THE EFFECTS OF INSTRUCTIONAL SWIMMING WITH TWO SUPPLEMENTARY EXERCISES ON CARDIOVASCULAR EFFICIENCY OF COLLEGE MALES

A Thesis

Presented to

the Division of Physical Education

Kansas State Teachers College of Emporia

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

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August 1969

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Approved for the Major Department

Approved for the Graduate Council

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THE PROBLEM AND DEFINITION OF TERMS USED

I. INTRODUCTION

Physical fitness has long been recognized as an important component of healthful living. In this respect the improvement of cardiovascular efficiency has been found to contribute greatly to physical fitness. Consequently, a variety of ideas and techniques for the improvement and maintenance of cardiovascular efficiency have been developed. Traditionally, distance running and swimming have been found to be effective in reaching this goal; therefore, it is necessary to decide whether instructional swimming programs, in which the students meet two days per week, are sufficiently strenuous to improve cardiovascular efficiency or if additional supplementary exercises should be included in these programs.

II. THE PROBLEM

Statement of the problem. It was the purpose of this study to investigate the significant improvement, if any, which an instructional swimming program would make upon cardiovascular efficiency of college males in comparison to an instructional swimming program with supplementary exercises. Specifically, this study will ascertain the effectiveness of:

1. An instructional swimming program.

2. An instructional swimming program with additional supplementary three-minute running in place exercise.

3. An instructional swimming program with additional supplementary forty-second isometric exercises.

Importance of the study. Physical educators are aware that the aims of physical education include physical fitness; however, the question as to how much improvement is made on cardiovascular efficiency through an instructional swimming program that meets two days per week is unanswered. Also, the question as to how much additional supplementary exercise is required to improve cardiovascular efficiency is unanswered.

III. LIMITATIONS OF THE STUDY

The subjects for this study were sixty-three male students who were enrolled in elementary and intermediate swimming courses at Kansas State Teachers College, Emporia, Kansas.

The study did not attempt to find a correlation between swimming and the modified Harvard Step Test. The modified Harvard Step Test was the tool used to measure cardiovascular efficiency. This test was chosen because of the following reasons:

1. The modified Harvard Step Test does not require any special or expensive equipment.

2. The test does measure the cardiovascular efficiency of college males.

3. The subjects in this study were trained in pulse counting and were able to assist in administering the test.

The training period was limited to six weeks during the spring of 1969. There was no objective method for determining whether each subject exerted maximal effort throughout each training period. Also, there was no way of knowing if the subjects participated in exercise outside the experimental program during the course of the study.

IV. DEFINITIONS OF TERMS USED

Cardiovascular Efficiency. In this study, cardiovascular efficiency was the speed at which the heart rate returns to its original pulse rate after exercise.

Isometric exercises. A neuromuscular contraction that does not involve a range of motion.

Instructional swimming program. In this study the instructional swimming program referred to elementary and intermediate swimming courses.

CHAPTER II

REVIEW OF LITERATURE

The review of literature pertaining to the development of cardiovascular efficiency was divided into the following categories: (1) Studies pertinent to exercise and pulse rate; (2) Studies pertaining to the improvement of cardiovascular efficiency by swimming; (3) Studies on the development of cardiovascular efficiency by running; and (4) Studies on the improvement of cardiovascular efficiency by isometric exercises.

I. STUDIES PERTINENT TO EXERCISE AND PULSE RATE

In order to evaluate the studies dealing with cardiovascular efficiency, it was necessary to refer to those studies pertaining to exercise and pulse rate.

Bucher related the ability to recover from fatigue as a result of physical training, but with the exception of the influence of heredity and nutritive environment "the organic system of the body can be developed only through muscular activity."[1] Bucher had this to say about the effects of a training program:

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[1] C. A. Bucher, Foundations of Physical Education, (St. Louis: C. V. Crosby Company, 1952), p. 202.

> Through vigorous muscular activity several beneficial results take place. The trained heart provides nourishment to the body. The trained heart beats slower than the untrained and pumps more blood per stroke with the results that more food and oxygen is delivered to the cells and there is better removal of waste products. During exercise the trained heart increases less and has longer rest periods between beats, and after exercise returns to normal much more rapidly.[2]

In an early study Boothby presented evidence that pulse rate increases, up to a point, in proportion to the severity of the exercise, and parallels fairly closely minute volume, the oxygen consumption, and total ventilation. However, when the pulse rate reaches a maximum, it levels off, such as in endurance exercises. When this occurs additional compensation prevails.[3]

Cureton had this to say about pulse rate recovery from strenuous exercise:

> One of the most acceptable tests of circulatory respiratory fitness is pulse rate reaction to a fairly strenuous standard exercise. A quick recovery of the pulse rate to the normal is one characteristic of fitness. Tests based on this idea are the most valid tests if the exercise is hard enough. The more strenuous the exercise, the more reliable is the pulse rate recuperation test. The recuperation time of the pulse to return to normal approximately

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[2] *Ibid.*, p. 145.

[3] W. M. Boothby, "A Determination of the Circulation Rate in Man at Rest and at Work," *American Journal of Physiology*, 37:383-417 (1915).

