THE EFFECTS OF THREE MAXIMAL EFFORT RUNNING PROGRAMS ON THE CARDIOVASCULAR EFFICIENCY OF JUNIOR HIGH SCHOOL BOYS

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by

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THE PROBLEM AND DEFINITION OF TERMS

I. INTRODUCTION

The physical fitness of youth has been a critical issue in the profession of physical education since 1950 and has been maintaining a strong hold upon public attention for many reasons. One recognized variable of physical fitness involves cardio-respiratory endurance. This variable has particularly long lasting effects upon man's state of health and happiness. A variety of ideas and techniques for the improvement and maintenance of "physical fitness" programs have been developed. Most physical fitness programs require considerable amounts of time. Therefore, the physical educator must decide whether the student's needs are best met by the inclusion of a specific physical training program within the daily instructional plan or rely on the daily instructional program to be sufficiently strenuous to provide for the basic physical fitness needs of the students.

II. THE PROBLEM

Statement of the problem. The purpose of this study was to determine the effects of three programs of maximal effort running on the cardiovascular efficiency of junior high school males. Specifically:

1. Can motivated running programs of thirty seconds, forty-five seconds or sixty seconds plus the regular physical education program significantly improve the cardiovascular efficiency of junior high school males.

2. Can a program of motivated running for thirty seconds, forty-five seconds or sixty seconds without a regular physical education program significantly improve the cardiovascular efficiency of junior high school males.

3. Is one of the three maximal effort running programs significantly superior in the improvement of cardiovascular efficiency of junior high school males.

Importance of the study. The matter of endurance in relation to the ability to perform becomes critical with the junior high school male. Peer group approval becomes very important. The physiological characteristics of rapid growth, great increase in strength and a resulting decrease in endurance underscore the need for assurance, within the physical education program, for cardiovascular development. The objective of providing a wide range of experiences for junior high school males puts a premium upon time for instruction. Since this is a critical period of growth and development of the cardiovascular system it becomes especially important to establish the usefulness of an activity which will significantly contribute to the cardiovascular efficiency and also meet the need for conserving time.

III. LIMITATIONS OF THE STUDY

The subjects for this study were eighty-one male students who were enrolled in Holliday Junior High School, Topeka, Kansas. Sixty-seven were enrolled in regularly scheduled physical education classes. Fourteen were not enrolled in physical education. None of the subjects was participating in the spring athletic programs.

The study does not attempt to evaluate the effect of other school activities or activities outside of the school in which the subject may have been involved. Other factors such as diet and sleeping habits were beyond the control of the investigator.

The period of training was limited to six weeks during the spring of 1968. There is no objective method for determining whether each subject exerted maximal effort throughout each training period. A variety of climatic conditions existed during the training period which could have been an influencing factor.

A modified version of the Harvard Step Test was used as the measure of cardiovascular efficiency. This method was chosen for the following reasons:

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

2. When time and trained assistants are at a premium, large groups may be tested by teaching the subjects to assist with the pulse counting.

IV. DEFINITIONS OF TERMS

Cardiovascular efficiency. In this study cardiovascular efficiency will refer to the speed or time it takes the heart to return to the original pulse rate after exercise.

Shuttle run. The shuttle run, for this study, was the act of running a straight line from a starting line to an end line, pivoting, returning to the starting line, pivoting and repeating the process as often as possible during the time alloted. The distance between the starting line and the end line, on the course laid out for the shuttle run, was sixty feet.

CHAPTER II

REVIEW OF LITERATURE

The review of the literature will indicate the findings of research pertinent to (1) the response of the hearts of youth to strenuous exercise; (2) the development of cardiovascular efficiency resulting from running programs; and (3) the development of cardiovascular efficiency as a result of various other training methods.

I. THE RESPONSE OF THE HEARTS OF YOUTH TO STRENUOUS EXERCISE

For one to adequately evaluate the studies related to cardiovascular efficiency of youth reference must be made to the studies which relate the response of the heart to strenuous exercise.

