

THE EFFECTS OF ISOMETRIC AND COMBINED ISOMETRIC AND
ISOTONIC EXERCISE ON HIGH SCHOOL STUDENTS

by

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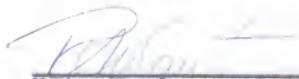
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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Strength is an important aspect of physical fitness and physical fitness is an important national concern. There is considerable emphasis today on how to raise the physical fitness of our nation's youth. Strength can be increased only by overloading the muscle. The majority of claims on how much strength has been increased have been done on the college level.

I. THE PROBLEM

Statement of the problem. This study has been made (1) to observe the effects of isometric contractile work on strength of students of high school age; (2) to compare the results of isometric and isotonic contractions on the same age group; (3) to stress the results on an individual basis as well as on a group basis; and (4) to show the effects of isometric and isotonic contractions in certain areas of physical fitness.

Importance of the study. Strength is a very important part of physical fitness. Physical fitness depends on strength in three important areas; (1) muscular strength; (2) muscular endurance; and (3) muscular power. In this

study the investigator has tried to find out how isometric contractions and isotonic contractions affect the gain of strength. The study attempted to show the effect of body development from employing these types of contractions. A large amount of material has been written claiming that one type of contraction is superior to the other in gaining strength. The purpose of this study was to attempt to show the best type of work for high school physical education programs in developing strength. Groups were set up to test the different types of contractile work and their effects on strength. Some authors have discussed this point at length and indicated the difficulty one has in comparing the results of isometric and isotonic contractile work. The writer attempted to keep this in mind when comparing results that were attained.

II. DEFINITIONS OF TERMS USED

Strength. The ability of a muscle to work against resistance depends on the amount of muscular force which can be exerted. This depends upon: (1) the size of the muscles; (2) the proportion of the constituent fibers engaged in the action; (3) the coordination of the muscle groups; (4) the physical condition of the muscles; and

(5) the mechanical advantage of the levers employed.¹

Power. This is the product of speed and force of a muscle. Muscular power would be the ability of a muscle group to release maximal power in a short period of time. If the speed factor was to be taken away then power and strength would be synonymous.

Muscular Endurance. This is the ability to continue a muscular contraction at a sub-maximal magnitude.

Isometric Contraction. There is said to be an isometric contraction when the length of the muscle does not change. Physical educators in the past have used the term "dynamic" but this term is seldom used any more. At the start of an isometric contraction there is a short movement of the muscle; however this small movement is accepted as there is no movement of the skeletal part of the body.

Isotonic Contraction. When the muscle shortens and the load remains the same this is known as an isotonic contraction. The following misnomer is used in order to avoid many cumbersome terms. When a contracting muscle lengthens this state is referred to as eccentric contraction; whereas

¹Laurence L. Morehouse and Augustus T. Miller, Physiology of Exercise (St. Louis: The C. V. Mosby Company, 1953), p. 209.

a conventional contraction may be called concentric.

CHAPTER II

RECENT MATERIAL WRITTEN ON ISOMETRIC CONTRACTIONS

The most important aspect of muscle training is to understand the movement involved and the muscles which contribute to this movement. By using this philosophy a conditioning program can be set up intelligently.

Recent work by physiologists have shown that the size of a muscle is determined by the amount of cytoplasm in each cell. The more work a cell is required to perform, the more cytoplasm is stored there by nature. A cell is limited as to size, so instead of having one large cell filled with cytoplasm, nature distributes it's fuel supply over a greater number of cells thus spreading its potential power over a larger area. This means then that a thin person has fewer cells filled with cytoplasm while an active athlete, one who exercises constantly, will have much more cytoplasm distributed over a greater number of cells. This can be more clearly illustrated by the person who has a limb in a sling or a cast. The limb will decrease in size. This is due to a loss in cytoplasm not a loss in cells of the muscle.²

²Joseph Goldenberg, "Improved Athletic Performance thru Weights," Physical Power, IV (March-April, 1963), pp. 16.

In athletic training there has been for many years the misconception that large muscles will hinder movement. To disprove this idea the following evidence should be considered. The muscles are solely responsible for every movement of our body. Movement is determined by how powerful the muscles are during contraction and relaxation.

If we put together, in proper sequence a series of muscle contractions and relaxations, all in their proper sequence, a series of muscle contractions and relaxations, all in their proper degrees, you will have a perfect foul shot in basketball. If on the other hand, one small group of muscles does not perform properly, in relation to the others, then the foul shot is missed.³

Athletes should exercise all muscle groups during weight training. This will develop all muscles, thus raising performance. Picking up ten pounds is certainly easier than one hundred pounds. This is why a powerfully developed group of muscles will give a person superior performance with less effort and fatigue.

THE DEVELOPMENT OF STRENGTH

The primary purpose of weight training should then be to increase or maintain a predetermined amount of strength. Today there are two general classifications of weight training. These two types of training are isotonic

³Ibid., p. 17.

and isometric. Isotonic training is employed by using some sort of resistance usually weights.

