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THE EFFECTS OF AN ISOMETRIC TRAINING
PROGRAM AND A WEIGHT TRAINING
PROGRAM ON THE VERTICAL JUMP,
DYNAMIC STRENGTH, STATIC STRENGTH
AND THIGH GIRTH IN MALE
COLLEGE STUDENTS

Thesis for the Degree of M. A.
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John Lancey Hannett
1964

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WEIGHT TRAINING PROGRAM ON THE VERTICAL JUMP,
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GIRTH IN MALE COLLEGE STUDENTS

By

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CHAPTER I

INTRODUCTION TO THE PROBLEM

For several years a difference of opinion has existed regarding the effectiveness of isometric training methods and weight training methods as a means of increasing muscular strength and power. ~~There are many studies~~ Many studies have shown that weight training has improved dynamic strength and vertical jumping ability. Other studies have shown that isometric training has improved static strength. However, there is a need to investigate the interrelationship of isometric strength training and dynamic strength training and performance in power activities.

I. THE PROBLEM

Statement of the problem. It was the purpose of this study to compare the effects of an isometric training program and a weight training program on the vertical jump, dynamic strength, static strength and girth in male college students.

Importance of the study. The cry for the improvement of physical fitness has been heard all across the United States for the past few years. The improvement of muscular strength is a basic necessity in the development

of physical fitness, as strength is generally conceded to be a basic component of physical fitness.¹ Evidence has shown that, other things being equal, physical performance will be more effective as a consequence of an adequate level of strength.² An abundance of research is available to show that strength can be improved by both progressive resistance exercises and isometric exercises, but a controversy still exists concerning which is the most effective exercise program to follow. It is hoped that this study will contribute to the knowledge in this area.

II. DEFINITIONS OF THE TERMS USED

Dynamic strength. The term is defined as the maximum applied tension that can be developed, instantaneously, on a single occasion to overcome an imposed load or resistance. In this study, dynamic strength was measured by the maximum weight lifted for one repetition in one parallel squat. Dynamic strength and isometric strength are synonymous as used in the study.

Parallel squat. A knee bend that has at its lowest point the thighs parallel to the floor is called a parallel squat.

¹H. Clarke, "Development of Volitional Muscle Strength as Related to Fitness," Exercise and Fitness (Chicago: The Athletic Institute, 1959), p. 203.

²Ibid., p. 202.

Static strength. This term is defined as the maximum applied tension that can be developed, instantaneously, on a single occasion in a vain attempt to overcome an imposed load or resistance. In this study, static strength was measured by a dynamometer. The terms static and isometric are used synonymous in the study.

Isometric exercise. This type of exercise is one such that a muscular contraction is held in approximately the same position for a designated period of time. In this study the isometric contractions were held for ten seconds.

Weight exercise. This is a type of exercise in which a dynamic muscular contraction takes place when an imposed load in the form of a barbell is raised and lowered. In this study the weight exercise performed was the parallel squat.

Vertical jump. As described by Mathews.³

III. LIMITATIONS OF THE STUDY

1. The training session was limited to eight weeks.
2. The motivation of the subjects could not be controlled.
3. It was not possible to control the outside activities of the subjects.

³D. K. Mathews, Measurement in Physical Education (Philadelphia: W. B. Saunders Company, 1958), p. 93.

CHAPTER II

REVIEW OF RELATED LITERATURE

It is the purpose of this chapter to present a brief but comprehensive survey of the literature related to this study. The first consideration will be a survey of the research that has been accomplished on the vertical jump.

I. THE VERTICAL JUMP

Several studies have shown a definite link between weight training and vertical jumping improvement. A gain of two or three inches obviously indicates improvement in explosive power.¹

Chui reported that weight training had a beneficial effect on vertical jumping ability. His experimental group doing weight training showed a mean gain of 7.2 cm., while his required physical education class (control group) increased a mean of 3.86 cm.²

Capen showed that both a weight training group and a conditioning group increased in the vertical jump, but in

¹R. Hoffman, Functional Isometric Contractions for Football (York, Pennsylvania: Hoffman Foundation, 1962), p. 19.

²E. Chui, "The Effect of Weight Training on Athletic Power, Strength, and Endurance," Research Quarterly 21:190, 1950.

every case the weight group improved more than the conditioning group.³

Gratton compared weight training with free maximal vertical jumping. He found that while both groups improved their jumping ability, the weight training group showed a significant improvement above the free jumping group.⁴

Michigan State basketball players were put on a weight program. They showed a mean improvement of six inches in the vertical jump after eighteen weeks of training.⁵

In an individual study at Michigan State, a Lansing boy improved twelve inches in the vertical jump after twelve months of weight training.⁶

Studies relating isometric training with vertical jump improvement were not found in the literature.

II. STRENGTH

There are at least two forms of strength, static and dynamic. Static strength is measured with such

³E. Capen, "The Effect of Systematic Weight Training On Power, Strength, and Endurance," Research Quarterly, 21:87, 1950.

⁴L. J. Gratton, "The Effect of Weight Training on the Jumping Ability of High School Basketball Players," (unpublished Master's Thesis, Michigan State University, 1958).

⁵T. Weeded. Master's Thesis, 1962.

