.

The "t" value of 1.48, which was derived from the jump and reach test scores, is approaching the 1.99 necessary for significance at the 5 per cent level of confidence, but the difference in scores is not great enough to be considered significant.

Although the results of the final testing showed no significant differences at the 1 per cent or 5 per cent level of confidence, it should be pointed out that the experimental group did improve to a greater degree than did the control group in the hanging test and in the jump and reach test. In a report by Nelson and Hurst, it was indicated, in testing one method of training athletes against a newer method, that, ". . . any sample evidence in favor of the new method should lead to its adoption."<sup>2</sup>

Nelson and Hurst also state:

It is impossible to calculate how many good research ideas have been abandoned because the results failed to achieve a 5 per cent level of significance. Researchers must realize that good

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<sup>2</sup>Dale O. Nelson and Rex L. Hurst, "Significant or Not Significant," Research Quarterly, 34:240, May, 1963.



ideas are precious. Many times they are worth more than the errors that would be admitted by a larger level of significance would cost.<sup>3</sup>

### III. COMPARISON WITH OTHER STUDIES

In most of the studies made concerning isometric contraction, more time was spent in performing the exercises, and boys rather than girls were used as subjects. Because of these two factors, comparisons of results of those studies with this experiment are difficult to make.

In studies made by Larsen,<sup>4</sup> by Muller,<sup>5</sup> and by Wolbers and Sills,<sup>6</sup> the subjects performed the exercises at least five times weekly, instead of the three weekly sessions of this experiment. Significant gains of strength were evident in each of these studies, whereas in this experiment, significant gains were not made.

It was interesting to note that in the study made by Wolbers and Sills, four tests of strength were used, one of

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<sup>3</sup>Ibid., p. 240.

<sup>4</sup>Eugene Larsen, "A Study of Two Methods of Building Static Muscular Strength," (unpublished Master's thesis, University of Wisconsin, Madison, Wisconsin, 1957).

<sup>5</sup>Peter V. Karpovich, Physiology of Muscular Activity (fifth edition; Philadelphia: W. B. Saunders Company, 1959), pp. 35-36.

<sup>6</sup>Charles P. Wolbers and Frank S. Sills, "Development of Strength in High School Boys by Static Muscle Contractions," Research Quarterly, 27:446, December, 1956.

which was the jump and reach test used in this experiment. In Wolber's study, significant improvement was made in every area except in the jump and reach test, whereas in this study, more improvement was made by the experimental group, as compared to the control group, in the jump and reach than in either of the other two tests.

In the study made by Rasch and Morehouse,<sup>7</sup> using gains in strength of elbow flexion as a guide, insignificant gains were found following a six week's training program of one daily fifteen-second isometric exercise bout performed three times a week. The study made by Muller, which was similar, found that significant gains were made. The difference between the two studies was that Muller's subjects performed five days a week, while Rasch and Morehouse's subjects performed only three times weekly.

The results of this study, in which the girls performed the exercises three times a week, tend to coincide with Rasch and Morehouse's experiment, with insignificant gains being made.

#### IV. EVALUATION OF METHODS AND EQUIPMENT USED

It was the purpose of this study to test the value of

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<sup>7</sup>G. Lawrence Rarick and Gene L. Larsen, "Observations on Frequency and Intensity of Isometric Muscular Effort in Developing Static Muscular Strength in Post-Pubescent Males," Research Quarterly, 29:338, October, 1958.

three simple and quickly performed exercises in their ability to aid in increasing the strength of girls. If the exercises could be performed quickly, they would take little time from the regularly planned curriculum. It was the opinion of the researcher that more was to be gained from other activities than from an intensive strength-building program. The isometrics were to be a supplement to the program rather than to be placed in the program as a unit.

Strength tests. In selecting tests which would indicate strength of the three areas of the body, various things were taken into consideration. It would have been desirable to have used strength testing equipment, such as dynamometers, but such equipment is not available in many public schools; and feasible methods of testing strength in girls were considered best if any part of this experiment might be incorporated into a school's physical education program.