> parallels the circulatory-respiratory efficiency to buffer fatigue products in the blood after exercise and to restore normality.[4]

In reference to the hearts of athletes in training as opposed to the hearts of men of sedentary habits, Brassfield found that the trained man's heart accelerates approximately as many beats for a given load as an untrained man's heart, but the trained heart functions with definite advantages:

> While the trained man's heart has the advantage of starting at a slower rate of beating, on the whole it accelerates as many beats in response to a task as does the heart of the untrained subject... The fundamental difference between the trained and the untrained man for a particular task is that the heart of the trained man pumps more blood per minute with fewer strokes than does that of the untrained man.[5]

In a study by Bowen, it was pointed out that the pulse rate is valueless unless standardized according to the position of relaxation of subjects. Graphic records of the pulse rate during work on a bicycle, a foot power lathe, and tapping a morse key were made. It was found that the pulse rate was influenced by (1) the speed of exercise; (2) the effort of the exercise; (3) the physiological condition of the subject;

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[4] 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.

[5] C. R. Brassfield, "Some Physiological Aspects of Physical Fitness," Research Quarterly, 14:108-109, 1943.

(4) age; and (5) the posture and mental state of the subject.[6]

Gillespie, Gibson, and Murray did a study concerning the effects of exercise on pulse rate and blood pressure of college males. The work load was varied from zero to three kilograms on a convertible ergometer. The work was done with one or both arms for periods of three minutes to over eight hours. The rate of movement varied from sixty to 180 per minute and was controlled through the use of a metronome. The results in relation to the pulse rate were as follows:

1. There was a rapid primary rise in the pulse rate when exercise began.

2. A secondary but slower rise occurred which was greater or less according to the work load.

3. The difference in the rise of the pulse rate which occurred in accordance with work varying severity, were more apparent in the rapid primary rise than in the subsequent slow increases which occurred as work proceeded.

4. Only in the lightest loads did the pulse rate maintain a constant level.

5. The highest pulse attained increased with the load, but the relation was not, in the individual subject, strictly a linear one.

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[6]W. P. Bowen, "A Study of the Pulse Rate in Man as Modified by Muscular Work," Contributions to Medical Research, XXX 402, (1903).

6. The pulse rates of two subjects reached as high as 192 without immediate causation to stop the exercise.

7. Percentage increases in pulse rate was directly proportional to the rate of work.

8. Within certain limits, the pulse ratio was directly proportional to the rate of work.

9. When the load was decreased during exercise the pulse rate did not necessarily decrease.

10. When equal amounts of work were done in unit time the maximum pulse rate in one-half hour was fairly constant in the same individual.

11. There was no tendency on the part of the pulse to reach subnormal levels within fifteen minutes after the exercise whether heavy or light loads were used.

12. The pulse rate after exercise was higher when the rate of work was higher.[7]

A study was conducted by Sharkey and Holleman in which they tested the effects of six weeks of training exercise eliciting either 120, 150, or 180 heart rates. During the training period, male subjects participated in walking on a motor driven treadmill for ten minutes a day, three days per week. Adjustment of the grade of the treadmill was the method used to maintain the specific heart rate. The 150

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[7]R. D. Gillespie, C. R. Gibson, and D. S. Murray, "The Effects of Exercise on Pulse Rate and Blood Pressure," <u>Heart</u> 12:1, (1926).

group was found to be significantly different from the 120 group and control group in the Balke Test Analysis. Analysis of the group differences revealed that the 180 beats per minute training group's improvement was significantly different from all the other groups. Significant differences were found in the analysis of pre and post Balke Treadmill test scores. The Astrand-Rhyming monogram prediction of aerobic capacity also showed highly significant changes to training. This study supported the idea that intense activity is necessary to bring about the changes associated with cardiorespiratory endurance.[8]

A study by Falls and Richardson investigated the effects of three types of recovery procedure on (1) circulatory recovery from a standardized bicycle ergometer exercise, (2) performance in a second standardized bicycle ergometer exercise, and (3) circulatory recovery from the second exercise. The recovery procedures were complete rest, light activity, and cold showers. Each of ten college male subjects underwent each recovery procedure on separate days. It was found that a cold shower was a significantly more effective recovery method than either complete rest or light

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[8]Brian J. Sharkey and John P. Holleman, "Cardiorespiratory Adaptions to Training at Specified Intensities," Research Quarterly XXXVIII (December, 1967), 698-703.

exercise and that there was no significant difference between the latter two conditions.[9]

Cooper, in a study to determine the amount of exercise needed to bring about a training effect or improvement upon cardiovascular efficiency, said that:

> The key to the whole thing is oxygen. . . the body can store food but it can not store oxygen. . . It needs to replenish its supply constantly. . . this is what separates the fit from the unfit. Because in some bodies the means for delivering the oxygen is weak and limited in its resources, so the energy demands surpass the body's capacity to produce it.[10]

The following results were found when Henderson, Haggard, and Dalley compared fifty college male subjects of poor, moderate, and good capacity for athletic exertion:

1. The pulse rate in athletes tends to be much slower and the stroke volume significantly larger during rest and exercise than in non-athletes.

2. In "second wind" the pulse rate and respiration rate drop to lower levels as fatigue reaches critical limits the pulse rate rises.[11]

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[9] Harold B. Falls and Robert D. Richardson, "Comparison of Recovery Procedures for the Reduction of Exercise Stress," Research Quarterly, XXXVIII (December, 1967), 550-555.

[10] K. H. Cooper, Aerobics (M. Evans and Company, 1968), 9.

[11] Y. Henderson, H. W. Haggard, and F. S. Dalley, "The Efficiency of the Heart and the Significance of Rapid and Slow Rates," American Journal of Physiology, 82:513-514 (November, 1927).