⁶W. Van Huss, Michigan State University, Personal Communication.

instruments as dynamometers, tensiometers, and strain gauges, while dynamic strength is usually measured by one maximum repetition of the movement in question. For example, the most weight lifted in one execution of the bench press would be the dynamic strength test for the movement. Because by definition strength is tension, it would appear that the method of developing the most tension would be best. Rasch found that the tension which could be exerted by trained subjects in a single maximum isometric elbow contraction and the maximum weight that could be moved in a single isotonic contraction was the same.⁷

Another factor considered was the optimum number of sets and repetitions in the weight program and the type and length of contraction used in the isometric program. In terms of the weight problem, Berger showed that the optimum range of repetitions for one set was three to nine repetitions.⁸

In terms of an isometric program, anywhere from a two-thirds maximum contraction held for six seconds to a maximum contraction held for twenty seconds was found recommended in the literature. Hoffman recommended a maximum contraction held for nine to twelve seconds.⁹

⁷P. J. Rasch, "Relationship between maximum isometric tension and maximum isotonic elbow flexion," Research Quarterly, March, 1957.

⁸R. Berger, "Optimum Repetitions for the development of Strength, Research Quarterly, 33:334, 1962.

⁹Hoffman, op. cit., p. 13.

Many studies have shown weight training to increase strength. Hellebrandt and Houtz conducted 620 experiments on seventeen normal adult subjects.

They concluded that strength improvement was directly related to the intensity of the overload.¹⁰

Clarke reviewed thirteen studies to determine the relative merits of other systems of progressive resistance exercise in improving muscular strength. In each study, strength was increased significantly. However, no one method was found to be superior to any other method.¹¹

Many studies have also shown isometric training to increase strength. Rose, in 1957, applied the method of Hettinger and Muller clinically. He found an increase in strength of from 82 to 162 per cent.¹²

A study by Liberson and Asa shows an increase of 203 per cent in static strength test after training twelve weeks with isometric contractions. It also shows an increase of 150 per cent in a dynamic strength test after training twelve weeks with isometric contractions.¹³

¹⁰F. A. Hellebrandt and J. Houtz, "Mechanisms of Muscle Training in Man: Experimental Demonstrations of the Overload Principle, Physical Therapy Review, 36:371-383, 1956.

¹¹Clarke, op. cit., p. 209.

¹²D. L. Rose, "Effect of Brief maximal Exercise on the Quadriceps femoris," Arch of Physical Medium and Rehabilitation, 38:157-164, 1957.

¹³W. T. Liberson and M. M. Asa, "Brief Isometric Exercises," Therapeutic Exercise, ed. Sidney Licht (New Haven: pp. 826-835, 1958).

III. HYPERTROPHY

Repeated muscular work produces an increase in the size of skeletal muscles.¹⁴ There is generally a positive relationship between the strength of a muscle and its cross-sectional area. However, there are repeated observations that exercised muscles can increase in strength, but not in size--and vice versa. It is possible to increase the strength of muscles three times or more without a proportional increase in volume.¹⁵

Asmussen checked the actual gains in strength of boys in age range from seven to seventeen years against theoretical values based upon computed indices of body mass and muscle cross-section and found that the observed gains in strength substantially exceeded the theoretical values based upon indices of size.¹⁶

In both the studies by Rose¹⁷ and Liberson and Asa¹⁸ there was no improvement in hypertrophy even though there was an increase of 80 to 200 per cent in strength.

¹⁴L. Brouha, "Training," Science and Medicine of Exercise and Sports, ed. Warren R. Johnson (New York: Harper Brothers, 1960).

¹⁵Ibid.

¹⁶E. Asmussen, "Dimensional Analysis of Physical Performance and Growth in Boys," Journal of Applied Physiology, 6:585-592, 1955.

¹⁷Rose, op. cit.

¹⁸Liberson and Asa, op. cit.

CHAPTER III

METHODOLOGY OF THE STUDY

The present study was undertaken to determine the effects of an isometric training program and weight training program on vertical jumping ability, dynamic strength, static strength and thigh girth. The purpose of this chapter is to discuss the method of selecting, matching and grouping the subjects, testing procedures, program that was followed, equipment that was used, and the type of analysis which the data underwent.

Subjects. The subjects used in this experiment were twenty-one Albion College male students 18-21 years of age who volunteered their services. They were matched according to their vertical jumping ability as demonstrated by the average of ten vertical jumps as described by Mathews.¹ Three groups of seven were formed and randomly assigned to the isometric program, weight program or control program.

How Selected . The subjects used in this experiment were all volunteers. The writer notified several fraternities at Albion College about a physical experiment to be

¹Mathews op. cit., p. 93.

carried out at the College gymnasium. Their only disqualifying feature was participation in varsity athletics at the time of the experiment. The subjects were matched on the basis of the means of ten vertical jumps.

Equipment. the following equipment was used in this study:

1. Disc-loading barbells²
2. Squat rack³
3. Benches
4. Back and leg dynamometer
5. Tailors tape-non-stretch
6. Six-inch ruler
7. Adjustable isometric rack⁴
8. Jumping board⁵
9. Chalk dust

Testing. Each subject was tested in the vertical jump, dynamic strength as measured by a maximum parallel squat, static strength as measured by the dynamometer, and girth measurements of both thighs before the program began. These results are referred to as the initial mean scores. After this initial testing, vertical jumps and thigh hypertrophy measures were taken every Friday for eight weeks. Dynamic and static strength tests were taken only on the fourth and eighth Friday. Testing always came before a workout and always followed the same order--thigh girth,

²Hoffman, op. cit., p. 44.

