THE EFFECTS OF PHYSICAL EDUCATION INSTRUCTION AND SUPPLEMENTARY EXERCISE ON CARDIOVASCULAR EFFICIENCY OF COLLEGE STUDENTS

A Thesis

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by

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CHAPTER I

INTRODUCTION

Never before in the history of mankind has there been such a profound need for physical fitness. With the increase of technilogical advancement the need for physical exercise has greatly expanded. President Eisenhower and later John F. Kennedy considered the fitness problem as one of greatest magnitude and reflected their concern by establishing the President's Council on Youth Fitness. President Kennedy stated,

> . . . . we do know what the Greeks knew; that intelligence and skill can only function at the peak of their capacity when the body is healthy and strong; that hardy spirits and tough minds usually inhibit sound bodies.[1]

Physical fitness involves more than just strength, muscle size and endurance. It involves cardiorespiratory endurance--heart, lung and arteries. Many studies have shown that all forms of running such as cross country, interval, and speed running have improved cardiovascular efficiency. It is necessary for the physical educator, the coach and other interested persons to be alert and aware of new and better methods to improve the cardiovascular efficiency of all people.

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[1]John F. Kennedy, "The Soft American," Sports Illustrated, No. 26 (December 26, 1960), 13.

I. THE PROBLEM

Statement of the problem. The purpose of this study was to investigate the effects of Physical Education classes with instruction and participation in supplementary exercise on cardiovascular efficiency of college males and females.

Specifically this study investigated the (1) effect of physical education classes on cardiovascular efficiency, (2) the effect of training three minutes on the Exer-Genie machine plus the regular physical education activity, (3) the effect of training six minutes on the Exer-Genie machine in addition to the physical education activity, and (4) the effect of training nine minutes on the Exer-Genie machine plus regular physical education class activities.

II. DEFINITION OF TERMS

Exer-Genie. The Exer-Genie is a machine which allows the exerciser to initiate the exercise isometrically to contract the muscle and then allows the muscle to complete isotonic movement against maximum resistance.

Isometrics. Maximum muscle tension without muscle movement.

Isotonics. Maximum muscle tensions with muscle movement.

Big Four. This exercise is done with the Exer-Genie and is a combination of the squat, dead lift, curl and military press. The subject controlled resistance with his finger around trailing rope and set muscles to hold isometrically for ten seconds. (See Appendix). At the beginning of the exercise the legs of the subject were bent at a forty-five degree angle with the back straight, head up, and weight placed on the balls of the feet. The exerciser straightened his legs duplicating the squat and brings the hands up with the elbows in and completed the forearm curl. After the handle had been curled to the chest, he reversed the hand grip, dropped the trailing line and completed the military press against the pre-set resistance.

Rowing exercise. This exercise was done with the Exer-Genie. At the beginning of the exercise the feet were pressed straight against the wall while the subject sat on the floor. (See Appendix). He continued to pull with the lower back until he was lying on his back with the arms in front of his face. Subject then reversed the grip and finished with his arms straight over the head.

CHAPTER II

REVIEW OF THE LITERATURE

The reviewed literature pertaining to the development of cardiovascular efficiency was categorized and placed under the following headings: (1) Studies concerning the development of cardiovascular efficiency by running programs; (2) Studies pertaining to cardiovascular efficiency by isometric and isotonic programs; (3) Studies on the development of cardiovascular efficiency by Exer-Genie exercise programs; and (4) Studies on the development of cardiovascular efficiency by various other training methods.

I. STUDIES CONCERNING THE DEVELOPMENT OF CARDIOVASCULAR EFFICIENCY BY RUNNING PROGRAMS

Thomas K. Cureton was a pioneer for continuous and hard endurance activities for the increasement of endurance. He has studied for many years the effects of continual, rhythmical movement and the resulting

improvement in cardiovascular function which he attributes to increased capillarization.[1]

Cureton stated for best gains in improved cardiovascular function such activities as repeated 220 and 440 yard runs or swimming repeatedly 100, 220 and 440 yard distances could be done. In keeping with interval training, Cureton suggested walking up hill on a treadmill for thirty minutes five days a week or varsity wrestling and football combined with running distances and wind sprints.[2]

Christenson did a study using two well conditioned subjects. He compared the effects of intermittent running on a treadmill at a speed of 12.4 miles per hour with continuous running at the same speed. The work and rest intervals for the intermittent condition were thirty seconds each. Two subjects ran continuously at 12.4 miles per hour during the experiment and became exhausted after approximately four minutes. Each experienced maximal oxygen consumption valves, high blood lactates and high pulse rates. On

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[1]Thomas K. Cureton, "Putting Physical Fitness into Physical Education," Journal of the Canadian Association for Health, Physical Education and Recreation. XXIX (October-November, 1962), 21.

[2]Ibid.

the other hand, when the subjects ran intermittently, they experienced only slight increases in blood lactates, lowered oxygen consumption valves, and a constant heart rate (140-150 beats per minute), even though the total exercise period was nearly twenty minutes. He concluded that the intermittent condition was: (1) a more economical way to work, (2) more demanding on the circulatory systems, and (3) more favorable to the development of efficient chemical reaction.[3]

Christenson in another experiment found that alternating work-rest periods of as short as five to fifteen seconds would produce results similar to those above. He pointed out that little if any increase in blood lactate occurred under these conditions. Apparently such short exercise periods with intervening rest periods do not produce significant amounts of lactate.[4]

Mirwald supported Christenson's study when he found that lactate-producing exercises impede performance

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[3]E. H. Christenson and P. Hogberg, "The Efficiency of Anaerobical Work," Arbeitsphysiologic, 14:149-50, 1950.