II. STUDIES PERTAINING TO THE IMPROVEMENT OF CARDIOVASCULAR EFFICIENCY BY SWIMMING

McCurdy recognized that endurance is basic to the measurement of organic capacity. Furthermore, he contended that if one is able to run or swim more than the normal amount without a great deal of fatigue this can be used as a real criterion of condition.[12] According to Yates, the ability to swim the same stroke continuously for one-eighth of a mile shows a development of organic power. Also, if there is a value in endurance swimming as a conditioner, it can be justified in that it builds physical stamina by bringing the total body into action; increases the depth of respiration by increasing the oxygen intake capacity culminating in greater utilization of oxygen leading to better circulatory fitness and a decrease in oxygen demand as a result of trained muscles.[13]

Swimming, like running, is a contributing component upon the development of cardiovascular efficiency as Harrison

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[12] J. H. McCurdy and L. A. Larson, "Measurement of Organic Efficiency for the Prediction of Physical Condition," Supplement to the Research Quarterly of the American Association for Health, Physical Education and Recreation, 6:2:11-14, May, 1935.

[13] Fren Yates, "Why Stress Endurance Swimming?" Journal of American Association for Health, Physical Education and Recreation, 27:16,53, May, 1956.

indicated in a study which was designed to determine the effects of a swimming conditioning program on male students Harrison pointed out that moderate endurance swimming was not adequate to build muscular strength; however, it did significantly improve the circulatory and respiratory responses.[14]

In 1951, Nakamura conducted a study to determine the contribution of swimming to physical fitness of an adult male. In this study Nakamura was the experimental subject working with the training program of one hour a day, six days a week for ten weeks. Nakamura found that the training period was not long enough in terms of weeks, but he concluded that swimming and running contribute to cardiovascular efficiency. Nakamura described the training period consisting of numerous one hundred-yard sprints three days a week, and three days a week were spent in endurance swimming of one mile.[15]

Woods found evidence to indicate that endurance swimming does alter certain components of physical fitness for college women. Woods was of the opinion that endurance swimming had much value in the role of a rapid conditioner,

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[14] Aix B. Harrison, "Effects of a Swimming Conditioning Program on the Physical Fitness of Adult Man" (Unpublished Master's Thesis, University of Illinois, Urbana, 1951).

[15] Paul Nakamura, "Contributions of Swimming to the Physical Fitness of an Adult Male" (Unpublished Master's Thesis, University of Illinois, Urbana, 1949).

particularly if cardiovascular efficiency is considered to be of prime importance in physical fitness.[16]

Woods stated that:

> Many conditioners have been employed to develop fitness, but very little has been done in the area of swimming in the utilization of activity as a medium for physical conditioning. Many authorities have recognized the quality of endurance, whether in terms of organic capacity or motor fitness, as being a fundamental component of physical fitness.[17]

Bonar conducted a study to determine whether or not one semester of participation in a regular swimming class will aid in the development of physical efficiency in regard to the amount of increase in vital capacity due to swimming. One hundred and thirty-two college women subjects participated in the study. It was found that the subjects had improved in the Sargent Jump Test for functional efficiency and following the retest of vital capacity definite gains were apparent over the original tests.[18]

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[16] Marcella Darlene Woods, "The Effectiveness of an Endurance Swimming Program on the Physical Fitness of College Women as Related to Cardiovascular Condition, Physical and Motor Fitness," (Unpublished Master's Thesis, Greensboro Women's College, University of North Carolina, 1958).

[17] Ibid., p. 28.

[18] A. Bonar, "The Effects of Swimming Upon Vital Capacity of Women Students," (Unpublished Master's Thesis, University of Illinois, Urbana, 1932).

III. STUDIES ON THE DEVELOPMENT OF CARDIOVASCULAR EFFICIENCY BY RUNNING

Running has long been recognized as being greatly influential on the improvement of cardiovascular efficiency; on the other hand some controversy exists as to the effectiveness of isometric exercises upon cardiovascular efficiency.

Voltmer and Esslinger have indicated that during the junior high school years, the heart increases greatly in size and volume. This is accompanied by a decrease in endurance. They suggested that the program of physical activity for this group should include activities sufficiently strenuous to challenge but not overtax the circulatory system.[19]

Milton compared four methods of developing cardiovascular efficiency in 463 college males at Kansas State Teachers College, Emporia, Kansas. The Harvard Step Test was administered as the initial and post measure of cardiovascular efficiency to subjects who were assigned to four groups. All groups trained four days a week, for seven weeks. One group ran ten minutes; another group ran for twenty minutes; the third group ran for thirty minutes; and the

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[19] E. F. Voltmer and A. A. Esslinger, The Organization and Administration of Physical Education (New York: Appleton-Century Crofts, Inc., 1958), pp. 7 and 91.

remaining group performed isometric exercises. Comparison of the mean pulse recovery rates on the initial and final Harvard Step Test revealed the following:

1. All four programs produced significant cardiovascular improvement.

2. A comparison revealed that there were no significant differences among the three running groups, but that all three running groups were significantly superior to the isometric exercise group in cardiovascular improvement.

3. No evidence of regressive effects were 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 with the 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 both the thirty minutes running group and the isometric exercise group. No significant difference was found between the ten minute running group and the twenty minute running group, nor was a significant difference found between the thirty minute group and the isometric exercise group.

5. No significant differences were found among the four training programs in the effectiveness of improving cardiovascular efficiency of subjects of low initial cardiovascular efficiency.