³Ibid.

⁴Ibid., p. 43.

⁵Mathews, op. cit., p. 93.

vertical jumps, dynamic strength and static strength. The results of testing on the eighth Friday are referred to as final mean scores. The exact procedure followed for testing each variable is given below:

1. Vertical jump--Each subject stood next to the wall and reached up as high as possible with the hand closest to the wall, keeping his heels on the floor. This height was marked and recorded. Then the subject put chalk dust on his finger tips. Standing next to the wall, he would jump up and touch the jumping board at the height of his jump. Each subject jumped ten times with his dominant hand. All ten jumps were recorded. The vertical jumping distance was obtained by subtracting the height reached while standing from the height reached while jumping. The average of these ten jumps was used as the matching criterion. Each Friday the same procedure was followed, except that only five jumps were taken with the dominant hand instead of ten.

2. Thigh girth--Measurements of each thigh were taken six inches above the top of the patella. A six-inch ruler, placed on top edge of the patella, served as a landmark. The subject stood with his weight on the leg to be measured and flexed the thigh. Three repeat measures were taken every Friday and recorded.

3. Static Strength--The subject being tested stood on the platform of the dynamometer and grasped the handle.

An adjustable chain from the handle to the platform made it possible to vary the hand position for each subject. The same link position was used for a given subject throughout the experiment. After locating the best link position, the bar was placed on the top of the thighs at the crotch. The body was now in a partial squat position with the head up and the back straight. From this position each subject exerted an upward vertical force. Each subject took three of these maximal steady pulls which were read and recorded in dial units. A minimum of three and a maximum of five minute rest period was taken between pulls.

4. Dynamic Strength--This was measured by one maximum parallel squat. The performer raised the loaded barbell off the squat racks with his shoulders and then took one step backwards. With a spotter on each side, he would lower himself to a parallel bench, so that his thighs were parallel to the floor and then rise back up to a standing position. Weight was added by estimation and the most weight lowered and raised once was recorded as the maximum. The weights were not covered and the subjects were aware of the amount of weight on the bar.

Training Program.

1. Isometric group--The subjects reported to the gymnasium five afternoons per week for eight weeks. They did one isometric contraction in each of three different

squat positions. First they held a ten-second maximum contraction at the parallel position. Next they held a ten-second maximum contraction at a half-squat or approximately forth-five degree angle. Last they held a ten-second maximum contraction at the quarter-squat position. They rested a minimum of two and a maximum of three minutes between contractions. This constituted their entire workout. Each Friday before their workout, they were measured for thigh girth and tested in the vertical jump. On the fourth and eighth Friday of the program, they were also tested in maximum dynamic and static strength.

2. Weight group--The subjects reported to the gymnasium three afternoons per week for eight weeks. They performed three sets of six repetitions in the parallel squat. Weight was constantly added so as to keep six repetitions the limit of their performance. They rested a minimum of two and a maximum of three minutes between sets. Each Friday before their workout, they were measured for thigh girth and tested in the vertical jump. On the fourth and eighth Friday of the program, they were also tested in maximum dynamic and static strength. The amount of weight used in each workout was recorded and appears in Appendix A.

3. Control group--The subjects did not participate in any dynamic or static exercise program during the week. They reported to the gymnasium each Friday to be measured

for thigh girth and to be tested in the vertical jump. On the fourth and eighth Friday of the program, they were also tested in maximum dynamic and static strength.

Statistical Analysis. The data was tabulated and treated statistically, using the "t" test as described by Edward's.⁶ Comparisons were made from initial to final for each group and also between groups in each of the five variables. For this paper the 5% level of confidence was selected for significance.

⁶A. L. Edwards, Statistical Methods for the Behavioral Sciences (New York: Rinehart and Company, 1957), pp. 278-282.

CHAPTER IV

ANALYSIS OF DATA

This study was undertaken to determine the effects of a weight training program and an isometric training program on the vertical jumping ability, dynamic strength, static strength and thigh girth of twenty-one Albion College male students. Using the Sargent Vertical Jump test as a matching criterion, three groups of seven subjects each were formed. The groups were randomly assigned to the weight program, isometric program or control program. The weight group performed three sets of six repetitions in the parallel squat three times a week. The isometric group did one ten-second maximum isometric contraction in each of three different squat positions five times a week. The control group did not participate in either activity during the week. Each Friday all groups were tested in the vertical jump and thigh girth. After the fourth and eighth week of the program, all groups were also tested in dynamic strength and static strength. This program was carried out for eight weeks, beginning October 20, 1962, and ending December 15, 1963. It is the purpose of this chapter to present and interpret the data from this study. This will be done in three parts. The first shows group improvements from initial testing to final testing, the second

compares the improvements of one group with those of another, and the third is devoted to observations by the writer.

Presentation of Data. Initial to Final--Tables I through V present the Initial Mean Scores, Final Mean Scores, Mean Improvement and the "t" values in each of the five variables.

Vertical Jump. Table I shows the mean improvement of each group in the vertical jump. All three groups improved significantly, and the isometric group showed the largest improvement, with a mean gain of 3.3 inches.