[4]Ibid.

by: (1) reducing the contractile power of the musculature and consequently the speed of running, and (2) leading to a more rapid fatigue.[5]

Costill stated that the work interval consists of two parts--the work distance and the work rate. Most modern distance-running coaches advocate speed work as a portion of training; although, there are differences in their beliefs as to when and to what extent speed is of prime importance. With regard to endurance, however, most authorities agree that mileage is the first consideration and that the runner should gradually increase the duration of his daily mileage.[6]

Egolinski has presented some results with regard to load size, rate of work and duration of work, respectively. Muscular endurance increased when the resistance was 15 to 30 per cent of the maximum strength of the muscle. Training at the low and middle rates was three to six times more effective for the development of endurance and the increase in endurance was slightly greater with the work of long duration

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[5]R. L. Mirwald, "A Comparison of the Effectiveness of Training Middle-distance Runners by the Swedish System and the Oregon System," (unpublished Master's thesis, Eugene: University of Oregon, 1965.)

[6]David L. Costill, What Research Tells the Coach About Distance Running, Washington D. C., American Association for Health, Physical Education, and Recreation, 1968, p. 13.

than with the shorter duration. He seemed to favor work periods of long duration at a low rate of work for the development of endurance.[7]

Fox completed a study to attempt to determine the frequency of interval training required to produce an improvement in cardiorespiratory endurance. He compared a training frequency of four days per week to a program of two work outs per week. The two groups of approximately twenty-five subjects each were young, healthy male students who worked for seven weeks in an interval training program. The four day week program consisted of two days of short distance running (55 to 220 yards) with as many as sixteen to twenty repetitions and one day of both short and long distance running. The two day week program consisted on one day of short distance running and one day of both long and short distance running. All running was performed at a fixed pace with a given work-to-rest ratio. Based on this prodedure, it was found that the cardiorespiratory fitness of young men can be improved by a seven week interval training program with as few as two work outs per week. It was further shown that such an

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[7]Y. A. Egolinski, "Some Data on Experimental Endurance Training," Physiological Journal, USSR, 47:38-47, 1961.

improvement is similar to that obtained from the same program with four work outs per week. The only difference between the two groups was found in recovery of heart rate with the four day week group showing greater improvement.[8]

Mathew's investigation concluded that the short, repetitious running is necessary for maximum improvement of cardiorespiratory endurance; long, less frequently repeated running is less necessary than is short distance running; and both types of running are helpful for proper leg conditioning, reduction of leg injuries and for variety and motivational purposes.[9]

Milton conducted an excellent study pertaining to the effects of three running groups and a program of isometric exercises upon the development of cardiovascular efficiency.

The 463 college males were given the Harvard Step Test for the initial measure of cardiovascular

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[8]E. L. Fox and others, Improvement of Physical Fitness by Interval Training. II. Required Training Frequencies, Report No. RF 2002-3, United States Army, Office of the Surgeon General, Medical Research and Development Command, April, 1967.

[9]D. K. Mathews and others, Improvement of Physical Fitness by Interval Training. I. Relative Effectiveness of Short and Long Distance Running, Report No. RF 2002-2, United States Army Office of the Surgeon General Medical Research and Development Command.

efficiency, and were placed into four groups. Group I ran ten minutes, Group II ran twenty minutes, Group III ran for thirty minutes, and Group IV engaged in an isometric program. All the groups trained four days a week for seven weeks, after which the Harvard Step Test again was administered.

Findings of the study were as follows:

1. All four training programs produced significant cardiovascular efficiency gains.
2. A comparison revealed that there were no significant differences among the three running groups, but that all three running groups were superior to the isometric exercise group in cardiovascular efficiency.
3. No evidence of regression effects was found among the three running groups, indicating that there was no relationship between the amount of running done in training and the amount of improvement made in cardiovascular fitness.
4. For subjects of highest initial cardiovascular efficiency, the gains in cardiovascular fitness of the groups who ran for ten and twenty minutes a day during training were significantly superior to the gains made by the thirty minute running group and the isometric exercise group. No significant difference was found between the effects of the ten minute running group and the twenty minute running group. Nor was there a significant difference found between the thirty minute running group and the isometric exercise group.[10]

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[10]George Milton, "The Effects of Three Programs of Long Distance Running and an Isometric Exercise Program on the Development of Cardiovascular Efficiency," (unpublished Doctoral thesis, Louisiana State University, Baton Rouge, 1966).

In Bogard's study he analyzed and compared the effectiveness of four training programs of distance running upon the development of cardiovascular efficiency in college men.

Subjects for this study were 120 college males enrolled in the required physical education program during the fall semester of 1966 at Kansas State Teachers College, Emporia, Kansas.

All subjects were given the Harvard Step Test during the first week of the study which served as the initial measure of cardiovascular efficiency. The subjects were divided at random into four training groups. Group I trained by running for two minutes each training session. Group II trained by running for four minutes; Group III ran for six minutes each training period; and Group IV ran for eight minutes each training period. All of the groups trained four days a week for a period of six and one half weeks. At the end of that period, the Harvard Step Test was again administered to all subjects.

The following conclusions were made:

1. Cardiovascular efficiency may be improved by participation in running programs.
2. Increasing the amount of running times does not bring about a proportionate increase in cardiovascular efficiency. The two-minute running group made a greater gain than the four, six or eight minute running groups.

3. The two-minute running group improved their cardiovascular efficiency with the highest degree of significance. Thus, when developing a running program to improve cardiovascular efficiency, a two-minute running period would provide the most improvement.[11]

II. STUDIES CONCERNING THE DEVELOPMENT OF CARDIOVASCULAR EFFICIENCY BY ISOMETRIC AND ISOTONIC EXERCISE PROGRAMS

Hettinger and Muller's experimentation with static contraction in Germany did much to stimulate weight lifting research. Their finding disagreed in principle with traditional weight training exercises and thus started a controversy as to which method was most effective in strength development. The researchers found that one daily static exercise, held for six seconds, produced strength equivalent to conventional exercises involving longer and more frequent training. The subjects for this study were nine male students who participated in twenty-one experiments over an eighteen month period. The training took the form of pulling and holding a predetermined amount of tension against a

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[11]G. W. Bogard, "The Effects of Four Running Programs on the Development of Cardiovascular Efficiency," (unpublished Specialist's thesis, Kansas State Teachers College, Emporia, 1967.)

spring scale by contracting the flexors and extensors of the forearm.[12]

Jesse pointed out over seven fundamentals basic to the use of any form of weight training. They are:

1. The "overload principle" is the dominating factor in strength development.

2. Weights must be made progressively in strength.

3. Maximum tension must be exerted throughout the entire range of motion to develop strength in the entire muscle.

4. Sufficient rest periods are needed between exercise (three minutes).

5. Regular work outs used at periodic intervals.

6. Exercises should be as specific to the specialty of the athlete as possible.

7. Heavy exercise loads and low repetitions are needed for strength development.[13]

Muller states in another study that vascularization is not markedly improved by static training and

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[12]T. Hettinger and E. A. Muller, "Muskellustung and Muskeltraining," Arbeitsphysiologic, 15:111-123, October, 1953.