During this report considerable attention was given to isometric contractile work. Muller stated muscular strength and fiber mass are strictly correlated, and that to keep up an unnecessarily large muscle mass is costly in metabolism and circulatory effect. The strength of a muscle is adapted to needs by muscular growth. The stimulus for increase in muscle strength is not fatigue, but the force exerted during the job. When this force exceeds a third of maximum strength, the maximum speed of increase in strength is reached with one single short duration static contraction per day. Strength is lost at the same rate as it is gained.⁴

Further investigation has shown that muscle strength increases more rapidly by increasing the intensity of training load up to about two-thirds of maximal strength. Beyond this, increase in training load has no further effect. At this amount of tension, capillaries of the muscle are compressed and oxygen supply becomes inadequate. This oxygen deficit is an important factor in the acquisition of

⁴Th. Hettinger and E. A. Muller, "Die Bedeutung des Trainingsverlaufs für die Trainingsfestigkeit von Muskeln," Arbeitsphysiologie, Bd. 15:452-458. (Translated by John D. Lawther.)

muscular strength.⁵

Isometric contractile work is amazing when compared with weight training. A person doing isometric work could get a complete body workout in five minutes; with weights the workout period may last one or two hours. Karpovich asserted, however, that although a weight lifting session may last from one to two hours, the time actually spent lifting may be only two to six minutes. Thus Muller's report and Karpovich's would be almost identical in terms of time spent for the isometric and isotonic contractions.⁶

These two studies, did not attempt to determine which of the two training programs, isotonic or isometric, was better for developing muscular strength. Almost all coaches have accepted the value of the weight training program, which involves isotonic muscular contractions, as beneficial and necessary for strength development.

One investigation attempted to determine the relative effectiveness of the two types of training in the production of strength and muscle girth. One method used

⁵G. L. Rarick and G. J. Larsen, "Observations of Frequency and Intensity of Isometric Muscular Effort in Developing Static Muscular Strength in Post-Pubescent Males," Research Quarterly, XXIX (October, 1958), pp. 452-458.

⁶Peter V. Karpovich, Physiology of Muscular Activity (Philadelphia: W. B. Saunders, 1959), p. 13.

isometric contractions and the other isotonic contractions. The findings showed that each group gained significantly in strength. Both groups gained in muscle girth.⁷ Some investigations have showed a positive gain for both groups with a slightly higher group gain for the ones using both isometric and isotonic exercises together.

⁷Stan Burnham, "The Value of Combined Isometric and Isotonic Exercise," Physical Power, V (May-June, 1963, pp. 14-15.

CHAPTER III

TESTS USED AND THE ANALYSIS OF THE RESULTS

The boys physical education classes of Riley County High School were used in an investigation to determine the effects of isometric and isotonic work on different areas of strength and body development. Two classes were used the fall semester of 1962. One class was used during the spring semester of 1963. The fall semester class consisted of one freshman group containing twenty boys. The other fall class consisted of seventeen junior and senior boys. The spring class consisted of eighteen sophomore boys. All groups were a combination of athletes and non-athletes. Boys participating in athletics were divided into each group as evenly as possible.

Each boy did his particular work out five days a week six minutes a day for a period of eight weeks. The boys were tested at the beginning of the eight week period and at the end of the eight weeks. The scores were recorded at the start and the end of the eight week period.

A recent investigation by Lorback attempted to determine the relative effectiveness of two types of training in the production of strength and muscle girth. One group used isometric exercises and the other group used isotonic exercises.

Both groups gained significantly in strength, indicating that both training programs were effective for developing strength of the muscle groups involved.

Both groups gained significantly in muscle girth.

Group B, utilizing the two-thirds maximum contraction method for six seconds per training period, gained a significantly greater amount of strength than did Group A in the muscle groups involved in knee flexion. Otherwise the two methods of strength training were approximately equal in effectiveness.

There was no significant difference between Groups A and B in girth of any of the muscle groups measured in the final test.⁸

This study thus used the following different groupings. The freshman group was divided into two groups each group containing ten boys. One group did isometric work only. The second group combined both isometric and isotonic and isotonic exercises. The seniors were left as one group of seventeen boys and did only isometric work. The sophomore class was divided into three groups of six boys each. The first group did isometric work only and the second group did a combined group of exercises of isometric and isotonic. The third group did isotonic work only.

One other recent research has been published on the value of combined isometric exercise. Its purpose and conclusions were:

It was the purpose of this study to determine the

⁸Hugh Thompson, "Weight Training VS Isometric Training," Scholastic Coach, XXXII (October, 1962), pp. 44-45.

effect upon performance of strength and endurance gained through isometric-isotonic methods as compared to strength and endurance gained through isometric methods alone.

Both the experimental group which trained isometrically-isotonically and the control group which trained isometrically made significant gains on all measures; however the data as revealed by this investigation indicates that the experimental group made greater improvements on the bench press and⁹ push up tests, both of which are dynamic measures.

The units of improvement for the testing program were determined by each pound gained and each chin up gained and each inch gained. These gains were given one credit for each unit. The clean and press was executed only twice during the eight weeks period. This was done at the start of the eight weeks and at the finish. This was done so that skill would not enter into the results. The students were not allowed to bend their knees after the bar was raised to the chest position. For the standing broad jump only six jumps were allowed during the eight week period. Three at the start and three at the finish. Chin ups were done with the palms in the forward position. A helper was used to keep the student from swinging. Credit for a chin up was not given unless the student completely straightened his arm at the elbow.