TABLE I
WITHIN-GROUP CHANGES IN THE VERTICAL JUMP
AFTER 8 WEEKS OF TRAINING

Group	Initial Mean Scores (in.)	Final Mean Scores (in.)	Difference Between Means (in.)	"t" value
Isometric	20.5	23.8	3.3	6.2*
Control	20.5	21.9	1.4	3.3*
Weight	20.5	23.1	2.6	5.65*

* = .05

Dynamic strength. Table II shows the mean improvement of each group in dynamic strength as measured by the maximum parallel squat. All three groups improved significantly, and the isometric group showed the largest improvement with a mean gain of 110 pounds.

TABLE II
WITHIN-GROUP CHANGES IN THE DYNAMIC STRENGTH
AFTER 8 WEEKS OF TRAINING

Group	Initial Mean Scores (lbs.)	Final Mean Scores (lbs.)	Difference Between Means (lbs.)	"t" Value
Isometric	235	345	110	6.96*
Control	245.7	267.1	21.4	2.446
Weight	251	339.3	88.3	13.178*

* = .05

Static Strength. Table III shows the mean improvement of each group in static strength as measured by the dynamometer. The isometric and weight groups both improved significantly, and the isometric group showed the largest improvement with a mean gain of 236.5 pounds.

TABLE III
WITHIN-GROUP CHANGES IN STATIC STRENGTH
AFTER 8 WEEKS OF TRAINING

Group	Initial Mean Scores (lbs.)	Final Mean Scores (lbs.)	Difference Between Means (lbs.)	"t" Value
Isometric	540	776.4	236.4	5.642**
Control	524.3	576.4	52.1	1.300
Weight	500	635.7	135.7	2.454*

* = .05

** = .01

Right Thigh Girth. Table IV shows the mean improvement of each group in the right thigh measurement six inches above the patella. The isometric and weight groups both showed significant improvement, and the weight group had the largest improvement with a mean gain of 1.2 inches.

TABLE IV
WITHIN-GROUP CHANGES IN RIGHT THIGH HYPERTROPHY
AFTER 8 WEEKS OF TRAINING

Group	Initial Mean Scores (in.)	Final Mean Scores (in.)	Difference Between Means (in.)	"t" Value
Isometric	21.7	22.4	.7	5.83**
Control	22.0	22.4	.4	2.35
Weight	20.4	21.6	1.2	10.0**

* = .05 ** = .01

Left Thigh Girth. Table V shows the mean improvement of each group in the left thigh measurement six inches above the patella. The isometric and weight groups both showed significant improvement, and the weight group had the largest improvement with a mean gain of 1.1 inches.

TABLE V
WITHIN-GROUP CHANGES IN LEFT THIGH HYPERTROPHY
AFTER 8 WEEKS OF TRAINING

Group	Initial Mean Scores	Final Mean Scores	Difference Between Means	"t" Value
Isometric	21.7	22.5	.8	6.666**
Control	22.0	22.3	.3	2.143
Weight	20.4	21.5	1.1	6.875**

* = .05

** = .01

Comparison of Groups. These data were compiled and treated statistically using the "t" test as described by Edwards. The gains of one group were compared to the gains of the other groups in each of the five variables. Table VI shows the "t" values of comparisons between groups. The isometric group improved significantly above the control group in the vertical jump, dynamic strength and static strength, but not in thigh hypertrophy. The weight group improved significantly above the control group in dynamic strength and thigh hypertrophy, but not in the vertical jump or static strength. In comparing the isometric group with the weight group there were no statistically significant differences.

TABLE VI
 "t" VALUES FOR IMPROVEMENT COMPARISONS BETWEEN GROUPS

Group	Vertical Jump	Dynamic Strength	Static Strength	Hypertrophy	
				Right	Left
Isometric vs. Control	2.533*	5.637*	3.379*	1.60	2.263
Weight vs. Control	2.175	6.632*	1.336	3.625*	4.75*
Isometric vs. Weight	1.10	1.496	1.004	1.954	1.329

* = .05

Figure 1 shows the Initial Mean Scores and the Final Mean Scores for each group in each of the five variables. Figure 2 shows the difference from the Initial Mean Scores to the Final Mean Scores in each of the five variables.

Discussion. Although there was no statistical significance between the isometric group and weight group, there seemed to be some advantages favoring the isometric program. The isometric group performed as well or even a little better in the power tests than the weight group. For example, in the maximum parallel squat which they did not train for, the isometric group showed a mean improvement of 110 pounds, compared to a mean improvement of 88 pounds by the weight group who were performing this exact movement three times per week. This is a mean difference of 22 pounds favoring the isometric group. There was,