6. Isometric exercises were significantly more effective in improving cardiovascular efficiency for subjects having low initial step test scores than for subjects of high initial cardiovascular efficiency.[20]

In a study concerning pulse recovery rates of high school males participating in a track program, Tuttle and Walker found a change in the recovery rates as a result of the comparison made of a pre-season and post-season stool stepping test. Furthermore, although the changes were insignificant, the authors found the improvement did occur because of fewer heart beats required to reach the pre-exercise resting level.[21]

Ikai, Hagaya, Yoshizawa, and Kagaga studied the physiological significance of endurance in distance and marathon runners. They found that the percentage of increase of the heart rate were more useful indexes of endurance than the value of the heart rate.[22]

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

[21]W. W. Tuttle and F. Walker, "The Effects of One Season of Training and Competition on the Response of the Hearts of High School Boys," Research Quarterly, 11:78-81, December, 1940.

[22]Michio Ikai, Hirohiko Kagaya, Shigehiro Yoshizawa, and Koya Jakagawa, "Physiological Significance of Endurance in Distance and Marathon Runners," The Journal of Sports Medicine and Physical Fitness, Vol. 6, No. 3, 1966, 158-162.

Bogard made a study on how much running is necessary to improve cardiovascular efficiency of college males. Bogard used 120 college males enrolled in physical education. The following training program involved motivational running for two, four, six, or eight minutes a day, four days a week, for six and one-half weeks. The Harvard Step Test was administered before and after the training program to measure cardiovascular efficiency. When the four training programs were compared, it was found that there were no significant differences in the gains among the four groups in the Harvard Step Test performance.[23]

At the University of Oregon, Bowles and Segiresth investigated the heart rate response of sixteen male subjects during rest and during differently paced one-mile running efforts. During the study each subject was equipped with a Sanborn-Cardiette Electrocardiograph that consisted of two electrodes and a transmeter. The subjects were tested during a one-mile run at a steady pace, at rest, during a one-mile run at fast-slow pace, during a one-mile run at a slow-fast pace, and during recovery. The results of the study indicated that:

1. At the start of the test run, the heart rate response to exercise was very rapid regardless of the pace pattern that followed.

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[23]W. G. Bogard, "The Effects of Four Running Programs on the Development of Cardiovascular Efficiency," (Unpublished Specialists Thesis, Kansas State Teachers College, Emporia, Kansas, 1967).

2. The exercise heart rate response was significantly higher in the slow-fast pace pattern but decreased in the steady pace and the fast-slow pace patterns.

3. There was no significant difference in the recovery heart rate response following any of the different pace patterns.[24]

A study was conducted by Bayer to determine the effects upon cardiovascular efficiency that results from programs of rope skipping and jogging. The Harvard Step Test was administered to ninety-two college males in order to determine their level of cardiovascular fitness. The subjects were then divided into two groups. One group skipped rope for ten minutes daily and the other jogged for thirty minutes daily. All groups trained for six weeks. Upon completion of the training program, the Harvard Step Test was readministered and comparisons were made of both tests. It was found that:

1. A daily ten-minute program of rope skipping significantly improved cardiovascular efficiency.

2. A thirty-minute jogging program significantly improved cardiovascular efficiency.

3. A ten-minute daily program of rope skipping was found to be as efficient as a particular thirty-minute

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[24]Charles J. Bowles and Peter O. Segiresth, "Telemetered Heart Rate Response to Pace Patterns in the One-Mile Run," Research Quarterly, XXXIX (March, 1968), 437-439.

jogging program for improving cardiovascular efficiency as measured by the Harvard Step Test.[25]

IV. STUDIES ON THE IMPROVEMENT OF CARDIOVASCULAR EFFICIENCY BY ISOMETRIC EXERCISES

Until recently, some authorities in the field of physical fitness found little, if any, cardiovascular development by using isometric exercises.[26,27] Life conducted a study in which four groups of college women were given initial and final physical fitness and cardiovascular efficiency tests. The subjects were assigned to four groups which included swimming, golf, swimming with additional supplementary isometric exercises, and golf plus isometric exercises. She found that intermediate swimming improves cardiovascular efficiency, but golf does not. However, intermediate swimming with additional supplementary isometric

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[25]John A. Baker, "Comparison of Rope Skipping and Jogging as Methods of Improving Cardiovascular Efficiency of College Males," Research Quarterly, XXXIX (May, 1968), 240-243.

[26]Thomas K. Cureton, "Putting Physical Fitness into Physical Education," Journal of the Canadian Association for Health, Physical Education, and Recreation, XXIX (October-November, 1962), 21-22.

[27]Franklin M. Henry and Frank L. Kleeberger, "The Validity of Pulse-Ratio Test of Cardiac Efficiency," Research Quarterly, IX (March, 1938), 32-46.

exercises and beginning golf with additional isometric exercises improve cardiovascular efficiency of college women.[28]

Hall investigated the changes that occurred in pulse-rate while exercises that involved isometric and isotonic muscle contractions were being performed. He compared the differences in pulse-rate changes for the two types of exercises. Hall used six male subjects enrolled in elementary weight-training at Iowa State University. The training included both isotonic and isometric contractions. The subjects were first restricted to isotonic contractions. The load was determined by having the subjects perform six isotonic contractions with the maximum weight they could lift. After a fifteen minute rest, the subjects performed isometric contractions using the same weight held halfway between the starting and finishing positions for the exercise. The subjects went through this routine once daily, for eight weeks. His findings were as follows:

1. Significant increases occurred between the heart-rate of the subjects at rest compared with the heart-rates of the subjects while performing isotonic or isometric contractions.

2. In both exercise programs significant differences were found between the mean increase in heart-rate.

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[28]Mary L. Life, "The Effects of Supplementary Exercises with Swimming and Golf on Selected Physiological Factors of College Women," (Unpublished Ph. D. dissertation, Louisiana State University, Baton Rouge, 1964).