⁹Stan Burnham, "The Value of Combined Isometric and Isotonic Exercise; The Overload," (May-June, 1962), pp. 14-15.

The first table shows the effects of isometric exercise upon the freshman group in the areas of clean and press, standing broad jump, and chin ups.

Table 1. The effects of isometric exercise upon freshman boys.

Group 1	Clean and Press		Standing Broad Jump		Chin ups		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	
No. 1	80	90	6'11"	7'0"	6	9	14
No. 2	65	80	5 0	5 5	2	4	22
No. 3	100	110	6 4	6 6	10	11	13
No. 4	50	60	4 11	4 11	0	1	11
No. 5	105	115	6 11	7 3	11	12	15
No. 6	75	85	5 1	6 5	2	4	28
No. 7	95	95	5 1	6 6	2	5	22
No. 8	85	95	5 10	5 10	1	2	11
No. 9	65	75	5 11	6 0	2	2	11
No. 10	60	70	4 2	4 3	0	0	11
Total							158

Table one shows that one out of ten participants failed to increase in the clean and press.

Eight out of the ten increased ten units in the clean and press, one boy gaining fifteen units, and one boy failing to gain a single unit. This shows substantial gain in the deltoid muscles, upper pectoralis major, and the

triceps. This gives a total group gain of ninety-five units in the clean and press. This was a group gain of twelve per cent.

The standing broad jump and chin ups were used so that comparisons could be made on how these types of exercises help in improving physical fitness. There was a group gain of forty-seven units in the standing broad jump, and fourteen units in the chin ups. The chin ups were improved on a group basis by thirty-eight per cent.

Table two shows the effects of combined isometrics and isotonic exercise upon the clean and press, standing broad jump, and the chin ups.

Table two shows that ten out of ten boys made improvement in the clean and press. Seven out of ten increased ten units, one boy gaining five units, one fifteen units, and one twenty units. This was a group gain of one hundred and ten units. This is a percentage increase of thirteen per cent.

The standing broad jump scores were increased sixty-nine units with ten out of ten boys showing improvement.

The chin ups were improved by sixteen units with nine out of ten boys showing improvement. The percentage increase being thirty per cent.

Table three shows the effect of isometrics upon freshman boys in the areas of forearm girth, biceps girth,

weight, and chest girth.

Table 2. The effects of combined isometric and isotonic exercise upon freshman boys.

Group 2	Clean and Press		Standing Broad Jump		Chin Ups		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	
No. 1	90	100	6'11"	7'5"	7	10	19
No. 2	75	85	4 6	5 11	2	4	29
No. 3	105	115	5 5	5 11	7	8	15
No. 4	75	85	5 2	5 11	4	6	21
No. 5	50	65	5 7	5 11	5	8	22
No. 6	100	110	6 5	6 7	8	10	14
No. 7	100	120	6 8	6 10	5	6	23
No. 8	100	110	4 8	5 8	0	1	23
No. 9	85	85	4 2	5 0	1	1	15
No. 10	65	75	6 5	6 8	7	8	13
Total							194

The results of table three show that nine out of ten of the group increased the size of their forearm. Five out of ten showed an increase of one-quarter of an inch, two had an increase of one-half inch, and two had an increase of three-quarters of an inch. This made a total increase of three and three-quarter units.

The region of the biceps and triceps showed a gain

by nine out of ten of the participants. Four boys gained one-half an inch, three gained one-quarter of an inch, one gained three-quarters of an inch, and one gained one inch. This made a group gain of four and one-half units.

Table 3. The effects of isometric exercise upon muscle girth of freshman boys.

Group	Forearm Girth		Biceps Girth		Weight		Chest		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	9%	10	11	11%	121	123	37	38	4½
No. 2	8%	9½	10	10%	103	105	31%	32%	3%
No. 3	9%	10%	11%	12	138	138	35	37	3%
No. 4	9%	10	10%	10%	120	118	32%	34	½
No. 5	10%	11	12%	13	148	150	38	38	2%
No. 6	10%	10%	12	12	145	149	34	35	5%
No. 7	10%	11½	11	11%	145	145	36	36%	1%
No. 8	10%	10%	12%	12%	145	148	36	36	3%
No. 9	9%	10½	11%	12	125	130	34%	35%	6%
No. 10	10½	11	12	13	163	175	38%	40	14%
Total									36%

Eight out of ten boys made a gain in weight during the eight weeks period. The total group gain was seventeen units.

The chest region made a gain by eight of the ten

members of the group. Two members gained two inches, two gained one and three-quarters inches, two gained one inch, one gained a half inch and, one gained one-quarter of an inch. This made a group gain of ten and one-quarter units.

Table four shows the effects of combined isometrics and isotonics upon the areas of forearm girth, biceps girth, weight and chest girth.

Table 4. The effects of combined isometric and isotonic exercise upon freshman boys.