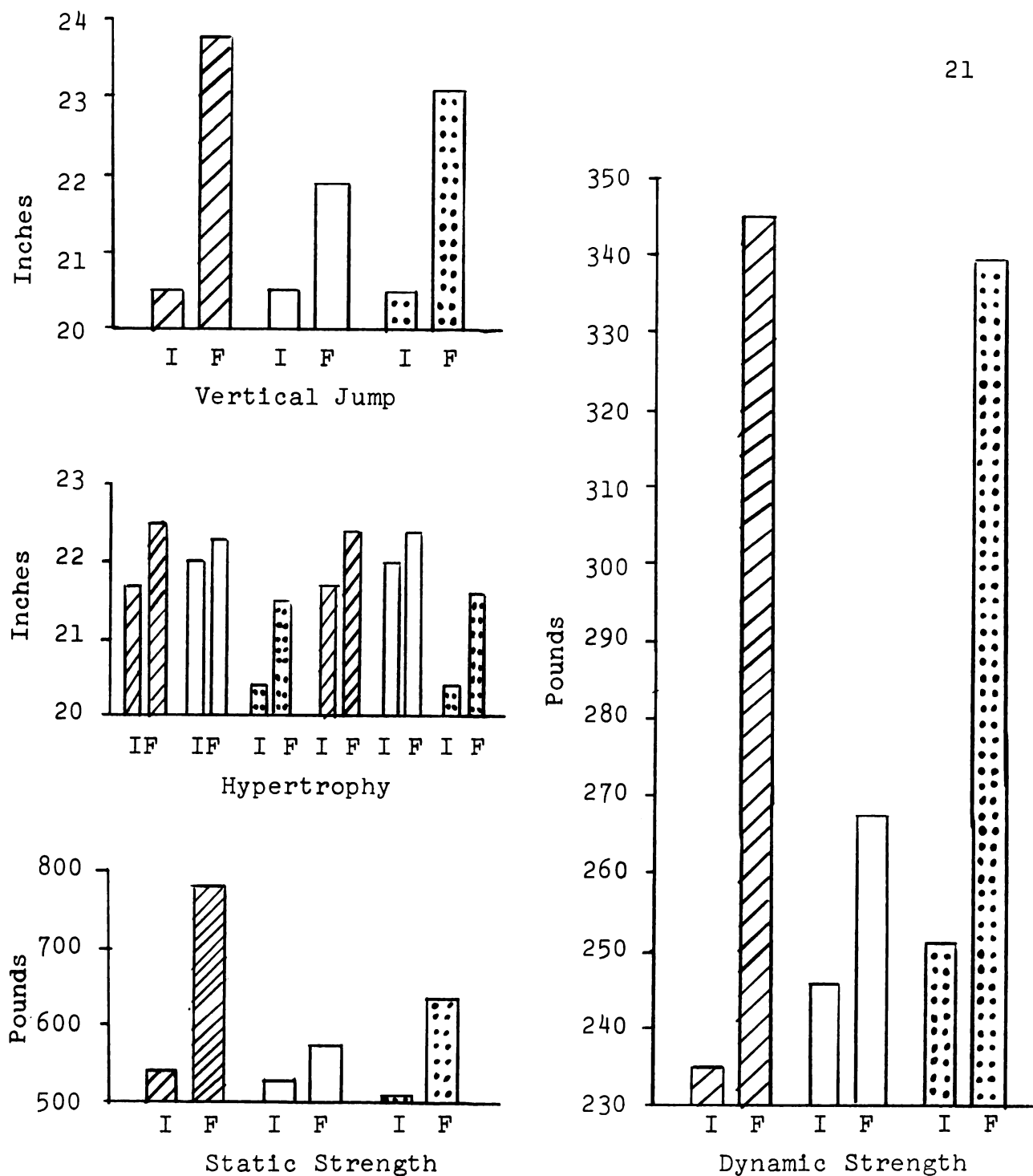


Figure 1. Initial mean scores and the final mean scores for each group.



Isometric



Weight



Control

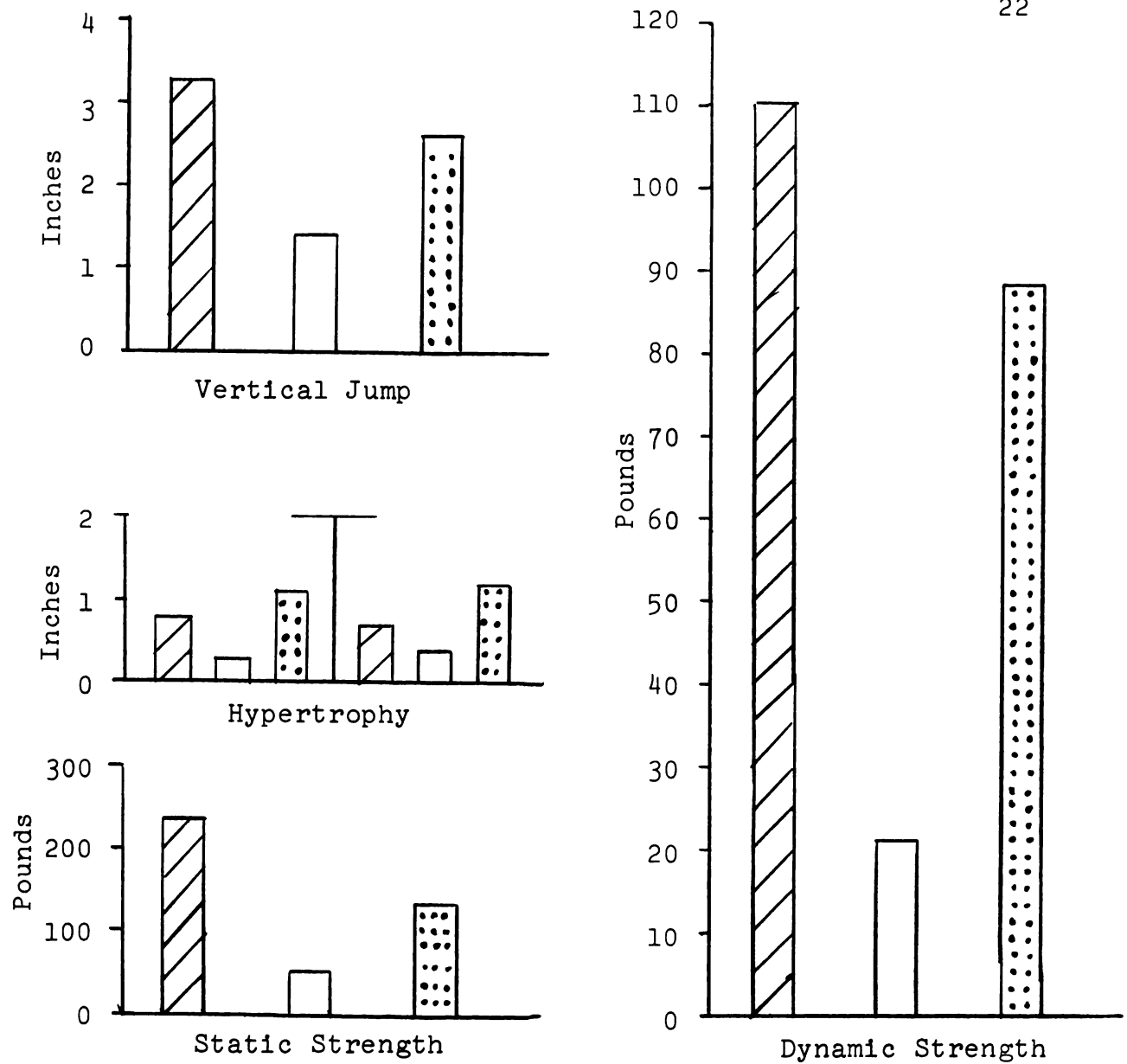
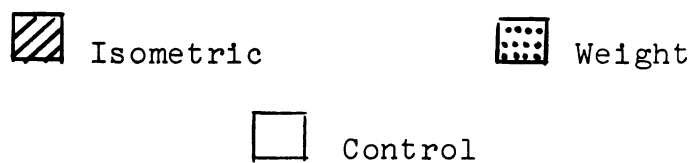