Gillespie, Gibson, and Murray studied the effects of exercise on the pulse rate and blood pressure. The work load was varied from 0 to 3 kilograms on a convertible ergometer. The rate of movements varied from 60 to 180 per minute and was controlled through the use of a metronome. The work was done with one or both arms for a period of from three minutes to over eight hours. The following results represent the essential parts of their experimental findings relating to pulse rate.

> 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 increases with the load, but the relation is not, in the individual subject, strictly a linear one.

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 work rate in submaximal exercise.

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 correspondingly.

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.[1]

Larson studied cardio-respiratory functions in relation to physical fitness. His findings supported the findings of Gillespie but included other factors which also influence pulse rate. He states:

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[1]R.D. Gillespie, C.R. Gibson, and D.S. Murray, "The Effects of Exercise on Pulse Rate and Blood Pressure," Heart. 12:1, 1926.

Factors influencing the normal pulse rate other than exercise are; age, sex, diurnal changes, season and climate, attitude, air and water movements, loss of sleep, respiration, metabolic activity, changes in body posture, digestion and emotional factors.[2]

Brassfield, in reference to the hearts of athletes in training as opposed to the hearts of men of sedentary habits, 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.[3]

McAdam investigated the effects of physical training on reducing peripheral resistance. The following conclusions were indicated:

> 1. The peripheral resistance in either the resting or post-exercise state, or in both, is reduced in some people during a long physical training program.
>
> 2. When the peripheral resistance is reduced during training, the reduction may be a reflection of lower blood pressure, of increased stroke volume or a combination of these.
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> 3. The investigation has, in no way, resulted in conclusive proof that physical training can reduce peripheral resistance in all people. But it has shown that in some people there is a trend toward peripheral resistance reduction with participation

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[2] L.A. Larson, "Cardiovascular-Respiratory Functions in Relation to Physical Fitness," Research Quarterly, 12:458, 1941.

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

in a physical training program.[4]

The ability to recover from and to resist fatigue appears to be a result of physical training. Bucher relates that with the exception of the influences of heredity and nutritive environment "the organic system of the body can be developed only through muscular activity."[5] The effects of a training program upon the various systems are summarized by Bucher as follows:

> Through vigorous muscular activity several beneficial results take place. The trained heart provides better nourishment to the body. The trained heart beats slower than the untrained and pumps more blood per stroke with the result 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.[6]

Studies in the Harvard Fatigue Laboratory have shown that physical fitness for hard work can be measured if certain physiological reactions of the subjects to hard work are known. Brouha states:

> A satisfactory estimate of a man's fitness can be obtained by exposing him to a standard exercise that no one can perform at a "steady state" for more than a few minutes and taking into account two factors: the length of time he can sustain it and the deceleration of his heart rate after exercise. For this purpose any type of exercise can be used provided that each subject works at a constant rate proportional to his body weight, that the exercise requires no unusual skill, and that the exercise puts the cardiovascular and respiratory systems under real stress by

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[4]R.E. McAdam, "An Investigation of the Effects of Physical Training on Cardiovascular Components in the Adult Male." (Unpublished Doctoral dissertation, University of Illinois, Urbana, Illinois, 1955.)

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

[6]Ibid., p. 145.

involving large muscle groups.[7]

Using the Harvard Step Test and a weight lifting procedure, Bouha, Fradd and Savage undertook a physical efficiency study of 2,167 students enrolled at Harvard University in 1942. The purpose of the study was to determine the status of physical efficiency of the various student groups and the effect of physical education or special training programs upon the physical efficiency of the various student groups. The findings from the study provided the following conclusions:

> 1. The fitness index, earned by means of the Harvard Step Test technique, gives a suitable indication of the physical efficiency of young men because, among other reasons, it improves under regular training and declines when training is insufficient or wanting.
>
> 2. Among young men who are medically fit, wide differences in physical efficiency occurred in the spread of fitness scores: the average index is higher and the spread of scores is smaller among men who regularly engage in various forms of muscular activity; the highest indices are obtained by athletes in training, whose actual performance proves their fitness.
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> 3. Under the conditions of the Harvard College training program, the majority of the freshmen scoring at college average (75) or under when they entered, improved their fitness under training. Among the students whose scores classified them as good or excellent at the time of their first test, the tendency was for them to show a poorer score on their second test two or three months later.
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> 4. This last finding indicates that the training program was adequate for the "unfit" but too easy for the already"fit."
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> 5. More satisfactory results were obtained when students scoring below average were subjected to a compulsory conditioning program, and those scoring above average were free to choose

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[7]Lucien Brouha, "The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," Research Quarterly, 14:31-35, March, 1943.

their own form of compulsory athletics.