Group	Forearm Girth		Biceps Girth		Weight		Chest Girth		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	10	10	11	11½	126	137	37½	38½	12½
No. 2	10	10½	11	11	120	126	34½	35½	7½
No. 3	11½	11	12½	12½	135	144	35½	36	9½
No. 4	9½	9½	11	11½	125	126	34½	35	2½
No. 5	9½	9½	9½	9½	105	105	31½	32½	1½
No. 6	10½	12	13	14	150	154	37½	39½	8½
No. 7	10	11	12	12½	150	155	38	38	6½
No. 8	10½	11½	12½	13½	176	182	39½	40½	8½
No. 9	11½	12	13½	13½	149	152	40	40	3½
No. 10	9½	10½	11½	12	125	130	34½	36½	8
Total									70½

From table four group two had a gain by seven out of the ten members in forearm girth. Three members gained one-quarter of an inch, two gained one inch, one gained three-quarters of an inch, one gained a half inch and, one lost a quarter of an inch. The total group gain was four units.

The biceps and triceps region showed a gain by eight out of ten members of group two. Three gained one-quarter of an inch, two gained one inch, two one-half inch, and one gained three-quarters of an inch. This made a group gain of four and one-half units.

Group two showed a tremendous gain in weight. The group gained fifty-three pounds.

The units of improvement were determined by each quarter of an inch gained in girth and each pound gained in weight. The measuring of girth of the forearm was done just below the elbow joint at the largest part with the muscle contracted. The biceps was measured with the muscle contracted at the area of biggest circumference. The chest was measured just under the arm pits with the muscles relaxed. The weight was recorded by using the school scales.

Table five shows the effects of isometric exercise upon junior and senior high school students in the areas of clean and press, standing broad jump, and chin ups.

Table 5. The effects of isometrics on junior and senior high school boys.

Group 1	Clean and Press		Standing Broad Jump		Chin Ups		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	
No. 1	185	210	6'4"	7'7"	6	8	30
No. 2	175	185	4 1	4 10	0	2	21
No. 3	160	165	7 8	8 7	7	11	20
No. 4	120	125	6 8	6 11	10	8	6
No. 5	115	125	6 11	7 2	11	12	14
No. 6	110	125	6 0	7 0	9	12	20
No. 7	125	130	7 7	7 11	11	12	10
No. 8	165	175	6 3	7 11	6	9	33
No. 9	160	165	6 2	7 5	8	10	22
No. 10	95	105	6 0	6 4	4	6	16
No. 11	135	140	7 3	7 4	7	9	8
No. 12	95	95	5 8	6 6	5	7	12
No. 13	115	120	7 1	7 8	11	12	13
No. 14	110	115	7 2	7 6	7	9	11
No. 15	115	130	6 4	6 5	8	9	17
No. 16	125	130	6 0	7 4	4	7	24
No. 17	100	105	6 8	7 1	8	9	11
Total							288

Seventeen out of seventeen boys made an increase in the clean and press. Nine boys showed an increase of five

pounds, four an increase of ten pounds, two had an increase of fifteen pounds and, one had an increase of twenty-five pounds. The significant thing about this increase was that it came while football season was in progress. Some reports have indicated that there were no increases during football season. The group showed an increase of six per cent.

The standing broad jump showed a substantial gain as seventeen out of seventeen increased their distance. The range was from one inch to twenty inches.

The chin ups were also increased by sixteen out of seventeen students. The range being from one to four. One boy dropped from ten to eight.

This group was measured by the same methods as already described for the freshman group.

Table six will show the effect of isometric training on large muscles.

Twelve out of seventeen made a significant growth in the forearm region using isometric exercises. Five remained at the same level and did not regress. The greatest gain was three-quarters of an inch. The freshman group also had a maximum growth of three-quarters of an inch, however there was only one that failed to make a gain in muscle girth. The group gained six and one-half units.

Table 6. The effects of isometrics on muscle girth of boys in the junior and senior class.

Group	Forearm Girth		Biceps Girth		Weight Gained		Chest Girth		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	13%	14	16½	17	215	220	43	44	1½
No. 2	13	13	15	16%	219	226	45%	46½	2
No. 3	11½	11%	12	13%	157	160	37	37	2
No. 4	11	11½	12%	13%	154	154	37	38	¾
No. 5	10	10	12	12½	130	130	38%	38½	5
No. 6	11	11%	12	12%	160	163	39%	40%	3¾
No. 7	11	11	12½	13	135	138	38	38%	1½
No. 8	12%	13	14%	14½	182	182	41½	42	6
No. 9	11½	11½	14	14½	170	165	40	40½	2¼
No. 10	10%	11	12½	13	133	131	38	37	2¾
No. 11	10	10%	12½	12%	145	145	39	40%	2¾
No. 12	10	10%	11½	11½	128	130	36%	37½	1¾
No. 13	10	10½	12	12%	125	125	35%	36%	5¼
No. 14	10%	11	12½	13	131	134	35	36	
No. 15	10%	11	12½	13	145	148	35	37	6¼
No. 16	10%	11%	12½	13½	135	136	37%	38%	3¼
No. 17	10%	11%	12%	12½	170	165	37½	38	1
Total									45½

The biceps and triceps region showed a significant gain with sixteen freshman out of seventeen making a gain.