Figure 2. Differences from initial mean scores to final mean scores.



however, quite a range of improvement within the isometric group itself. Subjects L. M., D. K. and T. D. of the isometric group, who improved 170, 160 and 135 pounds respectively, were all above the highest improvement in the weight group, which was 103 pounds. However, subjects G.K. and F. F. of the isometric group only increased 50 and 60 pounds, respectively. The point is that an individual seems to react in a manner peculiar to himself or the amount of improvement may be related to how much he is willing to push himself. The weight group was much closer together, with six of the seven improving 75 to 103 pounds, the seventh only 55 pounds. It appears that some people react very favorably to isometric training showing considerable improvement.

Aside from the performance improvements obtained from isometric training, there were certain operational advantages in favor of the isometric program. First, the isometric group as a whole did not exhibit the stiffness, strains, pains and fatigue that was observed in and testified to by the weight group. Second, the isometric program required far less time for a workout. Third, the isometric workout was performed without assistance. Spotters were required as a safety precaution in the weight program.

The current study is not sufficiently definitive to isolate the reasons for the differences in improvement.

It may be motivation, inherited potential or learning.

It is obvious that further investigation is necessary to provide further insight into these factors.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary. This study was undertaken to determine the effects of a weight training program and an isometric training program on the vertical jumping ability, dynamic strength, static strength and thigh girth of twenty-one male college students. Using the Sargent Vertical Jump test as a matching criterion, three groups of seven subjects each were matched. These groups were then randomly assigned to the weight program, isometric program or control program. The weight program consisted of three sets of six repetitions in the parallel squat three times per week. The isometric program consisted of one ten-second maximum isometric contraction in each of three different squat positions five times per week. The control program consisted of neither type of activity during the week. Each Friday all groups were tested in the vertical jump and measured for thigh girth. After the fourth and eighth week of the program, all groups were also tested in dynamic strength and static strength. This program was carried out for eight weeks and all measurements were recorded. The data were tabulated and treated statistically using the "t" test. Both the isometric group and weight group improved significantly in each of the five variables after eight weeks of training.

The control group also improved significantly in the vertical jump and dynamic strength, but not in the other three variables. There were no statistically significant differences between the results obtained in the isometric group and those obtained in the weight group in any of the five variables.

Conclusions.

1. Maximum ten-second isometric contractions will improve vertical jumping ability dynamic strength, static strength and thigh girth in male college students when carried out under the conditions of this study.
2. Weight training will improve vertical jumping ability, dynamic strength, static strength and thigh girth when carried out under the conditions of this study.
3. Maximum ten-second isometric contractions will improve vertical jumping ability dynamic strength and static strength more than the improvement made by a control group when carried out under the conditions of this study.
4. Weight training will improve dynamic strength and thigh hypertrophy more than the improvement made by a control group if carried out under the conditions of the study.
5. There were no statistically significant differences between the results obtained from isometric training

and those obtained from weight training when carried out under the conditions of this study.

Recommendations.

1. Carry out a similar study for at least 12 weeks.
2. The writer recommends the use of isometric training programs for the following reasons:
 - a. A large increase in strength and power can be achieved.
 - b. Little time is required for a workout.
 - c. Little equipment is needed.
 - d. Less chance of accidents or injuries.
 - e. Less stiffness and muscle soreness than that normally accompanying weight training programs.
 - f. Recovery from static fatigue is much faster than recovery from dynamic fatigue.¹

¹D. H. Clarke, "Strength Recovery from Static and Dynamic Muscular Fatigue," Research Quarterly, 33:355, 1962.