3. For college men with little weight-training experience there was a greater increase in heart-rate when performing isotonic exercises then when performing isometric contractions.[29]

Recently, Bartels, Fox, Bowers, and Hiatt conducted a study on the effects of a ten-second isometric exercise, which involved large muscles upon heart-rate, blood pressure, and net oxygen cost. Six subjects exercised in a fixed position against a Medart spring dynamometer. Each subject pulled to sixty percent of his previously determined maximum effort. The following conclusions were found:

1. The heart-rate showed a slight increase during exercise.

2. The heart-rate showed a sharp rise in the few seconds following exercise.

3. Within twenty to thirty seconds, the heart-rate dropped almost to the resting level.[30]

Shavartz in a study of the effects of isotonic and isometric exercises on the heart-rate of twelve college male subjects found that (1) isometric and isotonic exercises

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[29]Floyd Lawrence Hall, "Heart-Rate Relative to Isometric and Isotonic Muscle Contractions," (Unpublished Master Thesis, State University of Iowa, 1962).

[30]Robert L. Bartels and others, "Effects of Isometric Work on Heart-Rate, Blood Pressure, and Net Oxygen Cost," Research Quarterly, XXXIX (October, 1968), 437-439.

performed with one-half maximum load can stimulate heart-rate equally; (2) increasing the isometric contraction load with results in a proportional increase in heart-rate; and (3) maximum tensions developed isometrically will result in an almost doubled increase in heart-rate.[31]

Royce found that in a strong isometric exercise, circulation is shut out by internal muscle pressure. He found these results by noting that a sixty percent contraction of a muscle's strength stopped blood flow to that muscle.[32]

V. SUMMARY OF RELATED LITERATURE

The three major categories under which the related literature was classified were: (1) exercise and pulse rate, (2) swimming, and (3) running and isometric exercises.

Eleven studies pertinent to exercise and pulse rate indicated that pulse rate depends on the varied work load and the type of activity performed. It was also established that cardiovascular efficiency is best measured by pulse rate in studies by Boothby and Cureton.

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[31]Essar Shavartz, "Effects of Isotonic and Isometric Exercise on Heart Rate," Research Quarterly, XXXVII (March, 1966), 121-125.

[32]Joseph Royce, "Isometric Fatigue Curves in Human Muscle with Normal and Occluded Circulation," Research Quarterly, XXIX (May, 1958), 204.

The second part of the review of literature was concerned with swimming as a method of improving cardiovascular efficiency. Most of the studies agreed that swimming does improve cardiovascular efficiency. This depended on the amount of swimming done. Endurance swimming was pointed out as being one of the best methods for reaching this goal, but moderate swimming will also improve cardiovascular efficiency to a certain degree stated McCurdy and Yates.

In the section on running and performing isometric exercises as methods of improving cardiovascular efficiency, the studies indicated that both methods do improve cardiovascular efficiency, but in some of the studies, the improvement was not highly significant. Also in more recent studies isometric exercises have been found to be a component of improving physical fitness according to Voltmer and Life.

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CHAPTER III

METHODS OF PROCEDURE

I. INTRODUCTION

It was the purpose of this study to investigate the significant improvement, if any, which an instructional swimming program would make upon cardiovascular efficiency of college males in comparison to an instructional swimming program with supplementary exercises. Specifically, this study attempted to ascertain the effectiveness of:

1. An instructional swimming program.

2. An instructional swimming program with an additional supplementary three-minute running in place exercise.

3. An instructional swimming program with an additional supplementary forty-second isometric exercises.

There were four sections of swimming classes which included Physical Education 140, beginning swimming, and Physical Education 240, intermediate swimming. All sections met twice weekly for thirty five minutes of daily instruction during the semester.

II. NATURE OF THE PROGRAM

The instructional swimming program was not required, but the students enrolled in these programs earned one hour credit towards partial fulfillment of the four hours of physical education required of all students. The swimming program is purely elective; consequently, in some cases a student can elect to take instruction in beginning swimming one semester and then intermediate swimming the following semester earning two hours toward the required hours needed for graduation.

The thirty-five minute swimming program for beginning swimming included adjusting to the water, an instructional period, and a practice session. For intermediate swimming, the program included the same procedure as in beginning swimming.

III. SUBJECTS

The subjects employed in this study were sixty-three male students at Kansas State Teachers College who were enrolled in elementary and intermediate swimming classes during the Spring Semester, 1969. The subjects were full time students and represented many of the departments in the college other than physical education.

IV. GROUPS

The four swimming classes consisted of a total of sixty-three subjects. In each of the four classes three groups were represented. The placement of subjects into three groups was accomplished by random selection. During the second meeting of each of the sections, the subjects were asked to reach into a box and select a card without looking into the box. The cards were numbered. The number represented the respective group that individual would belong to. After all the subjects had been given an opportunity to select a card, their name and number were entered into a list. The following list will show the specific additional supplementary exercises performed by each group and the number of subjects:

1. Group I, performed an additional supplementary running-in-place exercise for three minutes. This group consisted of twenty-one subjects.

2. Group II, performed two ten-second isometric contractions with their arms and two ten-second isometric contractions with their legs. The group was made up of twenty-one subjects.

3. Group III, did not participate in any type of additional supplementary exercise during the study. It consisted of the remaining twenty-one subjects.