The range was from zero units gained to one and three-quarters units. The group gain was nine and three-quarters units.

The weight change was positive in ten out of the seventeen students. Five stayed at the same level and two lost weight. The weight gains were slight with seven pounds being the greatest.

There was considerable change in the girth of the chest. Fifteen out of seventeen grew in girth with one remaining stationary and, one losing in size. The range was from minus one inch to plus two inches.

This study shows that students in Riley High School can gain in muscle girth while participating in athletics. There was a wide range of individual differences in each area tested. The total group gain was forty-five and one-half units. This is a significant gain in these areas, and it may be accomplished while the student is participating in an athletic sport.

Table seven shows the effects of isometric exercise upon the areas of the thigh, calf, and waistline relationship to girth.

Sixteen out of seventeen gained in girth around the thigh of the upper leg. One lost in muscle girth. The measurement in this area was very difficult. There was a total gain of fourteen and one-half units in this area.

Table 7. The effects of isometric exercise upon areas of the lower body.

Group 1	Thigh Girth		Calf Girth		Waistline		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	
No. 1	23½"	24½"	16½"	17"	38½"	38½"	1¼
No. 2	24	24½	17¾	18	41	41½	1
No. 3	19	20	14	14¾	30¾	31	2¼
No. 4	19½	20	15	15¾	29¾	31½	2¾
No. 5	18½	19	13	13½	30	30	1
No. 6	19½	20¾	14½	14½	31	31	1¼
No. 7	18½	20	13¾	13¾	28	28½	2
No. 8	22	24	15	15	31½	32	2½
No. 9	22½	23¾	16½	15½	33	32½	¾
No. 10	19¾	20½	14½	14½	30¾	31	1½
No. 11	19¾	21	14½	14½	30½	31	2¾
No. 12	16½	18	13	13	28¾	29	2¾
No. 13	19	18½	13¾	13¾	27¾	28½	¾
No. 14	18½	19	14½	14½	30½	31	1
No. 15	19¾	20	14¾	14¾	27¾	29	1¼
No. 16	20	21	15	15	28¾	27	¾
No. 17	16¾	18½	12¾	13	25	24½	1½
Total							18¾

Five out of seventeen showed improvement in the calf of the lower leg. Ten did not change during the eight week

period and two lost in muscle girth.

Eleven out of seventeen made an increase around the waistline, three made no change and three lost in size.

Table eight shows the effects of isometric exercise on sophomore boys in the areas of physical fitness.

Table 8. The effects of isometric exercise upon areas of physical fitness.

Group	Chin Ups		Push Ups		Standing Broad Jump		Set Ups		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	10	13	25	35	7'3"	7'10"	51	100	68
No. 2	1	3	15	18	6 0	6 2	35	100	72
No. 3	4	10	7	21	5 8	6 0	30	75	69
No. 4	8	8	22	27	7 3	7 3	100	110	15
No. 5	5	9	17	24	7 0	7 1	100	120	28
No. 6	7	11	12	30	7 9	8 3	100	130	58
Total									310

Group one made an increase of nineteen units in the chin ups. There was an increase by five out of the six boys. The range was from zero to four. This was a significant increase in this event.

Group one made an increase of forty-eight units. The range was from three to eighteen. Six out of six made improvement. The push ups were done in pairs. One boy

assumed a push up position and the other boy placed his hand flat on the floor under the chest of his partner. One push up was given when the student extended his arms, and then returned to the floor close enough to touch his partner's hand.

The standing broad jump had a group increase of twenty units. The range was from zero to seven units. Five out of six had an increase with one staying at the same level.

Set ups were increased by six out of six of the participants. The range of increase was from ten to forty-nine. Group one had a total group increase of three hundred and ten units.

Table nine shows the effects of combined isometric and isotonic exercise on areas of physical fitness.

Group two made an increase of sixteen units in the chin ups. The range of increase was from one to four with six out of six making a gain.

The push ups were increased by sixty-one units for the group. The range of increase was from three to twenty-three. This was a substantial increase. Six out of six showed an increase.

The standing broad jump group had an increase of forty-nine units. Five out of six made an increase. The range of increase was from zero to twenty-three units.

Table 9. The effects of combined isometric and isotonic exercise on areas of physical fitness.

Group	Chin Ups		Push Ups		Standing Broad Jump		Set Ups		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	2	5	21	24	5'9"	6'0"	100	115	24
No. 2	15	16	30	41	7 0	7 3	100	150	65
No. 3	5	8	15	22	7 8	7 8	51	100	59
No. 4	4	6	7	14	5 3	7 2	20	60	72
No. 5	4	8	17	40	5 11	7 1	100	110	51
No. 6	8	11	15	25	7 1	7 7	80	105	42
Total									313

The set ups were increased by six out of six participants. The range of increase was from ten to fifty.

Table ten shows the effects of isotonic exercise upon the sophomore boys in the areas of physical fitness.

Group three had an increase in the chin up area of fifteen units. Six out of six made an increase. The range was from one to four.

Push ups were increased by forty-six units with six out of six showing an increase. The range of increase was from two to fourteen units.