[13]J. P. Jesse, "A New Look at Strength Development in Track and Field Athletes," The Physical Educator, Vol. 22, No. 2, May, 1965, p. 72-75.

that ventilation and circulation to the increased muscular training. Thus one would assume that muscular endurance depended partially upon the efficiency of capillary circulation and would not be significantly improved by a program of static training.[14]

In Berger's investigation fifty-seven male college students were trained statically three times weekly for twelve weeks. Training involved six (8 seconds) maximum contractions in two positions of the bench press lift--one with barbells at chest and another with arms flexed at ninety degrees. After 12 weeks of training three times weekly, the following conclusions were drawn:

1. Training statically for 6-8 seconds at two different positions is more effective for increasing muscular strength than training dynamically with two R-M for two bouts but not as effectively as six R-M for three sets.
2. Training statically for six (8 seconds) at two different positions is an effective in increasing strength as training dynamically with two R-M for one or two bouts; six R-M for one or two bouts and ten R-M for one, two or three bouts.[15]

Sullivan's study, utilizing eighty-one male students enrolled in the service program of the School

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[14]E. A. Muller, "The Regulation of Muscular Strength," Journal of the Association for Physical and Mental Rehabilitation, 11:41, March, 1957.

[15]R. A. Berger, "Comparison Between Static Training and Various Dynamic Training Programs," The Research Quarterly, May, 1963, p. 131.

of Physical Education, investigated the two programs of weight training. The control group participated only in the pre-test and post-test. The isotonic group exercised two times weekly with intervals of one and four days between periods. The exercises consisted of lifting a weight from ninety to 180 degrees for ten maximal repetitions. In order to give the muscle maximum load an increment of 1.5 pounds was added each exercise period. The isometric exercise consisted of two, six second maximal contractions of the quadriceps, with a one minute rest interval between each contraction. The conclusions were:

1. Two consecutive six-second static contractions of the quadriceps twice weekly, for a six week period, produced significant gains in strength and endurance, and a significant loss in knee joint flexibility.
2. The maximal isotonic contraction of the quadriceps twice weekly for a six-week period produced significant gains in strength and endurance, and a slight loss in knee joint flexibility.
3. The subjects performing static exercises showed significantly better gains in strength than subjects performing isotonic exercises.
4. The subjects performing isotonic exercises showed significantly better gains in endurance than subjects performing static exercises.[16]

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[16]George Morris Sullivan, "The Effects of Isotonic and Static Contraction of the Quardiceps on Strength and Endurance," (unpublished Master's thesis, Washington State University, Pullman, 1961).

Rogwell conducted a study at the University of Illinois where 177 subjects in weight lifting classes were divided into nine groups. The purpose of the study was to determine whether progressive resistance exercise with greater or lighter loads, and more or fewer repetitions produced faster gains in strength. The conclusion of the study was that progressive resistance exercise involving all possible combinations of sets and repetitions improved strength significantly.[17]

The purpose of Berger's study was to determine whether progressive resistance exercise with frequent sets, heavy loads and fewer repetitions per set were more effective for improving strength than training with fewer sets, lighter loads and more repetitions per set. The subjects were set up in three classes: (Group I) two R-M for six sets, (Group II) ten R-M for three sets, and (Group III) ten R-M for three sets. Berger concluded from the results of this study that training for nine weeks, three times weekly with heavy loads for fewer repetitions per set and numerous sets, is not more effective for improving strength than

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[17]L. B. Rogwell, "Effect of Varied Weight Training Programs on Strength," The Research Quarterly, Vol. 33, No. 4, 1962, p. 168.

training with lighter loads for more repetitions per set and fewer sets.[18]

Dennison conducted a study using twenty students enrolled at the University of British Columbia. The subjects were placed into two groups that met two times a week for eight weeks. Group I had isotonic training with the minimum of five repetitions and a maximum of ten repetitions. Group II, the isometric group, had thirteen exercises doing only one repetition on each exercise day. The finds of Dennison's study were:

1. Both groups showed statistically significant improvement in the arm strength index.
2. Both exercise programs brought about a statistically significant improvement in muscular endurance of the upper arm.[19]

Howell conducted a study at the University of Alberta using seventeen college freshmen. The subjects were divided into two groups that met two times a week for four weeks. Group I had a circuit training program which consisted of twelve different isotonic

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[18]R. A. Berger, "Comparative Effects of Three Weight Training Programs," The Research Quarterly, Vol. 34, No. 3, October, 1963, p. 396.

[19]J. D. Dennison, M. L. Howell, and W. R. Morford, "Effect of Isometric and Isotonic Exercise Programs Upon Muscular Endurance," The Research Quarterly, Vol. 32, No. 4, 1961.

exercises at different repetitions and loads. Group II, the control group, played badminton and volleyball for approximately 30 minutes, two times a week for four weeks. The results showed a statistically significant improvement in performance in the circuit training group with respect to the Harvard Step Test following four weeks of activity.[20]

III. STUDIES CONCERNING THE DEVELOPMENT OF CARDIOVASCULAR EFFICIENCY BY EXER-GENIE EXERCISE PROGRAMS

The Exer-Genie is a resistive exercise program based on the overload principle. The first step is to tire the muscle and step two is to make the tired muscle move through a complete range of motion. Isometrics are used to tire and strengthen the muscle and isotonics are used to build flexibility and endurance.[21]

Alexander made an interesting study using seventeen members of a karate class activity. Group II or experimental group, worked twenty minutes a day on the

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[20]M. L. Howell, J. L. Hodgson and J. T. Sorenson, "Effects of Circuit Training on the Modified Harvard Step Test," The Research Quarterly, Vol. 34, No. 2, May, 1963, p. 154.