The hanging test was considered better than other arm tests that were studied because it was felt a more accurate measure could be made with less chance of error than was possible in other tests. With one person administering all of the tests, it was hoped that errors were held to a minimum.

The modified sit-ups, testing abdominal strength, was used because it employs more abdominal muscles and less

leg, neck, and back muscles than do other sit-up type tests. Girls who assisted the instructor were chosen for reliability, and by using two girls, one could check the other. The girls counted out loud so that they did not lose track of the count.

A jumping board, marked in half inches, was useful in the jump and reach test, and the instructor placed herself in a position to see clearly where the finger of the girl being tested touched the board. This test was selected as a test of leg strength rather than the standing broad jump because it was thought that less coordination was necessary for the jump and reach.

The instructor felt that the testing periods went very smoothly. The girls seemed interested in their results and, for the most part, they tried to do their best.

Exercises. For the exercise involving the arms, each girl could find her own rope quickly and assume the proper position. All girls could perform the exercise at once, thus taking a minimum of time.

The exercise involving the abdominal muscles was chosen chiefly because no extra apparatus, such as an isometric bar, was needed; and every girl could perform at the same time. It was the opinion of the researcher that this exercise was weak because she could not be certain each girl

knew exactly what to do and she might not be performing to the best of her ability.

As first planned, partners were to work together in the exercise for the legs. Using this method, the exercise would take four six-second sessions in order for each girl to perform. Within a week, however, most of the girls were unable to hold each other as they pushed, so doorway bars had to be used. Two bars were available, and two girls could use one bar at the same time. In the class containing the most girls, thirteen were in the experimental group, so more time than originally planned was consumed with this larger group.

Pushing with the foot against the doorway bar was hard on the bar, and a girl had to push down on the bar as the girls pushed up with their feet in order to keep the bar from bending.

Altogether, the exercises took approximately four minutes from regular class time, which was not considered excessive in an activity period averaging thirty-five minutes in length.

Special bars for isometric training are available, on which a variety of exercises can be performed. However, usually only one person at a time uses the bar, and it is a rather costly piece of equipment designed to be used exclusively for exercising. It was the intent of this study to test exercises that took little time and equipment, so the exercise bar was not considered for this experiment.

## V. SUMMARY

To determine whether or not the means of the final test scores of the experimental group were significantly different from the means of the final test scores of the control group, the "t" test involving the Fisher "t" value table was administered. The experimental group did not show significant gain over the control group at the 5 per cent level of confidence in any of the three tests, but gains were made by the experimental group over the control group in the hanging test, which tested arm strength, and in the jump and reach, which tested leg strength. No gain was made by the experimental group over the control group in the sit-ups, a test of abdominal strength.

In comparing this experiment with similar studies, the indication seemed to be that a study involving three weekly sessions of isometric exercises showed fewer significant gains than did studies using five weekly sessions of isometric exercises. In this study, using only three sessions weekly, insignificant gains were made.

It was felt that the methods and equipment used were adequate for the intended purposes of this study. If a more elaborate training program were desired, an isometric bar might be of value, and more exercises for each area of the body might be used if time were not a consideration.

## CHAPTER V

### SUMMARY AND CONCLUSIONS

#### I. SUMMARY

Statement of the purpose. It was the purpose of this study to determine the value of isometric contraction by finding whether the strength of ninth grade girls who performed these exercises improved to a greater degree than did the strength of girls who did not do the exercises.

Method of procedure. Ninety-two girls enrolled in the same number of physical education classes a week were selected and divided into two equated groups through the use of the Nellisen-Cozens Classification Index and three strength tests that measured the degree of strength in the girls' arms, legs, and abdomens.

The experimental group, in addition to participating in regular physical education classes, took part in a program of isometric contraction three times a week. The control group participated in physical education classes, without the addition of the isometric contraction exercises.

The isometric exercises were designed to strengthen the muscles of the arms, abdomen, and legs, and were performed by the experimental group, three times weekly, for nine weeks.

At the end of the nine weeks, all girls repeated the strength tests. Scores were tabulated, and appropriate statistical techniques were applied to discover whether or not any significant gain had been made by the experimental group as compared to the control group.