The standing broad jump increased by thirty-six units. An increase was made by five out of six of the participants.

The range of increase was from zero to fourteen units.

Table 10. The effects of isotonic exercise on areas of physical fitness.

Group	Chin Ups		Push Ups		Standing Broad Jump		Set Ups		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	3	7	15	24	7'4"	7'7"	100	120	36
No. 2	3	4	17	26	5 0	6 4	39	100	85
No. 3	8	12	25	38	7 10	7 10	100	130	47
No. 4	7	9	30	34	7 0	7 6	100	115	27
No. 5	4	7	18	22	5 11	6 4	100	118	40
No. 6	3	4	12	14	5 5	5 6	65	90	39
									<u>294</u>
									Total

The total group gain was two hundred and ninety-four units.

Table eleven shows the effects of isometric exercise upon the clean and press, hand dynamometer, for the right and left hands.

Group number one made an increase of ninety-five units in the clean and press. This was a sixteen per cent increase. The range of increase was from five to twenty-five units.

On the hand dynamometer the right hand of group number one had an increase of thirty-seven units. The range of

increase was from zero to ten units. The left hand had an increase of forty-eight units. The range or increase being from five to twenty units.

Table 11. The effects of isometric exercise upon areas of strength of the upper body.

Group 1	Clean and Press		Hand Dynamometer Right Hand		Hand Dynamometer Left Hand		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	
No. 1	70	85	108	110	100	110	27
No. 2	80	95	130	130	110	130	25
No. 3	85	105	110	120	95	100	35
No. 4	110	115	105	110	95	100	15
No. 5	115	130	130	140	120	125	30
No. 6	110	135	120	130	117	120	33
Total							165

Table twelve shows the effects of combined isometric and isotonic exercise upon the clean and press and the hand dynamometer.

Group number two had an increase of one hundred and twenty units. The range was from ten units to thirty units. The total increase was twenty per cent. The total group gain was one hundred and eighty-five units.

The right hand of group number two had an increase of forty-five units. The range of increase was from five

to ten units. With five out of the six gaining five units. The left hand of this group had a total gain of forty-eight units. The range of increase being from three to twenty units. The total group gain was two hundred and thirteen units.

Table 12. The effects of combined isometric and isotonic exercise upon areas of strength of the upper body.

Group	Clean and Press		Hand Dynamometer Right Hand		Hand Dynamometer Left Hand		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	
No. 1	105	130	100	115	90	110	60
No. 2	105	125	110	115	102	105	28
No. 3	95	125	130	135	115	120	40
No. 4	100	115	120	130	125	130	30
No. 5	75	95	105	110	90	100	35
No. 6	105	115	115	120	105	110	20
							Total 213

Table thirteen shows the effects of isotonic exercise upon the upper body and the hand and forearm.

Group three had an increase of ninety-five units in the clean and press. This was a fifteen per cent increase. The range of increase being from ten to twenty units.

The right hand of group number three had an increase

of forty units. The range of increase was from five to ten units. The left hand had an increase of thirty units. One person lost ten units, two remained the same and three showed a positive increase. The total increase of this group was one hundred and sixty-five units.

Table 13. The effects of isotonic exercise upon areas of the upper body.

Group 3	Clean and Press		Right Hand		Left Hand		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	
No. 1	95	115	100	110	120	100	10
No. 2	65	85	110	115	100	110	35
No. 3	140	150	105	110	130	130	15
No. 4	135	145	130	135	120	120	15
No. 5	85	105	100	110	100	105	35
No. 6	90	105	90	95	95	110	35
Total							165

Table fourteen shows the effects of isometrics upon the areas of biceps, forearm, chest, and neck in relation to girth.

Group number one made an increase of two and one-half units in the area of the biceps. The range of increase was from one-fourth of an inch to three-quarters of an inch. The total group increase was two and one-half units.

Table 14. The effects of isometrics upon muscle girth.

Group 1	Biceps Girth		Forearm Girth		Chest Girth		Neck Girth		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	11½	11½	9½	10½	33	35	12½	13½	4¼
No. 2	13½	13½	11	11½	39½	40	15	15½	1¼
No. 3	12½	12½	10½	10½	33	34½	13½	14	2½
No. 4	11½	11½	9½	10½	36	37	13	14	3¼
No. 5	12	12½	10½	10½	35	37	14	15	4
No. 6	12½	13½	10½	11	36½	37	15	15½	2½
									<u>17¼</u>
								Total	17¼

The forearm area increased three and one-fourth units with the range being from one-fourth of an inch to one inch.

The chest made an increase of seven and one-half units. The range of increase being from one-half inch to two inches.

The neck increased in range from one-fourth of an inch to one inch during the eight week period. The total group increase for the neck was four and three-fourths units. The total increase was eighteen and one-fourth units.

Table fifteen will show the effects of combined isometric and isotonic exercise upon areas of muscle girth.

Table 15. The effects of combined isometric and isotonic exercise upon areas of muscle girth.