V. EQUIPMENT AND FACILITIES

The equipment used in this study consisted of the following: (1) a bench fifteen feet long, eight inches wide, and eighteen inches high; (2) stop watches; (3) a tape recorder; and (4) two four-by-six cards for each subject.

The swimming pool was used for the instructional swimming program and the additional supplementary isometric exercises; while, the locker room was used for the running in place exercise. These facilities are on the ground floor of the gymnasium at Kansas State Teachers College.

VI. TESTING PROCEDURE

Subject Orientation. A week before the initial test was administered, two class periods were used for instruction and orientation to the study. During this time the procedures to be employed in administering the initial and final modified Harvard Step Test were explained and practiced. The subjects were divided into groups of threes. Two subjects from each group were directed to locate the radial artery of the third and count his pulse.

On the second meeting the subjects practiced counting pulse and were given an orientation in regard to the modified Harvard Step Test. They were instructed to meet in the baseball locker room, at the football stadium for the following class meeting. The subjects wore gym shorts, T shirts, and tennis shoes for the initial and final modified Harvard Step Test.

On the day of the initial step test, the subjects were asked to write their full name at the top of two four-by-six cards (see Appendix A, page 48). These cards were used for recording the pulse count after the stepping exercise. The subjects were then instructed to sit on benches, in the original three man teams, and locate the testees radial artery and count his pulse for thirty seconds. This was done to every subject before beginning the exercise so that the observers could practice counting pulse.

The modified Harvard Step Test. Upon completing the thirty-seconds pulse count, a tape recording was played. The recording reviewed the instructions for the stepping exercise and the procedures to be followed by the observers in counting the pulse and recording the results. The recorded voice then said, "Subjects stand up and face the bench." "Ready, Up Two, Three, Four," etc. The cadence was repeated for five minutes, thirty times per minute.

On the command "Up" the subjects stepped up on the bench with their right foot. On the command "Two" the subjects stepped up with the other foot and came to an erect position standing on the bench. On the command "Three" they stepped down with their right foot, and on the command "Four" they stepped down with their other foot. The command "Stop!

Sit down" was given at the end of the five minute period. The subjects sat down between the two observers who located his pulse. At the end of one minute the recording gave the command, "Prepare to start counting! Start." After thirty seconds the recording gave the command, "Stop counting and record." Two minutes after exercise, the recording repeated the commands. "Prepare to start counting! Start." After thirty seconds, the recording again gave the command "Stop counting and record." This procedure was repeated for the last time at three minutes after exercise. Then the pulse counts were added and recorded at the bottom of the card. The cards were then collected. The observers did not compare cards at any time. The same procedure was followed by all classes during the administration of the initial and final modified Harvard Step Test.

Several stop watches were available in case one of the subjects could not continue for the duration of the stepping exercise. If this occurred, the subject was to hold up his hand and continue for twenty seconds. At the end of twenty seconds, an assistant would start the stop watch and wait for one minute before counting pulse. None of the subjects stopped during the course of the exercise.

VII. TRAINING PROGRAM

The sixty-three subjects used in this study were divided into three groups by random selection. In each of the four classes, each group was assigned a student leader who was responsible for leading that group through the additional supplementary exercise before every class meeting.

The subjects in Group I performed a running-in-place exercise for three minutes. This exercise took place in the locker room adjacent to the swimming pool and the student leader was responsible for leading the exercise and keeping time.

Group II performed two ten-second isometric contractions with their arms. (See Appendix B, page 51) This was done in the standing position. The legs were spread and the hands were placed in front with the fingers hooked together. On the command "Start" the subjects performed the first isometric contraction. At the end of a ten-second contraction, the leader gave the command "Stop." At the end of ten seconds, the same exercise was repeated. Upon completion of the arm exercise, the subjects were told to sit down on benches and prepare to perform two ten-second isometric contractions with their legs. (See Appendix C, page 52) The subjects placed their right foot, with the right leg slightly extended, directly in front of them on the swimming pool deck. The members of Group III then sat on the foot of these subjects so that their back was turned to the subjects of exercising group. On the command "Start" the members of Group II attempted to lift the persons sitting on their right foot. At the end of ten seconds, the command "Stop" was given by the student leader. The sitters immediately changed to the subject's opposite foot. This procedure was repeated at the beginning of every class meeting for six weeks.

Group III did not participate in any supplementary exercise during the study. There was no objective way of knowing if the members of group III participated in exercise outside the study.

The investigator and swimming instructor supervised each group during the exercises, but the student leaders were given the responsibility of keeping time and leading the exercises.

VIII. STATISTICAL PROCEDURE

The data used for this study were gains made between initial and final scores on the modified Harvard Step Test. The statistical procedure computed for this study was the *t* test of significance between correlated means for all groups and analysis of variance to determine whether differences existed among the training groups on the final modified Harvard Step Test performance.

CHAPTER IV

ANALYSIS OF DATA

I. INTRODUCTION

The purpose of this study was to determine the effects of an instructional swimming program upon cardiovascular efficiency of college males in comparison to an instructional swimming program with supplementary running in place for three minutes and isometric exercises for forty seconds.

The gains between the initial and final test scores on the modified Harvard Step Test was the data used for this study. The statistical procedure computed for this study was the t test of significance between correlated means for all groups and analysis of variance to determine whether differences existed among the training groups on the final Harvard Step Test performance.

II. THE SIGNIFICANCE OF THE MEAN DIFFERENCE FOR EACH GROUP IN MODIFIED HARVARD STEP TEST PERFORMANCE

In testing for the significance of mean difference in the modified Harvard Step Test performance, t tests were computed comparing the means of the initial and final cardiovascular efficiency scores for each of the three groups. The difference method for small groups as suggested by Garrett was utilized.[33] These data are presented in Table I for all of the groups.