Results. The experimental group scored slightly lower than the control group in the test of abdominal strength. The experimental group scored higher, but not significantly higher at the 5 per cent level of confidence, than the control group in the arm strength test and in the leg strength test.

Both groups, as a whole, improved in the final testing period. In comparing individual scores, only a few girls in either group, with the exception of the experimental group in the sit-ups, scored lower in the second testing than they had in the first. The individual scores of the initial and final tests are shown in the Appendix.

## II. CONCLUSIONS

The following conclusions seem justified by the findings of this study:

1. Gains were made by the experimental group over the control group in the tests involving arm strength and leg strength, although the gains were not great enough to be considered significant at the 5 per cent level of confidence.



2. No gain was made by the experimental group over the control group in the test of abdominal strength.
3. Approximately four minutes were spent in doing the exercises out of an activity period averaging thirty-five minutes.
4. The space in the locker room was ample for the small groups. In a large class, a few girls at a time could use the locker room area while other activities were being conducted in the gymnasium.
5. Because the experimental group did show improvement over the control group in the tests of arm strength and leg strength, exercises involving the arms and legs might merit the time required to administer them, particularly if the exercises and number of sessions were revised.

### III. RECOMMENDATIONS FOR FURTHER STUDY

This study dealt with only a small area of the field of isometric exercises. Additional studies which use different exercises might be suggested from the results of this study.

In light of the fact that several experiments have found significant results from a study of isometric contraction with sessions held five times weekly, it would be interesting to determine the degree of significance with the exercises given to girls five days a week instead of three.

Greater gains in strength were made by the girls using the isometric exercises for the arms and the legs, than were made by the girls who did not perform the exercises.

Therefore, it might be suggested that a longer unit of exercises or daily exercising would prove that isometric contraction would be of significant value as a strength building aid.

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#### BIBLIOGRAPHY

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## BIBLIOGRAPHY

- Evans, R. T., and C. E. Wilson. Handbook on Isometric Contraction. Johnson City, Tennessee: American Fitness Programs, 1962. 18 pp.
- Dennison, J. D., M. L. Howell, and W. R. Morford. "Effect of Isometric and Isotonic Exercise Programs Upon Muscular Endurance," Research Quarterly, 32:348-52, October, 1961.
- Garrett, Henry E. Statistics in Psychology and Education. New York: Longmans, Green and Co., 1947. 487 pp.
- Hoffman, Bob. "Functional Isometric Contraction Training," Athletic Journal, 43:20, November, 1962.
- Howell, Maxwell, Ray Kimoto, and W. R. Morford. "Effect of Isometric and Isotonic Exercise Programs upon Muscular Endurance," Research Quarterly, 33:536-540, December, 1962.
- Hubbard, Alfred W., and Raymond A. Weiss (comp.). Completed Research in Health, Physical Education, and Recreation. Washington, D. C.: American Association for Health, Physical Education, and Recreation, 1959.
- Karpovich, Peter V. Physiology of Muscular Activity. Fifth edition. Philadelphia: W. B. Saunders Company, 1959. 368 pp.
- Larsen, Eugene. "A Study of Two Methods of Building Static Muscular Strength." Unpublished Master's thesis, University of Wisconsin, Madison, 1957. 54 pp.
- Larson, Leonard A., and Rachael Yocom. Measurement and Evaluation in Physical, Health, and Recreation Education. St. Louis: The C. V. Mosby Company, 1951. 507 pp.
- Morehouse, Laurence E. Physiology of Exercise. St. Louis: The C. V. Mosby Company, 1959. 349 pp.
- Nelson, Dale O., and Rex L. Hurst. "Significant or Not Significant," Research Quarterly, 34:239-242, May, 1963.
- Norman, D. C. "Active vs. Passive Exercise," Ladies Home Journal, 76:86-87+, November, 1959.