[21]Arnie Friedman, "Wizard Muscle Maker for Conejo's Gridders," The News-Chronicle, August 7, 1966, p. 4.

Exer-Genie. The findings were that the experimental group improved significantly on the physical fitness index while the control group did not improve. Both groups displayed small gains in cardiovascular efficiency fitness. The result of the study indicated that physically conditioned young males, exercising with the Exer-Genie brought about changes in girth and skinfold measurements, improves muscular strength and endurance, and has a small positive effect on improvement of the cardiovascular fitness level.[22]

Glenn Tuckett, baseball coach at Brigham Young University, contends that an optimum program should have three integral areas: (1) isometric contractions, (2) isotonic movement, and (3) functional overload. The Exer-Genie machine has been able to duplicate these three integral areas of his program in much less time.

Tuckett's program consists of a six station circuit and it was found that the entire squad of thirty-five players could complete their workout in less than thirty minutes. Each exercise was performed three times with a ten second isometric contraction to

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[22] J. F. Alexander, S. L. Martin and K. Mitz, "Effects of a Four Week Training Program on Certain Physical Fitness Components of Conditioned Male University Students," The Research Quarterly, Vol. 39, No. 1, March, 1968, p. 17.

begin each exercise. The exercises were done in pairs, thus allowing for periods of recuperation and guaranteeing that each player would be working against maximum resistance.[23]

McKinney and Logan's investigation was concerned with the effect of resistance through a throwing range of motion on the velocity of a baseball. Members and potential members of the varsity baseball team were used.

Each subject was pretested on the velocitimer and divided into three groups. Group I pulled the ball through the Exer-Genie thirty times a day, five days a week, for six weeks. Group II threw a baseball thirty times a day in the regular throwing motion. Group III was the control group which did nothing other than take the pre and post test.

After the final test, Group III had shown virtually no change in throwing speed going from 75.159 miles per hour to 75.206 miles per hour. Group II had increased its speed from 75.895 miles per hour to 78.842 miles per hour. Group I had upped its speed from 75.895 miles per hour to 84.001 miles per hour.[24]

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[23]Glenn Tuckett, "A Revolution in Body Conditioning," Coach and Athlete (March, 1966), p. 31.

[24]Dave Schulty, "Exer-Genie Gives Fast Ball Boost," Sunday News and Leader (Springfield, Missouri), January 9, 1966, p. 42.

Lewis, basketball coach at Syracuse University, set up a program that was mandatory for every player and was carefully supervised.

The parts of the body which were to be developed were the legs, abdominal muscles, back muscles, the upper shoulder girdle, and the arms with special emphasis on the triceps and the hands and fingers.

Three repetitions of each set of exercises at each individual's maximum capacity were required. These five exercises were used in Lewis's program: (1) lat pulls (latissimus dorsi), (2) triceps pull (triceps), (3) big four (all major muscles), (4) sit-ups (abdominal), and (5) rowing (all major muscle groups).

The following routine for the exercises was followed. The exercising player would assume the starting position for the specific exercise and start isometrically for ten seconds. His partner would secure the trailing rope. At the signal to start, ten numbers would be counted off. The exercising player was encouraged to hyperventilate. At the count of ten, the exercising player would move isotonically through a full range of motion completing the exercise. The partner controlling the trailing rope would offer enough resistance so that the exercising player would be working at his full capacity.

As a result of the program, Lewis makes the following comment:

> Some of our players improved their vertical jump as much as three inches in a four-week period of time they spent working with Exer-Genies. During four weeks of training before the 1965-66 basketball season, the players wore harnesses connected to Exer-Genies and practiced jumping against the resistance from the device.[25]

Crane's study analyzed and compared the effects of two programs of weight training upon the vertical jump performance of college males. Specifically this study investigated the effect of training with the Exer-Genie, and an isometric training program upon the vertical jump.

Forty-seven male students enrolled in a required physical fitness course were randomly divided into two groups; Group I was the Exer-Genie group and Group II was the isometric group. Both groups met for fifty minutes a day and performed three comparable exercises four times a week for five weeks.

The findings of Crane's study were as follows:

1. The vertical jump performance of college males can be improved through the use of five-week weight training programs.

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[25]Fred Lewis, "A Dynamic Approach to Body Conditioning," Athletic Journal, XLVI (June, 1966), 35.

2. Group I, utilizing the Exer-Genie training program, although not making a significant improvement showed an overall increase in vertical jump performance.

3. In using the isometric training program, Group II made a greater gain in vertical jump performance than did Group I; this increase was also found to be significant at the .05 level of confidence.[26]

IV. STUDIES ON THE DEVELOPMENT OF CARDIOVASCULAR EFFICIENCY BY VARIOUS TRAINING METHODS

The consensus of knowledgeable physical educators accepts strength as a primary component of physical fitness. While freedom from disease, organic soundness and proper nutrition are essential elements, they are not alone sufficient to satisfy the definition physical fitness. They do not by themselves provide "the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure time pursuits and to meet unforeseen

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[26]N. E. Crane, "A Comparison of Two Programs of Weight Training Upon Vertical Jump Performance of College Males," (unpublished Master's thesis, Kansas State Teachers College, Emporia, 1967), p. 46.

emergencies. The positive qualities of muscular strength, muscular endurance, and circulatory endurance."[27]

Clarke stated that during vigorous exercise, the blood circulation quickens--blood and lymph stream through the muscles, supplying the cells with oxygen and nutrition and removing waste products. The heart's activity is accelerated, exercising and strengthening its own fibers, as well as pumping the blood and stimulating its circulation. Muscles are enlarged and their endurance is increased through strenuous exercise. The gain in the endurance of a muscle, however, is out of all proportion to its size. Therefore, the quality of contractions must be improved through such factors as fuel being made available in a greater amount becoming more abundant owing to improved circulation of blood through the muscle, better coordination of the individual muscle fibers and more complete use of all muscle fibers being realized.[28]

Bender and Shea pointed out in their book that "standardized exercises which require you to use as many of the larger muscles of the body as possible while at

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[27]H. H. Clarke, Application of Measurement to Health and Physical Education (fourth edition; Englewood Cliffs, New Jersey: Prentice-Hall, Inc.), p. 144.