When subjected to computation on the 1401 IBM computer, Group I or the three-minute running in place group had an initial mean score of 180.38 and a final mean test score of 171.86 which resulted in the mean difference of 8.32. Further analysis and understanding of the significance of the difference between correlated mean was completed by the difference mean especially designed for small groups. The difference method resulted in a mean difference of 13.00 between the initial and final Harvard Step Test. (See Table I, page 34 for computed data) The standard error of the mean difference was a 3.85 which in turn resulted in a *t* of 3.37 with 20 degrees of freedom. To be significant at the .05 level a *t* of 2.09 was necessary while a 2.84 was required for significance at the .01 level of significance. With a *t* of 3.37 it can readily be noted that the running group did make significant improvement upon cardiovascular efficiency performance.

In order for groups two and three to reach significance a *t* of 2.09 was needed for the .05 level of probability, and a *t* of 2.84 was required to be significant at the .01 level. Group II resulted in a *t* of .067 with 20 degrees of freedom and Group III resulted in a *t* of 1.23 with 20 degrees of freedom; consequently, from Table I, page 34, it can be seen that no significant improvement was made by Groups two and three

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[33]Henry E. Garret, *Statistics in Psychology and Education* (New York: David McKay Company, Inc., 1962), p. 227.

TABLE I

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN INITIAL AND FINAL CARDIOVASCULAR EFFICIENCY SCORES FOR ALL GROUPS

Group	N	Initial Mean	Final Mean	Mean Diff.	SE Diff.	t	P
3 min. Running and Swimming	21	180.38	171.86	8.52	3.85	3.37	.01
40 sec. Isometrics and Swimming	21	184.47	180.55	3.92	2.95	.067	-
Swimming	21	180.71	175.50	5.21	3.24	1.23	-

t necessary: 2.09 for .05 level of probability
2.84 for .01 level of probability

upon cardiovascular efficiency. The significance of the difference between correlated mean for groups two and three was completed by the difference mean especially designed for small groups.

III. ANALYSIS OF VARIANCE

When there are more than two groups in the design of an experimental study and the investigator wishes to study the amount of variance existing with a given set of scores, analysis of variance is a method of analyzing the data.

For the purpose of this study analysis of variance was computed on the initial, final, and the differences of the Harvard Step Test scores for all groups. It can be noted on Table II, page 36 which shows the analysis of variance in full for the initial score the F test of .545 resulted which indicated that all groups were of similar standing, in so far as the Harvard Step Test scores are concerned at the initial stage of the study.

At the conclusion of the training period, the Harvard Step Test was again administered and the analysis of variance yield an F Test of 1.66. For a significance at the .05 level an F of 3.15 was needed and at the .01 level an F of 4.98 was required. Again this was a non-significant F which indicates that the difference between the groups was small in the final scores. This data is presented on Table III on page 37.

Table IV, page 38, illustrates in full the analysis of variance on the differences of the Harvard Step Test scores for all groups. An F of 3.15 with 2 degrees of freedom was needed at the .05 level and the .01 level required an F of 4.98. An F of .147 resulted however, indicating that all groups were similar and there were no significant differences in terms of improvement among the three group scores.

TABLE II

ANALYSIS OF VARIANCE
INITIAL HARVARD STEP TEST

Source	Sum of Squares	df	Mean Squares	F
Among groups	23869.90	2	11934.95	.545
Within groups	1311890.50	60	21864.84	
Total	1335760.40	62		

F necessary at .05 level, 3.15
at .01 level, 4.98

TABLE III

ANALYSIS OF VARIANCE
FINAL HARVARD STEP TEST

Source	Sum Squares	df	Mean Squares	F
Among groups	80001.300	2	40000.650	1.6576
Within groups	1447902.4	60	24131.7	
Total	1527903.7	62		

F necessary at .05 level, 3.15
at .01 level, 4.98

TABLE IV

ANALYSIS OF VARIANCE
DIFFERENCES BETWEEN INITIAL & FINAL
HARVARD STEP TEST OF ALL GROUPS

Source	Sum Squares	df	Mean Squares	F
Among Groups	58196.00	2	29098.000	1.47
Within Groups	1180292.29	60	19671.548	
Total	1238488.29	62		

F necessary at .05 level, 3.15
at .01 level, 4.98

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, COMMENTS, AND RECOMMENDATIONS

I. SUMMARY

It was the purpose of this study to investigate the significant improvement, if any, which an instructional swimming program will make upon cardiovascular efficiency of college males in comparison to an instructional swimming program with supplementary exercises. Specifically, this study did ascertain the effectiveness of:

1. An instructional swimming program.
2. An instructional swimming program with additional supplementary three-minute running in place exercise.
3. An instructional swimming program with additional supplementary forty-seconds of isometric exercises.

The subjects for this study were sixty-three college males enrolled in Physical Education 140, beginning swimming and Physical Education 240, intermediate swimming at Kansas State Teachers College.

All subjects were administered the Harvard Step Test during the first week of the study, which served as the initial measure of cardiovascular efficiency. The subjects were randomly divided into three groups: Group I performed a three minute running in place exercise; Group II performed four ten-second isometric contractions; and Group III did not participate in any type of training exercises. All groups participated in the instructional swimming program which met two days a week for thirty-five minutes. The subjects in Group I and II trained two days a week for six weeks. The additional supplementary exercises were performed at the beginning of every instructional period. At the end of the training period, the Harvard Step Test was again administered to all subjects.