Group 2	Biceps Girth		Forearm Girth		Chest Girth		Neck Girth		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	14	14 $\frac{1}{4}$	11	11	38	38 $\frac{1}{2}$	15	16	2 $\frac{1}{4}$
No. 2	11 $\frac{1}{4}$	12 $\frac{1}{4}$	10	10 $\frac{1}{2}$	36 $\frac{1}{2}$	37 $\frac{1}{2}$	15 $\frac{1}{2}$	15 $\frac{1}{2}$	3 $\frac{1}{2}$
No. 3	12 $\frac{1}{4}$	13 $\frac{1}{4}$	11 $\frac{1}{4}$	11 $\frac{1}{4}$	35 $\frac{1}{2}$	36 $\frac{1}{2}$	14 $\frac{1}{2}$	15	3 $\frac{1}{4}$
No. 4	12	12 $\frac{1}{2}$	11 $\frac{1}{4}$	11 $\frac{1}{2}$	34 $\frac{1}{2}$	34 $\frac{1}{2}$	14	14	$\frac{1}{2}$
No. 5	12	13	10 $\frac{1}{2}$	10 $\frac{1}{2}$	36	37	14	14 $\frac{1}{2}$	2 $\frac{1}{4}$
No. 6	11 $\frac{1}{4}$	11 $\frac{1}{2}$	10 $\frac{1}{2}$	10 $\frac{1}{2}$	34	35	14	14 $\frac{1}{2}$	1 $\frac{1}{4}$
									<u>14$\frac{1}{4}$</u>
									Total

Group two made an increase of four and one-fourth units in the biceps area. The range of increase was from one-fourth of an inch to one inch. The increase was positive for all the participants.

The forearm increase only one and one-half units in group two. Three boys failed to show an increase.

The chest had an increase of four and one-half units. The range was from zero to one inch.

The neck increased from zero to one inch with five out of the six making a positive increase. The total group increase was fourteen and one-half units.

Table sixteen will show the effects of isotonic exercise alone upon areas of muscle girth.

Table 16. The effects of isotonic exercise upon areas of muscle girth.

Group 3	Biceps Girth		Forearm Girth		Chest Girth		Neck Girth		Units of Improvement
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
No. 1	11½	11½	11	11½	38	39	14½	15½	2
No. 2	12	12½	10½	11	34	35	13½	13½	2½
No. 3	12½	13½	10½	11½	37	37	14½	15	2½
No. 4	12½	12½	11	11½	37	37½	15½	16	1½
No. 5	12½	12½	10½	11	36½	37½	14½	14½	1½
No. 6	11½	11½	10½	10½	34½	35	14	14½	1½
									Total 11

Group three made an increase of two and one-fourth units increase. Six out of six made an important positive increase. Four out of six made a one-quarter increase.

The forearm increased two and one-half units. The range of increase was from zero to one inch increase.

The chest area increased three and three-fourths units. The range of increase was from zero to one inch.

The neck increase was a total of two units. The range of increase was from zero to one-half of an inch.

RESULTS AND DISCUSSION

Comparing table one with table two shows that group two made the largest increase in units gained in each of the three areas tested. Group one gained twelve per cent in the press with group two gaining thirteen per cent. The data thus shows that combining isometric and isotonic exercise gives a greater increase in strength. The difference is very slight and both groups did gain significantly in strength.

The standing broad jump showed a significant difference as group two gained sixty-nine units while group one gained only forty-seven units.

The chin ups gained by each group were almost the same. Group one gained fourteen units and group two gained sixteen units; however, the percentage increase by both groups was the same at thirty-eight per cent.

The data should also be surveyed on an individual basis. This shows that there were wide ranges of individual development. This is especially evident in the standing broad jump where the range of improvement was from zero units to seventeen units in group one and from two units to seventeen units in group two.

In table three group one and table four with group two the comparison shows that in the region of forearm girth group two gained a total of four units and group one gained

a total of three and three-quarters units. This is a very slight difference and shows little or no significance. The region of the biceps and triceps showed a group gain of four and one-half units by both groups. This compares favorably with work done on college level students in that neither isometrics or isotonic exercise shows a greater increase in muscle girth. These results then show that combining isometric and isotonic exercises does not show a greater increase than by just using isometrics or isotonics by themselves.

The area of weight gained was surprising as group two showed an increase of over three times as much as group one. No other comparison was made during the research between combined isometrics and isotonic exercise on weight gain so no valid conclusions can be reached other than to say group two showed a significant increase over group one.

Chest development was also almost equal between group one and group two. Group one gained ten and one-quarter units and group two gained nine units. Both groups made a substantial increase in chest growth.

Comparing tables eight, nine, and ten they consist of group one, group two, and group three respectively. Group one had an increase of nineteen units, group two sixteen units, and group three fifteen units. All three groups had a positive increase. Group one had a fifty-four per

cent increase, group two a forty-four per cent, and group three a fifty-three per cent increase. These figures can be misleading because of the total number in each group involved. Each member of the group did not increase this amount but some members made over a one hundred per cent gain.

Group three made the greatest increase with a sixty-one unit increase compared with an increase of forty-eight units for group one, and forty-six units for group three. Here group two made a significant increase over groups one and three.

Group two made a greater increase in the standing broad jump than groups one or three; however, they each made a positive gain. Group one made an increase of two hundred and nine units in the set ups. This was more than group two or group three.