- Rarick, G. Lawrence, and Gene L. Larsen. "Observations on Frequency and Intensity of Isometric Muscular Effort in Developing Static Muscular Strength in Post-Pubescent Males," Research Quarterly, 29:334-341, October, 1958.
- Scott, M. Gladys, and Esther French. Measurement and Evaluation in Physical Education. Dubuque, Iowa: Wm. C. Brown Company Publisher, 1959. 493 pp.
- Slater-Hammel, A. T. "Research on Muscle Development," Research Quarterly, 31:236, May, 1960.
- Steinhaus, Arthur H. "Training for Strength," Physical Education Newsletter, 6:2, February 12, 1962.
- Thompson, Hugh. "Values of Isometric Training," Scholastic Coach, 32:38-40+, September, 1962.
- Thompson, Hugh. "Weight Training vs. Isometric Training," Scholastic Coach, 32:42-47, October, 1962.
- Thompson, Hugh. "Functional Isometric Exercise Program," Scholastic Coach, 32:30-31, November, 1962.
- Wagner, Berny. "Simple Isometrics," Scholastic Coach, 32:22-23, December, 1962.
- Wolbers, Charles P., and Frank S. Sills. "Development of Strength in High School Boys by Static Muscle Contractions," Research Quarterly, 27:446-50, December, 1956.

CHAPTER 11  
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• proper position in  
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**APPENDIX**

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## INSTRUCTIONS FOR THREE STRENGTH TESTS

### HANGING

Adjust bar to level of top of performer's head.

Grasp bar with hands about shoulder width apart and palms toward face. Spring upward so arms are flexed firmly against body, chin above bar and body hanging straight and unsupported except for hands. Hold position as long as possible. If arms start extending, go down as slowly as possible. Time from time proper position is obtained until moment when chin is lowered to level of top of bar.<sup>1</sup>

### SIT-UP

Assume hook sitting position with feet flat on floor and back straight. Put hands on shoulders with elbows reaching forward to rest on top of knees. Place feet in proper position and have partner hold them. Lie on back, hands on shoulders. On Ready, Go! lift trunk up to touch elbows to knees and return to back lying without touching head. May stop and rest, if necessary. Score is total of correct movements (up and down) in one minute.<sup>2</sup>

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<sup>1</sup>Gladys M. Scott, and Esther French, Measurement and Evaluation in Physical Education (Dubuque, Iowa: Wm. C. Brown Company Publishers, 1959), p. 297.

<sup>2</sup>Ibid., p. 299.

## JUMP AND REACH

Stand with face to wall, toes touching wall. Reach evenly overhead with both hands and mark height of reach. Turn sideward to wall, jump and reach with one hand and touch as far up wall as possible. Score is difference between reach while standing and when jumping.<sup>3</sup>

The girls were allowed to jump three times, and the best jump of the three was recorded.

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<sup>3</sup>ibid., p. 360.



SAMPLE OF INDIVIDUAL SCORE CARDS

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WHITE, SHARON (Exper.)

Hr. 7

AGE: 14(5/24/48)

SCORES

HT: 60 $\frac{1}{2}$

Arms:

(1) (T)

44.9 66

(2)

60.7

WT: 93

Abd:

42 69

52

CLASS: E

Legs:

15 65  
200

14 $\frac{1}{2}$

Av. T: 66

---

TABLE V

## T-SCORES USED TO EQUATE GROUPS

Control	Experimental	Control	Experimental
66*	66	49	49
61	65	48	49
60	64	48	49
60	61	47	49
60	59	47	48
58	57	47	48
57	57	45	47
57	57	45	47
56	56	45	46
56	56	45	45
55	55	45	45
54	55	44	45
54	55	44	44
54	55	44	44
53	54	43	44
53	53	43	42
53	53	41	42
53	52	41	41
51	51	41	41
51	50	39	37
50	50	39	33
50	50	38	33
49	49	30	30

Mean

Control . . . . . 49.2

Experimental . . . . . 49.6

\*Average of T-scores of the three strength tests.