> 6. Each man has a maximum efficiency which he can develop through regular and adequate training: but no matter how hard and assiduous the training, superior scores can only be attained by men who constitutionally possess the potential physical efficiency.[8]

In relation to the pulse rate recovery from strenuous exercise as a measure of physical fitness, Cureton states that:

> One of the most acceptable tests of circulatory respiratory fitness is the 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 the return to normal approximately parallels the circulatory-respiratory efficiency to buffer the fatigue products in the blood after exercise and to restore normality.[9]

Cooper, in a most comprehensive study to determine the amount of exercise needed to bring about a training effect or improved cardiovascular efficiency, states that:

> The key to the whole thing is oxygen . . . the body can store food but it can't 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]

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[8]Lucien Brouha, N.W. Fradd and B.M. Savage, "Studies in Physical Efficiency of College Students," Research Quarterly, 15: 211-224, 1944.

[9]T.K. Cureton, "Putting Physical Fitness into Physical Education," Journal of the Canadian Assoc. for Health, Physical Education and Recreation, XXIX, p.21, Oct.-Nov., 1962.

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

The physiological characteristics and functions of the heart of youth needs to be known if one is to adequately interpret data collected by the step test method. Voltmer and Esslinger say that during the junior high school years the heart increases greatly in size and volume and endurance is reduced; and suggest that the program of physical activity for this age group should include activities sufficiently strenuous to challenge but not overtax the circulatory system.[11]

Several studies have been conducted specifically to throw light upon the strength or weakness of the heart of youth. The purpose of a study by Shirley was to determine whether or not the child's heart responds to exercise in a manner comparable to the normal adult heart. The stool stepping technique was used to test thirty-four boys and girls between the ages of nine and eleven. The sex difference was disregarded. Within the limits of the study the following conclusions were drawn:

> 1. The response of the normal prepubescent hearts to exercise of graded intensity is directly proportional to the severity of the exercise and the relationship is rectilinear.
>
> 2. The normal prepubescent heart responds to exercise of graded intensity in a manner exactly like that of the normal adult heart.[12]

Karpovich traced the origins of the idea that the child's heart was proportionally weak compared to the body size. He concluded:

> 1. Contrary to an established notion, there is no discrepancy

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[11] 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.

[12] M.J. Shirley, "Response of the Normal Prepubescent Heart to Exercise of Graded Intensity," Research Quarterly, 6:104-112, October, 1935.

between the development of the heart and the cross section of the largest arteries.

2. The heart volume and the cross section of the aorta and the pulmonary artery show a close proportionality.

3. The ratio of heart volume to the size of the blood vessel is not decreased at the age of seven. There is a steady gradual increase in this ratio which starts at the end of the first year.

4. Hygienic warnings based upon erroneous interpretations should be discarded.[13]

An excellent study was conducted by Braun to determine the heart rate reaction of elementary school children to exercise under conditions such as they are found in the elementary school. He used the method of exercise involving a stool stepping technique similar to that used in the Tuttle Pulse Ratio Test. Seventy-nine boys and a like number of girls ranging in age from nine to twelve were tested. The results give evidence for the following conclusions:

1. Heart rate tests in pre-pubertal children are reliable.

2. Children aged nine to twelve show no greater increased heart rate from recumbent to standing position than do adults.

3. Negative phase following exercise was present in sixty-five per cent of the cases. Other authors have shown the same thing to be true in adults.