The data shows that each type of exercise tested shows a positive increase. Combined isometrics and isotonics tends to show a greater increase than the other two types by themselves.

Tables eleven, twelve, and thirteen consist of groups one, two, and three respectively. Comparing the results of these three groups the most important results are the total increase of the three measurements. The second group made the greatest increase with a total of two hundred and

thirteen units. Group one had an increase of one hundred and eighty-five units as compared to one hundred and sixty-five units for group three. The total difference is not a great difference. All three groups made a positive increase. The fact is here; however, that the combining of isometric and isotonic exercise was best for these groups that were tested. There are wide ranges of individual change. The wide areas of change were not just by the athlete or non-athlete. This research has shown consistently that different boys will respond to weight resistant work differently. Sometimes a top athlete will make the greatest gain and sometimes the non-athlete will respond with greater increase. This is important and significant. A coach can not just subjectively evaluate a boy as to his potential or his non-potential. This has been clear in trying to evaluate boys in the junior high school systems. Sometimes a boy does exceedingly well at that level of competition and then in high school does not make the grade. The sophomore boys had a tendency to score or make greater individual increases than any other group tested.

This study continues to show that there is not greater or significant difference between isometric and isotonic training. The combination of the two types of training has a consistent slight increase. There were several significant increases above the expected five per cent each week

and some below this level. To increase the individual must put forth a maximum effort.

CHAPTER IV

SUMMARY AND CONCLUSIONS

This study was conducted to see if there was any difference on high school students from isometric, isotonic, and combined isometric and isotonic exercise. To see if there were great individual differences in the different types of exercise and to show the effects of these types of exercise upon areas of physical fitness.

The study was conducted to show the improvements in strength, endurance, and muscle girth. The data that was collected tended to show that training with any of the three types of exercise made a positive increase in almost all areas of development. There were cases of individuals who did not make increases in some areas, but made good positive increases in other areas. This shows that physical development and strength increase is a very complicated thing. General statements can be made, but no definite laws can be established to say that this is the way it will always happen.

Combining both isometric and isotonic exercise tended to make a slightly better gain. The isometric group was second and the isotonic group was third. This is not unusual, but agrees with the current literature on the subject. The reason for this is that isotonic work can not be

done in as short a time as isometric. This report does not say that isometric or isotonic exercise surpasses the other as an effective means of training. There were times when the isotonic group made larger gains. Both ways of exercise are effective means of improving strength when a set method of training is established.

All areas of physical fitness can not be helped with the use of a resistive type of exercise. There are specific areas of the President's physical fitness that can be aided as this study shows. The chin ups, set ups, and the standing broad jump are these areas of fitness. Other areas may be helped, but there are other activities that can be of greater benefit.

Contrary to popular belief strength can be increased while the student is taking part in athletic training. Some reports have shown that boys retain the same strength level instead of dropping, but the data collected by this research shows that an increase can be made.

Muscle girth can be increased by the three methods of training. An increase in muscle girth does not always mean an increase in strength. Muscle girth is important in many sports and physical education activities.

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THE EFFECTS OF ISOMETRIC AND COMBINED ISOMETRIC AND
ISOTONIC EXERCISE ON HIGH SCHOOL STUDENTS

by

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Strength is an important aspect of physical development. There are two main ways to develop strength using the resistance principle. These two methods are isotonic and isometric exercise. The first part of the research was done just to observe the effects of isometrics and combined isometrics and isotonics upon boys of high school age.

The data was collected by dividing the physical education classes of Riley County High School into various control groups. The boys were tested at the start of the program, and after eight weeks of work. Athletes competing in interscholastic sports were a part of the program and were mixed equally into the various groups. Both sets of test scores were recorded and then comparisons were made between the two scores.

The freshman class was divided into two groups. One group did isometric only and the other group did combined isometric and isotonic exercise. The senior and junior boys were put on isometrics alone. The second semester physical education class consisted of sophomore boys. This class was divided into three groups. One group of isometrics, one group of combined isometrics and isotonics, and one group of pure isotonics.

The results showed that a positive gain can be made by resistive exercise whether it be isometrics, combined

isometrics and isotonics, or isotonic exercise. In almost every area of work the combined exercise group made slightly higher scores. The isometric group was second and the isotonic group third. This would indicate that for a group more of an increase could be made by combining the isometric and isotonic exercise.

The program was not detrimental to any of the athletes, and an important aspect of the study was that athletes can make gains while competing in interscholastic activities.

There was no evidence that any one type or group of individuals made a greater increase. In two different groups the biggest increases were made by top athletes. This is important in that it shows that by subjective means alone you can not predict how a boy will react to resistive exercise. It can be said that a positive increase can be obtained. The amount of increase can not be pre determined. There is a tendency for large ranges of difference between different individuals. This was found to be true in each type of resistive exercise.

The experiment was important to the morale of the physical education and athletic programs at Riley County High School. Many of the participants were astonished at the improvement that they made.

Weight training is not the sole answer to the

problems that confront the physical educator today, but it is one means by which a start can be made. This study made it clear that any boy can make vast improvement in many areas of strength and physical fitness by working hard for a short period every day.