[28]Ibid., p. 179.

the same time performing the exercises at a fairly fast degree of speed, have proved themselves to be effective in developing cardiovascular efficiency."[29]

Thomas K. Cureton is in agreement with Bender and Shea in his article in Health and Fitness. From an experience of over ten years constantly struggling to improve stamina and circulatory-respiratory fitness in young boys and young men, Thomas K. Cureton makes the following suggestions and comments:

1. Several weeks are needed for training to adjust to a fairly vigorous program.

2. Every endurance drill should be accompanied by definite effort to breathe well, and deep breathing should be stressed following every work performance.

3. Motivation to "standards" is constantly needed including participation and demonstration by the instructors. Rating tables are used for all endurance events.

4. Over eating should be avoided.

5. Some competition is needed, including competition with relative grades or scores in the endurance tables and in the cardiovascular tests; i.e., competition against one's own scores.

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[29]J. Bender and E. J. Shea, Physical Fitness Tests and Exercises (New York: The Ronald Press Company, 1964), p. 5.

6. The best events to develop circulatory-respiratory endurance so far known include:

a. Steeplechase running
b. Continuous muscular endurance exercises done for thirty minutes without stopping.
c. Interval training
d. Road running--jogging
e. Fartlek running
f. Weight-training routines
g. Rope skipping
h. Rowing machine routines
i. All-out test exercises

7. Endurance will usually not improve in connection with skill-centered games and sports instruction.

8. Temporary set-backs may be expected if the program is too hard at first.

9. Relatively more sleep is needed with the practices of endurance programs.

10. Moderation is advocated in the drinking of water, milk, and the eating of ice cream.[30]

Cureton stated that in general we know that gradually progressive physical training produces: (1) a lower pulse rate at the end of a standardized exercise, (2) a greater stroke volume of the heart,

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[30]Leonard A. Larson and others, Health and Fitness in the Modern World (Rome, Italy: Athletic Institute, 1961), p. 352.

(3) greater relative density of the body by specific gravity test, (4) greater relative amounts of Hb, glycogen in the liver, and a larger relative number of red blood cells, (5) greater endurance by muscular endurance tests, (6) greater strength per pound of body weight, (7) greater relative circulation related to increased vascularization, (8) greater speed and power capacity, (9) greater respiratory reserves and ability to stand distress or oxygen deprivation, and (10) improved neuromuscular capacity.[31]

A system has been worked out for the scientific testings of athletes by T. K. Cureton. The purpose of this type of testing is to determine the characteristics which are casually related to performance and to determine the physical fitness levels of different sportsmen. In this type of testing standardized exercises are combined as tests to measure muscular endurance.

As an example, the muscular endurance tests were used with Roger Bannister, who was tested in the Royal Free Medical College, in London, in June of 1952. His back and leg muscles were found to be weak. From a table in the monograph he was shown the muscular

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[31] Ibid., pp. 321-322.

endurance exercises which correlated with the mile run above 0.40. These he promised to practice after the Helsinki Olympics:

1.	Floor push-ups	(0.72)
2.	Sit up	(0.552)
3.	Repetitious 300-600 yard run	(0.715)
4.	Repetitious 100 yard run	(0.575)
5.	Repetitious 1,000 yard runs	(0.758)
6.	Chin-ups	(0.491)
7.	Squat-jump	(0.436)
8.	Continuous hops	(0.404)

It is possible that some of these exercises helped to strengthen his back, and this may have been a factor in his magnificant run of 3.58.8 the next year.

Cureton said it is probably more important that we did predict that of all the men we had ever tested, Bannister seemed to have the best possibilities to run under 4:00 minutes.

Cureton, in a lecture in the College of Tripical Medicine and Hygiene, University of London, on June 5, 1952, made this prediction:

> Right here in London was the man who had the cardiovascular potential to run under 4:00 minutes for the mile, for the first time in history.[32]

In a study done by Baker, the subjects were tested before and after a six weeks period of training. The designation of the two groups were rope skipping

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[32] Ibid., p. 321.

ten minutes a day for five days a week for Group I, and Group II jogging for thirty minutes a day for five days a week.

The results of the analysis of the data would seem to warrant the following conclusions:

1. A daily ten minute program of rope skipping will significantly improve cardiovascular efficiency.

2. A daily thirty minutes of jogging will significantly improve cardiovascular efficiency.

3. A ten minute daily program of rope skipping is a thirty minute daily program of jogging for improving cardiovascular efficiency.[33]

Harper and others conducted a study in which three groups of college men were given initial and final cardiovascular efficiency tests. They were assigned to three groups. Group I did calisthenics, twelve miles of marching and combative drills. Group II was the interval running group which consisted of running 110, 220, 440 and 880 yards with five minutes of rest. Group III, the control group, did light training such as archery, golf and recreational swimming.

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[33]John Baker, "Comparison of Rope Skipping and Jogging as Methods of Improving Cardiovascular Efficiency of College Men," The Research Quarterly, Vol. 39, No. 2, May, 1968, p. 240.

Findings of the study were as follows:

1. The Harvard Step Test index improved significantly in both experimental groups but none in the control group.

2. A seven week period of interval training (running) significantly improved maximum oxygen consumption and performance on the Harvard Step Test.

3. A seven week conditioning program of combative exercises, calisthenics, and marching significantly improved performances on the Harvard Step Test but did not produce significant improvement in maximum oxygen consumption.