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APPENDICES

APPENDIX A

VERTICAL JUMP--INCHES

	<u>Weeks</u>							
	Initial	1	2	3	4	6	7	Final
Isometric Group								
T.D.	21.4	20.9	21.7	22.6	24.4	23.2	23.4	23.5
D.K.	20.8	19.1	20.1	21.5	23.6	24.6	24.4	24.3
J.K.	19.2	19.4	21.2	21.1	21.5	22.3	23.0	24.2
L.M.	24.0	24.4	24.4	25.3	24.3	24.6	25.6	25.2
J.H.	19.1	20.0	20.2	20.2	21.4	22.0	22.0	23.6
F.F.	16.9	16.7	18.2	18.0	19.5	20.5	20.5	21.1
G.K.	<u>22.0</u>	<u>20.8</u>	<u>21.5</u>	<u>22.4</u>	<u>23.3</u>	<u>23.3</u>	<u>24.1</u>	<u>24.4</u>
MEAN	20.5	20.2	21.0	21.6	22.6	22.9	23.3	23.8
Weight Group								
J.S.	21.5	21.2	22.7	22.8	23.0	23.1	23.9	24.0
T.B.	20.5	16.5	18.8	20.5	20.2	21.5	22.5	23.0
D.H.	19.1	19.8	19.4	21.2	20.1	20.1	20.7	21.1
L.B.	25.0	25.3	24.8	27.4	26.7	26.5	26.8	28.0
B.P.	19.0	20.5	20.0	21.2	21.9	22.0	23.3	23.8
J.G.	16.6	15.6	15.6	17.3	17.3	17.5	18.7	19.2
B.M.	<u>21.9</u>	<u>19.9</u>	<u>19.7</u>	<u>19.9</u>	<u>20.2</u>	<u>21.4</u>	<u>21.3</u>	<u>22.8</u>
MEAN	20.5	19.8	20.1	21.5	21.3	21.7	22.5	23.1
Control Group								
J.M.	21.6	21.9	23.2	24.0	23.2	23.7	24.6	25.2
Do.S	20.8	21.4	20.6	22.2	21.6	21.8	21.9	22.1
J.L.	19.3	20.0	20.1	21.2	19.3	20.7	20.7	20.3
J.G.	24.6	23.3	26.8	25.7	23.4	24.4	25.1	25.5
P.H.	18.4	18.9	17.5	18.3	18.8	20.1	20.8	20.1
T.W.	17.5	17.1	16.9	17.9	17.8	17.8	17.7	17.5
De.S.	<u>21.6</u>	<u>21.0</u>	<u>21.5</u>	<u>21.8</u>	<u>22.1</u>	<u>21.7</u>	<u>22.7</u>	<u>22.7</u>
MEAN	20.5	20.5	20.9	21.6	20.9	21.5	21.9	21.9

APPENDIX B

DYNAMIC STRENGTH--POUNDS

	Initial Testing	4 Week	Final Testing
Isometric Group			
T.D.	145	235	275
D.K.	305	410	465
J.K.	245	255	345
L.M.	275	380	445
J.H.	235	290	325
F.F.	215	235	285
G.K.	<u>225</u>	<u>285</u>	<u>275</u>
MEAN	235	298.6	345
Weight Group			
J.S.	250	310	345
T.B.	285	340	375
D.H.	212	285	315
L.B.	225	290	325
B.P.	315	350	390
J.G.	225	300	325
B.M.	<u>245</u>	<u>285</u>	<u>300</u>
MEAN	251	308.6	339.3
Control Group			
J.M.	295	355	355
Do.S.	220	250	265
J.L.	245	250	245
J.G.	235	265	255
P.H.	280	275	280
T.W.	205	205	215
De.S.	<u>240</u>	<u>240</u>	<u>255</u>
MEAN	245.7	262.8	267.1

APPENDIX C

STATIC STRENGTH--POUNDS

	Initial Testing	4 Week	Final Testing
Isometric Group			
T.D.	295	355	390
D.K.	710	960	970
J.K.	770	875	955
L.M.	565	785	1000
J.H.	370	500	670
F.F.	600	715	800
G.K.	<u>470</u>	<u>575</u>	<u>650</u>
MEAN	540	680.7	776.4
Weight Group			
J.S.	595	665	710
T.B.	500	685	630
D.H.	425	575	875
L.B.	510	560	630
B.P.	620	630	655
J.G.	400	440	450
B.M.	<u>450</u>	<u>475</u>	<u>500</u>
MEAN	500	575.7	635.7
Control Group			
J.M.	510	545	675
Do.S.	615	565	500
J.L.	550	595	605
J.G.	500	660	695
P.H.	565	520	615
T.W.	430	480	435
De.S.	<u>500</u>	<u>590</u>	<u>510</u>
MEAN	524.3	565	576.4