TABLE VI

SCORES FROM HANGING TESTS - INITIAL TESTING PERIOD

<u>Scores - Seconds</u>			
Control	Experimental	Control	Experimental
54.8	50.0	20.1	19.0
50.1	48.8	20.0	18.5
43.2	48.7	19.8	17.8
41.3	44.9	19.4	17.6
36.9	42.5	19.4	17.4
36.9	40.8	17.6	16.2
32.5	40.0	16.6	15.0
32.1	38.5	16.2	14.7
31.9	37.6	15.7	14.7
31.3	35.5	15.5	14.7
29.7	31.1	14.1	13.8
27.4	30.5	13.7	13.5
26.4	29.1	13.0	13.4
26.0	29.1	11.9	12.2
25.9	27.0	11.5	11.4
25.5	23.7	11.0	9.8
24.8	23.2	10.9	9.5
24.6	22.7	9.0	9.0
23.0	22.2	8.3	5.7
22.6	21.5	5.7	5.5
22.1	21.4	4.1	.0
22.0	20.1	4.1	.0
21.2	19.0	.0	.0

TABLE VII  
 SCORES FROM SIT-UPS - INITIAL PERIOD

Control	Scores - Number Performed		Experimental
	Experimental	Control	
41	44	31	32
39	42	30	31
39	42	30	31
38	38	30	30
37	38	30	30
37	38	29	29
36	36	29	29
36	36	29	28
36	36	29	28
36	36	29	28
35	36	28	28
35	35	27	28
35	35	27	27
35	33	27	27
34	33	25	27
34	33	24	26
33	33	24	25
33	33	24	25
33	33	23	24
33	33	22	23
33	33	20	21
32	32	19	16
32	32	19	14

TABLE VIII  
 SCORES FROM JUMP AND REACH - INITIAL TESTING

<u>Scores - Inches</u>			
Control	Experimental	Control	Experimental
16.0	17.5	12.0	12.0
15.5	16.0	12.0	12.0
15.0	15.0	12.0	12.0
15.0	15.0	11.5	11.5
14.0	15.0	11.5	11.5
14.0	14.5	11.0	11.5
14.0	14.0	11.0	11.5
14.0	14.0	11.0	11.5
13.5	13.5	11.0	11.5
13.5	13.0	11.0	11.0
13.5	13.0	11.0	11.0
13.0	13.0	10.5	11.0
13.0	13.0	10.5	11.0
13.0	13.0	10.5	10.5
12.5	13.0	10.0	10.0
12.5	12.5	10.0	10.0
12.5	12.5	9.5	9.5
12.5	12.5	9.5	9.5
12.5	12.5	9.5	9.5
12.5	12.5	9.5	9.5
12.0	12.5	8.0	9.5
12.0	12.5	8.0	9.0
12.0	12.0	5.5	8.5

## INDIVIDUAL SCORES OF INITIAL AND FINAL TESTS

<u>Control</u>		<u>Hanging Test</u>		<u>Experimental</u>	
Initial Testing	Final Testing	Initial Testing	Final Testing	Initial Testing	Final Testing
54.8	65.7	50.0	57.6		
50.1	50.7	48.8	40.4*		
43.2	49.6	48.7	56.3		
41.3	35.6*	44.9	60.7		
36.9	55.4	42.5	32.7*		
36.9	36.0*	40.8	64.9		
32.5	26.5*	40.0	62.7		
32.1	55.5	38.5	34.0*		
31.9	36.2	37.6	44.1		
31.3	31.2*	35.5	41.1		
29.7	47.3	31.1	31.1		
27.4	27.1*	30.5	42.6		
26.4	28.2	29.1	35.9		
26.0	23.4*	29.1	37.5		
25.9	31.9	27.0	34.6		
25.5	32.2	23.7	36.7		
24.8	16.0*	23.3	33.1		
24.6	27.3	22.7	21.2*		
23.0	21.5*	22.2	38.9		
22.6	26.9	21.5	27.8		
22.1	35.4	21.4	29.7		
22.0	38.5	20.1	15.3*		
21.2	23.2	19.0	26.9		
20.1	20.5	19.0	23.0		
20.0	18.9*	18.5	28.4		
19.8	23.7	17.8	35.7		
19.4	35.0	17.6	30.7		
19.4	26.4	17.4	10.2*		
17.6	26.8	16.2	26.0		
16.6	23.6	15.0	21.0		
16.2	20.0	14.7	26.4		
15.7	18.5	14.7	19.6		
15.5	21.5	14.7	19.1		
14.1	20.3	13.8	24.1		
13.7	27.2	13.5	43.3		
13.0	33.8	13.4	14.8		
11.9	10.9*	12.2	16.8		
11.5	19.4	11.4	12.4		
11.0	18.6	9.8	11.9		
10.9	25.0	9.5	15.1		
9.0	6.4*	9.0	16.2		
8.3	22.3	5.7	7.7		
5.7	8.8	5.5	16.5		
4.1	9.3	.0	.9		
4.1	2.7*	.0	.6		
.0	.0	.0	3.5		