4. It is believed that interval training programs can produce more improvement in physical fitness than a program of calisthenics and marching with a considerable saving of time.[34]

Astrand and others in their study of thirty girl swimmers who had won nine Swedish national championships reported that the better endurance performers trained more times per week and swam a much greater total distance per week.[35]

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[34]D. D. Harper, C. E. Billings and D. K. Mathews, "Comparative Effects of Two Physical Conditioning Programs on Cardiovascular Fitness in Man," The Research Quarterly, Vol. 40, No. 2, May, 1969, p. 293.

[35]P. O. Astrand, "Human Fitness with Special Reference to Sex and Age," Physiological Revue, 36:307-29, 1936.

V. SUMMARY OF RELATED LITERATURE

The four major categories under which the related literature were classified were: (1) running programs, (2) isotonics and isometric exercises, (3) Exer-Genie programs, and (4) other training methods.

In the studies reported as a method of improving cardiovascular efficiency all of the authors agreed that running improved fitness. Most of the authors agreed that short interval running was as effective for development of cardiovascular efficiency as mileage running. However, Egolinski and Astrand favored work periods of long duration at a low rate of work for better endurance. Milton found that running ten or twenty minutes was superior to running thirty minutes or using isometric exercises. However, all of the varing methods did improve cardiovascular efficiency.

Of the investigations on isometric and isotonic exercises, all nine authors agreed that both forms of exercise would increase strength. Muller stated in his research that isometric form of exercise did not help endurance. Whereas Sullivan and Dennison reported that both forms, isometric and isotonic exercises, did help muscle endurance.

In the six studies reported as a method of improving cardiovascular efficiency, all the authors agreed that progressive physical training showed the best results.

In the investigation on the Exer-Genie the seven authors were in agreement on the increasement of muscular strength. Alexander, however, in his investigation using seventeen members of a karate class found an increase of endurance and a small positive effect on improvement of the cardiovascular fitness level.

CHAPTER III

METHODS OF PROCEDURE

The purpose of this study was to investigate the effects of physical education classes with instruction and participation in supplementary exercise on cardiovascular efficiency of college males and females. Specifically this study investigated the (1) effect of physical education classes on cardiovascular efficiency, and (2) the effect of training three, six and nine minutes on the Exer-Genie machine plus the regular physical education class.

Nature of the Program. The eighty-three subjects for this study were male and famale students at Fort Hays Kansas State College. All four groups met fifty minutes twice a week during the spring semester of 1969. Beginning Swimming and Beginning Tennis are part of the physical education curriculum offered at Fort Hays Kansas State College. These classes are required and help to meet physical education requirements for graduation from the college. Enrolled in these classes were only freshmen and sophomore males and females.

Subjects. All of the men and women were required to wear the official physical education uniform con-

sisting of a T shirt, shorts, socks and sneakers for the males and shorts, blouses, socks, and sneakers for the females.

The second meeting in each of the participating classes the subjects were placed into one of four groups of approximately twenty each. To ensure random selection to form the four different groups, individual class student cards were placed in a large hopper and moved about several times and drawn one at a time. The first card selected was placed in Group I. The second card in Group II, third into Group III, fourth into Group IV until all cards were drawn and placed into groups in a like manner. The subjects in Group I acted as the control group and participated only in the regular planned program of instruction and practice. Group II had three minutes of Exer-Genie exercise plus an organized class activity. Group III had six minutes of Exer-Genie plus regular planned activity while Group IV had nine minutes of Exer-Genie and regular supervised activity.

Equipment and Facilities. This study was conducted in Sheridan Colosseum on the campus of Fort Hays Kansas State College. The Exer-Genie groups were conducted on the first floor gymnasium of Sheridan Colosseum. Group II of the Exer-Genie groups used one

machine for the males and one machine for the females. Groups III and IV each employed three machines for the males and three machines for the females. A total of fourteen Exer-Genies were employed in this study. In performing the rowing exercises, screw hooks were fastened into the baseboard of the floor into which the Exer-Genie machines were inserted. Gym mats were used for the subjects as they performed the exercises.

The tennis courts are located 200 yards south of the Colosseum. The swimming pool is situated on the first floor at the west end of the Colosseum, parallel to the gymnasium.

The tape was cut on a portable tape recorder with the metronome set at thirty times a minute. The investigator recorded a cadence of up, up, down, down for five minutes.

Four benches eighteen inches from the floor were used for the Harvard Step Test. Six stop watches were used to insure accuracy during the Harvard Step Test.

Orientation procedures. The first class period the students met in Sheridan Colosseum for an explanation of the study. A brief lecture was given on cardiovascular efficiency and how it relates to every-day living. For motivation, the girls were told that

if maximum effort was given they would possibly see a reduction of hip area, waist and weight with an increase in the bust line. The males were told that they should see improvement of muscle build and in general look much better in a swim suit. It was also pointed out that their grade depended upon their complete cooperation and hard work.

During the second class period, the students were divided at random into four groups and were given their individual Harvard Step Test cards. The subjects filled out test score cards placing names and group to which they were assigned. The cards were then returned to the group leaders. The next fifteen minutes of the class were spent illustrating the use of the Exer-Genie machines stressing the proper lifting angles and again stressing the motivating factors. Each subject was then assigned at random a partner and a two minute Harvard Step Test was given for practice counts. The partner was shown where to find the radial artery and was instructed how to place the three middle fingers. The subject being tested also counted his own pulse by placing the free hand on the side of his lingual vein.

During the third class period the same procedure was used as for the second day. The subjects again showed a great desire to perform well as there

were only a few who had to be instructed on the proper use of the Exer-Genie.

Testing Procedures. Following the instruction of the orientation, the males and females in Group I took the Harvard Step Test first using the subjects from Group II as pulse counters. They then changed position as Group II took the Harvard Step Test and Group I served as pulse counters. Group III took the test while Group IV were the counters. Again the groups exchanged positions, with Group IV becoming the counters while Group III took the Harvard Step Test.

By using the metronome set at thirty times a minute the investigator recorded a cadance of up, up, down, down which continued for five minutes. At the end of the five minute cadence the recording gave the command to stop.