APPENDIX D

LEFT THIGH HYPERTROPHY--INCHES

	<u>Weeks</u>							
	Initial	1	2	3	4	6	7	Final
Isometric Group								
T.D.	18.7	18.6	19.2	19.3	19.3	19.5	19.4	19.6
D.K.	22.0	22.2	22.4	22.4	22.8	23.3	23.3	23.1
J.K.	23.3	23.6	23.9	24.1	24.0	24.0	24.2	24.3
L.M.	23.6	23.7	23.9	24.3	24.3	24.3	24.1	24.4
J.H.	19.9	20.6	20.4	20.6	20.4	20.7	21.1	20.6
F.F.	24.1	23.8	24.0	24.4	24.3	24.5	24.5	24.5
G.K.	<u>20.4</u>	<u>20.7</u>	<u>20.7</u>	<u>20.6</u>	<u>21.0</u>	<u>21.0</u>	<u>21.0</u>	<u>20.9</u>
MEAN	21.7	21.8	22.1	22.2	22.3	22.5	22.5	22.5
Weight Group								
J.S.	20.0	20.2	20.4	20.5	20.7	20.9	21.0	21.4
T.B.	20.7	21.0	21.1	21.5	21.5	21.5	21.5	21.3
D.H.	20.3	20.7	21.1	20.8	21.0	21.3	21.3	21.5
L.B.	20.1	20.2	20.4	20.8	20.8	21.2	21.0	21.5
B.P.	20.5	20.8	20.9	21.2	21.5	21.5	21.5	21.5
J.G.	21.0	21.6	21.5	21.6	22.0	22.2	22.3	22.5
B.M.	<u>20.1</u>	<u>20.2</u>	<u>21.4</u>	<u>20.6</u>	<u>20.9</u>	<u>20.9</u>	<u>20.9</u>	<u>20.7</u>
MEAN	20.4	20.7	21.0	21.0	21.2	21.4	21.4	21.5
Control Group								
J.M.	22.3	22.3	22.1	22.1	22.3	22.6	22.4	22.4
D.S.	21.8	21.6	21.5	21.5	21.3	21.8	21.8	21.7
J.L.	20.0	20.3	19.9	20.0	20.1	20.3	20.0	20.2
J.G.	21.0	21.0	21.5	21.7	21.7	22.0	21.9	22.0
P.H.	24.8	24.5	24.8	25.0	25.0	25.2	25.5	25.4
T.W.	22.1	22.1	22.4	22.4	22.7	22.9	22.3	22.4
De.S.	<u>21.7</u>	<u>22.0</u>	<u>21.7</u>	<u>21.6</u>	<u>21.7</u>	<u>22.2</u>	<u>22.0</u>	<u>22.0</u>
MEAN	22.0	22.0	22.0	22.0	22.1	22.4	22.3	22.3

APPENDIX E

RIGHT THIGH HYPERTROPHY--INCHES

	<u>Weeks</u>							
	Initial	1	2	3	4	6	7	Final
Isometric Group								
T.D.	18.5	18.5	18.8	19.0	19.0	19.1	19.1	19.1
D.K.	22.1	22.1	22.5	22.5	22.8	23.4	23.5	23.1
J.K.	23.0	23.2	23.5	23.2	23.4	23.3	23.3	23.2
L.M.	23.5	23.7	23.9	23.8	23.8	24.1	24.2	24.2
J.H.	19.6	20.2	20.1	20.3	20.3	20.3	20.6	20.6
F.F.	24.1	24.4	24.2	24.0	24.2	24.5	24.5	24.5
G.K.	<u>21.0</u>	<u>21.4</u>	<u>21.3</u>	<u>21.6</u>	<u>21.6</u>	<u>21.6</u>	<u>21.7</u>	<u>21.8</u>
MEAN	21.7	21.9	22.0	22.1	22.2	22.3	22.4	22.4
Weight Group								
J.S.	19.8	20.0	20.2	21.0	20.8	21.0	21.4	21.5
T.B.	20.8	21.2	21.6	21.6	21.7	22.0	21.5	21.6
D.H.	20.5	20.7	21.1	21.2	21.4	21.9	21.4	21.8
L.B.	20.1	20.2	20.2	20.7	20.8	21.1	20.8	21.5
B.P.	20.9	21.1	21.2	21.5	21.8	21.8	21.6	21.8
J.G.	21.5	21.6	22.1	22.0	22.4	22.2	22.5	22.4
B.M.	<u>19.4</u>	<u>19.6</u>	<u>20.8</u>	<u>20.7</u>	<u>21.0</u>	<u>20.6</u>	<u>20.5</u>	<u>20.5</u>
MEAN	20.4	20.6	21.0	21.2	21.4	21.5	21.4	21.6
Control Group								
J.M.	22.5	22.3	22.4	22.3	22.2	22.6	22.4	22.5
Do.S.	21.8	21.8	21.9	21.6	21.8	22.0	22.3	22.1
J.L.	20.3	20.3	19.9	20.3	20.1	20.4	20.2	20.1
J.G.	21.1	21.2	21.4	21.6	21.8	21.6	21.8	22.1
P.H.	24.8	24.8	24.8	24.9	25.0	25.2	25.1	25.4
T.W.	21.5	21.6	21.6	21.8	22.2	22.0	22.4	22.2
De.S.	<u>21.9</u>	<u>21.8</u>	<u>22.1</u>	<u>22.2</u>	<u>22.2</u>	<u>22.6</u>	<u>22.5</u>	<u>22.5</u>
MEAN	22.0	22.0	22.0	22.1	22.2	22.3	22.4	22.4

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