\*Individuals who had lower scores on final testing.

TABLE IX (continued)

<u>Sit-ups</u>			
<u>Control</u>		<u>Experimental</u>	
Initial Testing	Final Testing	Initial Testing	Final Testing
41	39*	44	44
39	36*	42	44
39	41	42	52
38	46	38	41
37	33*	38	36*
37	41	38	32*
36	42	36	38
36	44	36	34*
36	43	36	39
36	38	36	36
35	37	36	42
35	37	35	40
35	31*	35	35
35	37	33	31*
34	38	33	41
34	32*	33	31*
33	34	33	29*
33	34	33	37
33	26*	33	35
33	42	33	33
33	35	33	42
32	38	32	28*
32	38	32	34
31	31	32	33
30	32	31	30*
30	41	31	35
30	30	30	31
30	28*	30	29*
29	27*	29	25*
29	32	29	27*
29	22*	28	28
29	27*	28	31
29	28*	28	49
28	30	28	34
27	26*	28	30
27	34	27	30
27	31	27	26*
25	33	27	25*
24	29	26	21*
24	33	25	32
24	29	25	32
23	33	24	25
22	25	23	29
20	25	21	14*
19	20	16	20
19	23	14	19

\*Individuals who had lower scores on final testing.

TABLE IX (continued)

<u>Jump and Reach</u>			
<u>Control</u>		<u>Experimental</u>	
Initial Testing	Final Testing	Initial Testing	Final Testing
16.0	14.5*	17.5	16.0*
15.5	15.5	16.0	18.0
15.0	14.5*	15.0	16.0
15.0	15.0	15.0	16.5
14.0	12.0*	15.0	14.5*
14.0	12.5*	14.5	15.5
14.0	15.0	14.0	14.5
14.0	16.0	14.0	15.0
13.5	13.0*	13.5	13.5
13.5	14.0	13.0	13.5
13.5	13.5	13.0	13.5
13.0	13.0	12.0	14.0
13.0	14.0	13.0	14.0
13.0	12.0*	13.0	15.0
12.5	11.5*	13.0	13.0
12.5	12.5	12.5	11.0*
12.5	11.0*	12.5	12.5
12.5	13.0	12.5	12.0*
12.5	13.0	12.5	13.0
12.5	12.0*	12.5	14.0
12.0	13.0	12.5	13.0
12.0	13.0	12.5	13.5
12.0	13.5	12.0	12.0
12.0	12.0	12.0	13.0
12.0	12.5	12.0	11.5*
12.0	12.5	12.0	12.0
11.5	10.5*	11.5	12.5
11.5	12.0	11.5	12.0
11.0	13.0	11.5	14.0
11.0	12.0	11.5	12.0
11.0	11.5	11.5	14.5
11.0	11.5	11.5	12.0
11.0	12.0	11.0	13.0
11.0	12.0	11.0	11.5
10.5	12.5	11.0	11.0
10.5	11.0	11.0	12.0
10.5	11.0	10.5	12.5
10.0	10.0	10.0	10.5
10.0	12.0	10.0	9.5*
9.5	10.0	9.5	9.5
9.5	11.0	9.5	12.0
9.5	11.5	9.5	9.5
9.5	9.5	9.5	10.0
8.0	13.0	9.5	14.0
8.0	8.5	9.0	9.0
5.7	7.0	8.5	10.5

\*Individuals who had lower scores on final testing.