On the command of "subject please stand", the testee stood facing an eighteen inch high bench and followed the directions from the tape recorder. On the command "up" the testee stepped up on the bench with one foot. On the command of "up" he stepped up with the other foot to an erect position on the bench. On the command of "down" he stepped down with the one foot and on the second "down" he stepped down with the other foot to the starting position. The subject could

lead off with the same foot each time or change feet as he desired as long as the four count step was maintained. The instructor and helpers were available to those who got out of step.

The step exercise continued for exactly five minutes unless the subject was forced to stop sooner due to exhaustion. At the end of the exercise period the recording gave the command "stop". The testee was then told to sit down. At the end of the first thirty seconds after exercising the tester found his pulse and the testee found his pulse by placing three fingers on the lingual vein. At the end of the first minute the command to begin counting was given. Thirty seconds later the command of stop and record was given. Two minutes after the test the same command was given and at the end of thirty seconds a command of stop and record was given. Three minutes after exercising the command of start was given and at the end of thirty seconds the command to stop and record was given.

After each group had been counted and recorded on the score card and when all three counts had been recorded they totaled the three scores to find the total pulse count. The cards were then handed to the group leaders and the testee then changed positions so that another member of the group became the testee and he

became the pulse counter. This procedure continued until all the subjects had been tested.

At the end of six weeks the post-Harvard Step Test was given following the identical procedure as was administered during the pre-test.

Training procedure. All of the subjects were expected to be present, prompt and participate to their maximum ability. This study of twelve class periods was conducted in Sheridan Colosseum on the campus of Fort Hays Kansas State College over a six weeks period of time. The Exer-Genies were dialed to a determined poundage and placed by numbered stantions when the students arrived for class. The subjects were not allowed to change the poundage of the preset machines. Group II had one machine for the male subjects and one machine for the female subjects. To equalize time due to the number of exercises Groups III and IV had to perform, it was necessary for these groups to have three machines for the males and three machines for females. The total number of Exer-Genies were fourteen employed for the study. The machines were predialed to thirty-two pounds for the females the first week, forty pounds of resistance the second week, forty-five pounds of resistance the third week, fifty pounds of resistance the fourth and fifth weeks,

and fifty-six pounds of resistance the sixth week. As for the males the first week's setting was fifty pounds of resistance, sixty-five pounds of resistance the second week, seventy-five pounds of resistance the third week, eighty-five pounds of resistance for the fourth and fifth weeks, and it was raised to ninety-five pounds of resistance the sixth week.

The number of each exercise was predetermined as the rowing and big four exercises took approximately thirty seconds to complete per person. Therefore, Group II did three rowing and three big fours which accounted for three minutes; Group III did six rowing and six big fours which totaled approximately six minutes; and Group IV did nine big fours and nine rowing which took approximately nine minutes. These were recorded daily by a helper and a student squad leader.

In doing the big four exercise, the Genies were placed on a 16" by 8" board with a hammock screw attached. The exercise is a combination of the squat, dead lift, curl and military press. The subject controlled resistance with his finger around trailing rope and set muscles to hold isometrically for ten seconds. At the beginning of the exercise the legs of the subject were bent at a forty-five degree angle with the back straight, head up, and weight placed on the balls

of the feet. The exerciser straightened his legs duplicating the squat and brought the hands up with the elbows in and completed the forearm curl. After the handle had been curled to the chest, he reversed the hand grip, dropped the trailing line and completed the military press against the pre-set resistance. The rowing exercise had a hook screw attached to the base-board of the gymnasium. The exerciser controlled resistance with his finger around the trailing rope and set muscles to hold isometrically for ten seconds. At the beginning of the exercise the feet were pressed straight against the wall while the subject sat on the floor. He continued to pull with the lower back until he was lying on his back with the arms in front of his face. Subject then reversed the grip and finished with his arms straight over the head.

CHAPTER IV

PRESENTATION OF DATA

I. INTRODUCTION

There were two statistical treatments computed to investigate the effects of the Exer-Genie machine upon cardiovascular efficiency of college students. The first computation was the *t* test for sign of the difference between mean for each of the four groups. The second statistical treatment was analysis of variance for all groups on both initial and final Harvard Step Tests.

II. SIGNIFICANCE OF THE DIFFERENCE BETWEEN INITIAL AND HARVARD STEP TESTS MEAN SCORES FOR ALL GROUPS

One of the primary purposes of this study was to gain insight into the effectiveness of the Exer-Genie machine in terms of enhancing cardiovascular efficiency of college students. To gain this information *t* tests were computed for all groups employing the initial and final Harvard Step Test mean scores.

Group I or those subjects which did not have any supplementary exercise with the Exer-Genie machine

the initial Harvard Step Test score was 188.91 with the final Harvard Step Test mean score showing an increase to 190.70.

The raise in the mean score gave a difference of -1.78. This minus difference resulted in *t* of .192 which is obviously a nonsignificant result.

TABLE I

SIGNIFICANCE OF THE DIFFERENCE BETWEEN INITIAL AND FINAL HARVARD STEP TEST SCORE FOR ALL GROUPS

Group	N	Initial Mean	Final Mean	Mean Diff.	*t*	P
I	23	188.91	190.69	-1.78	.192	--
II	21	181.66	179.90	1.76	.241	--
III	20	190.20	184.50	5.70	.953	--
IV	19	187.10	181.57	5.53	.741	--

t needed: with 19 df 2.09 for .05; 2.86 for .01. 23 df 2.07 for .05; 2.83 for .01.

As can be seen from Table II on page 44 the mean difference for the male was 1.22 which resulted in a *t* score of .856 and the female mean difference was 2.87 with a *t* score of .964 which is obviously a non-significant result.

TABLE II

SIGNIFICANCE OF THE DIFFERENCE BETWEEN INITIAL AND FINAL HARVARD STEP TEST BETWEEN SEXES

Group	N	Initial Mean	Final Mean	Mean Diff.	t	P
Male	51	184.37	183.15	1.22	.856	--
Female	32	191.21	186.34	2.87	.964	--

t needed: with 50 df a 2.01 necessary at .05 level of significance with 31 df a 2.04 necesary at .05 level of significance.