The $\underline{t}$ test of significance between correlated means was used to evaluate mean difference between initial and final Harvard Step Test performance for all the groups. Analysis of variance was used to determine whether there were differences among the groups on the final modified Harvard Step Test performance.

II. FINDINGS

The findings of the study were as follows:

1. The only group that produced cardiovascular efficiency gains of 8.32 which was significant at the .01 level of significance was the three-minute running in place plus instructional swimming group.

2. The forty-second isometric contraction group and the group which had only the instructional swimming program did not make significant cardiovascular efficiency improvements.

3. There were no significant differences in the gains among the three groups in the Harvard Step Test performance.

III, CONCLUSIONS

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

1. An instructional swimming program that meets two days per week for fifty-minutes does not improve cardiovascular efficiency of college males.

2. Additional supplementary three-minute running may improve cardiovascular efficiency.

3. Isometric contractions performed for forty-seconds two days a week plus a swimming instructional program will not improve cardiovascular efficiency.

IV. COMMENTS

The subjects in this study were interested in improving their physical fitness and therefore cooperated in participating in the study. However, there was no objective way of determining maximum effort. There was a very low rate of absenteeism and absentees cooperated in making up their absences. Fewer absences occurred among the subjects in the seven thirty morning class. The subjects in the isometric exercise group seemed to be the most skillful swimmers and the most eager students.

V. RECOMMENDATIONS FOR FURTHER STUDY

As a result of the findings from this study the following recommendations are made for further study:

1. A study employing a similar experimental design, but for a period of eighteen weeks should be considered.

2. A similar study should be made involving additional supplementary running in place for three-minutes using female students enrolled in physical education at Kansas State Teachers College.

3. A study that would compare the development of cardiovascular efficiency by several activities that meet one hour a day two days a week for a period of twelve weeks should be conducted.

4. A study employing the same experimental design but conducted at the high school level using subjects of high initial cardiovascular efficiency should be conducted.

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BIBLIOGRAPHY

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APPENDIXES

APPENDIX A

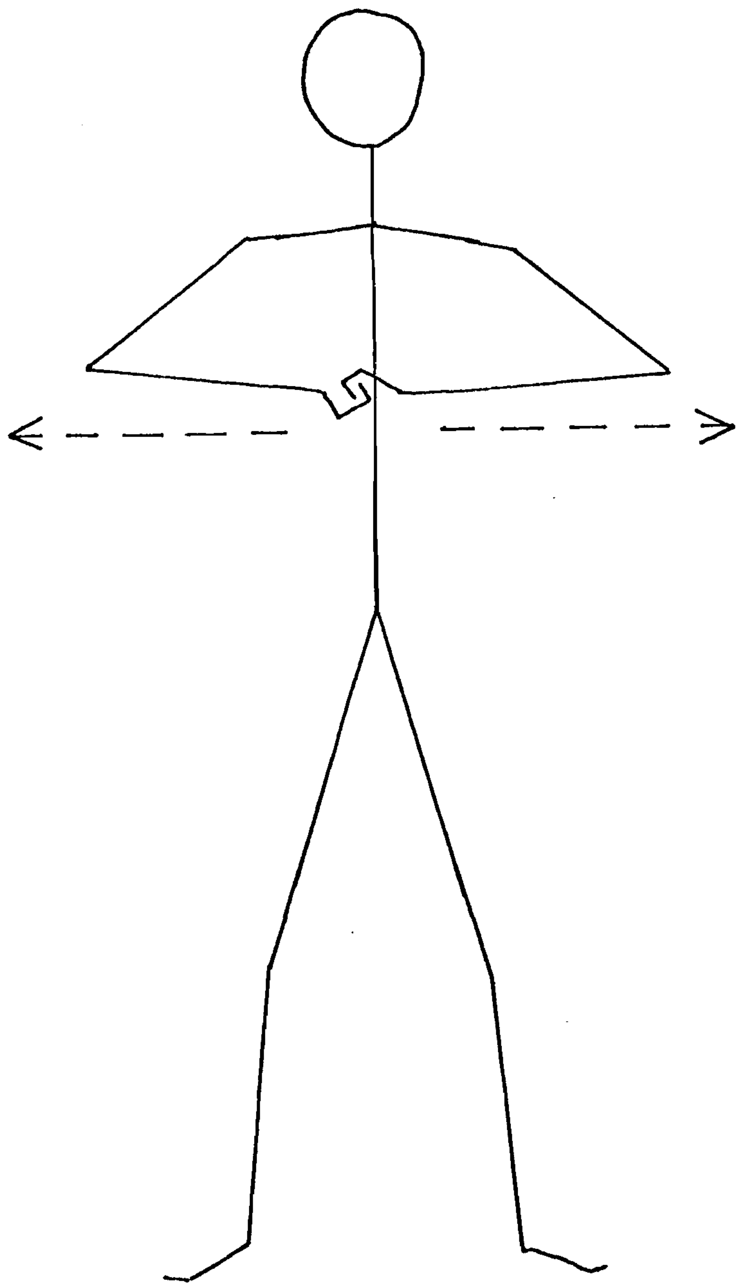
HARVARD STEP TEST RECORD CARD

Last Name	First Name	Group & Sub Group

First H. S. T.	Second H. S. T.
1 min.________	________
2 min.________	________
3 min.________	________
Totals________	________

APPENDIX B

ARM ISOMETRIC CONTRACTION



APPENDIX C

LEG ISOMETRIC CONTRACTION