III. ANALYSIS OF VARIANCE

The statistical procedure most often employed when more than two experimental groups are in the research design is analysis of variance.

For the present study cardiovascular efficience was computed for the difference between the initial and final Harvard Step Test for all groups. As can be seen from Table III, page 45, with all the details a non-significant F of 1.88 resulted from among sum of square of 910.33 and a difference in sum of square of 12695.76. These two sums of square yielded in a mean square of 303.44 and 160.71 respectively. To be significant a F of 2.72 would be necessary with 3 and 82 degree of freedom.

With a non-significant F the results demonstrate that although there are differences between the groups, these differences are not in large enough quanity to provide for significant differences.

Due to the times of day differences in classes, no attempt was made to make comparisons of activities in swimming and tennis.

TABLE III

ANALYSIS OF VARIANCE OF MEAN GAIN BETWEEN THE INITIAL AND FINAL HARVARD STEP TEST FOR ALL GROUPS

Source of Variance	Sum of Squares	df	Mean Squares	F	P
Among	910.33	3	303.44	1.88	--
Within	12695.76	79	160.71		
Total	13606.09	82			

F needed: at .05 level of significance equals 2.71 and .01 level of significance equals 4.04.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY

The purpose of this study was to investigate the effects of physical education classes with instruction and participation in supplementary exercise on cardiovascular efficiency of college males and females. Specifically, this study investigated the (1) effect of physical education classes on cardiovascular efficiency, and (2) the effect of training three, six and nine minutes on the Exer-Genie machine plus the regular physical education class.

The study was conducted on the campus of the Fort Hays Kansas State College. Eighty-three subjects enrolled in a required physical education class of Beginning Swimming or Beginning Tennis which met twice a week during the spring semester of 1969. The subjects were randomly divided into four groups. Group I, the control group, had just the physical education class activity. Group II had three minutes of Exer-Genie plus the regular class activity. Group III used the Exer-Genie six minutes plus the physical education

class activity; and Group IV worked with the Exer-Genie for nine minutes plus the class activity.

Testing procedures included one week of pre-testing and demonstration. Six weeks of training and one week of post-training. The pre-test and post-test of the Harvard Step Test were obtained and recorded.

II. FINDINGS OF THE STUDY

The findings of this study were as follows:

1. The Exer-Genie training program over a six-week period did not produce significant cardiovascular efficiency gain.

2. Group III and IV, the six and nine minute Exer-Genie groups, produced an improvement of cardiovascular efficiency but was not significant.

3. Group I with no Exer-Genie exercise showed a decrease in cardiovascular efficiency.

III. CONCLUSIONS

Within the limitations of this study the following conclusions were made:

1. Cardiovascular efficiency of college age individuals may be improved by participation in Exer-Genie exercise but not to a significant degree.

2. Increasing the amount of time spent on the Exer-Genie will bring about proportionate increase in cardiovascular efficiency. The six and nine minute Exer-Genie groups made a greater gain than the three minute groups and the controlled groups; however, the gain was not significant.

3. Cardiovascular efficiency cannot be maintained in a general physical education course of Beginning Swimming and Beginning Tennis.

IV. RECOMMENDATIONS FOR FURTHER STUDY

The recommendations for further study are as follows:

1. A study employing the same procedure but including flexibility, strength and muscle endurance.

2. A study employing the same procedure but using motivational and nonmotivational factors.

3. A study that would compare cardiovascular efficiency using the Exer-Genie involving different age groups.

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APPENDIXES

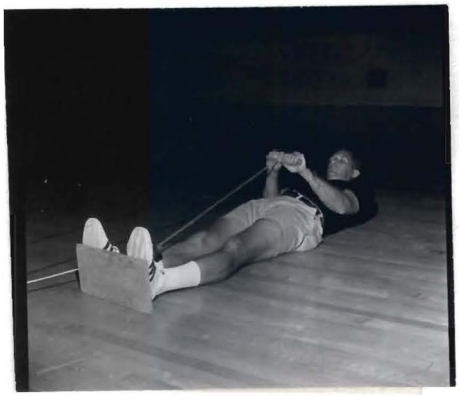
APPENDIX A

HARVARD STEP TEST RECORD CARD

Last Name	First Name	Group and Sub Group

First H. S. T.		Second H. S. T.	
1 minute after exercise		1 minute after exercise	
2 minutes after exercise		2 minutes after exercise	
3 minutes after exercise		3 minutes after exercise	
TOTALS		TOTALS	

APPENDIX B

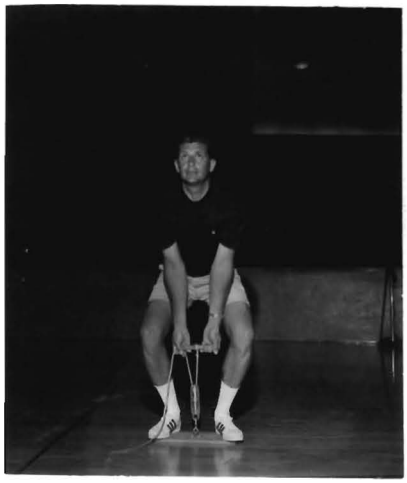


Rowing (Position 1)

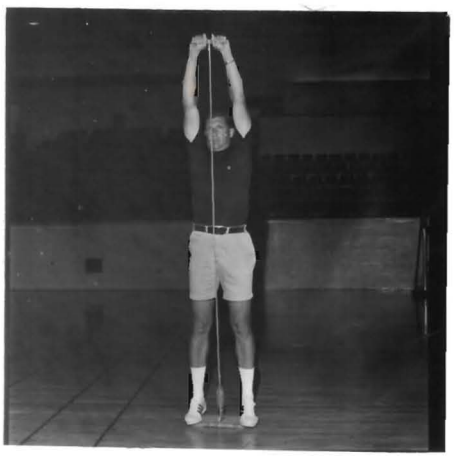
Rowing (Position 2)

Rowing (Position 3)

Big Four (Position 1)



Big Four (Position 2)



Big Four (Position 3)