4. Children show a rectilinear relationship between amount of exercise and increase in pulse rate.

5. Girls show a slightly higher pulse rate than do boys of the same age.

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[13]Peter V. Karpovich, "Textbook Fallacies Regarding the Development of the Child's Heart," Research Quarterly, 18:33-37, October, 1937.

6. In most cases the pulse rate returned to resting level or slightly below within a minute after exercise.[14]

Using the McCurdy-Larson Organic Efficiency Test, Dane's study proposed to determine, within the physiological age grouping of boys, whether there are changes in the various respiratory-circulatory variables; and if changes were found to determine whether they are significant. The study was limited to junior and senior high school boys classified into pre-pubescent, pubescent, and post pubescent periods. It included the chronological age range from ten and one-half to seventen and one-half years. The results of the study indicated the following conclusions:

1. A gradual change takes place in the physiological variables as age increases from pre-pubescent to post pubescent.

2. The least change is noticed between the pre-pubescents and the pubescents and the greatest change between the pre-pubescents and the post pubescents.

3. The post pubescents are highly superior and the pre-pubescent boys are the least efficient in circulatory-respiratory functions.

4. The physiological ages are significantly different and each needs a scoring table by which to calculate the circulatory-respiratory efficiency of a boy according to his growth status.[15]

Gallagher, Roswell and Brouha, in their study to modify the Harvard Step Test to establish norms for boys, state that:

Physical fitness, by which we mean the ability to perform hard

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[14] G.L. Braun, "Pulse-Rate of Children to Graded Exercise," Research Quarterly, 13:79-85, March, 1942.

[15] W.C. Dane, "A Study of Circulatory-Respiratory Changes as Indicated by the McCurdy-Larson Organic Efficiency Test in Relation to Physiological Age," Research Quarterly, 15:98, May, 1944.

> work in an efficient manner . . . cannot be evaluated by observing or testing a boy at rest; it demands that the boy be observed at work . . .; it should be a test of his dynamic state when he is hitting on all cylinders. Fitness as measured by this test is the general capacity of the body to adapt itself to hard work and recover from what it has done.[16]

The purpose of Doroschuk's study in 1962 was to determine what factors were involved in endurance performance and in what amounts. The activities subjected to measurement were the six hundred yard run and the all out treadmill run. The subjects were forty-nine ten to fourteen year old boys enrolled in the University of Illinois Sports Fitness Summer Day School. All the subjects had previous experience with treadmill running. Among the conclusions, the best individual test of both the six hundred yard run and the all out treadmill run was gross oxygen intake.[17]

II. STUDIES PERTAINING TO THE DEVELOPMENT OF CARDIOVASCULAR EFFICIENCY BY RUNNING PROGRAMS

Running, as a part of the training program for athletes, is generally accepted as a method of improving cardiovascular efficiency. Tuttle and Walker investigated the effects of a season of training for track on the hearts of high school boys. Step tests were administered

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[16] R.J. Gallagher, J. Roswell and L. Brouha, "A Simple Method of Testing Physical Fitness of Boys," Research Quarterly, 14:23-30, March, 1943.

[17] E.V. Doroschuk, "The Relationship of Metabolic, Cardiovascular, and Motor Fitness Tests with Endurance Running of Young Boys," (Unpublished Doctoral dissertation, University of Illinois, 1962).

before the season, at mid-season, and at the completion of the season. They found that there were no significant changes in the resting heart rate, the pulse rate immediately following exercise, the rate above the resting rate after exercise, and the primary recovery time, and the recovery time. The recovery pulse was less after the season. This indicated an improvement in physical condition. Whenever the data showed trends toward altered cardiac responses it was always in favor of more efficient heart action.[18]

Cunningham conducted a study to determine the extent to which selected cardiovascular and strength measures differentiate the physical fitness of trained athletes. Track was selected as the field of experimentation and the events included were the sprints, middle and long distance runs. The subjects were male athletes between nineteen and twenty-eight years of age who were outstanding track performers, including many world champions. The results of the study indicate the following:

1. Pulse rate, breath-holding after exercise, and pulse recovery after exercise best differentiate extreme physical fitness of trained athletes. The data are inconclusive to determine the degree of the relationship.

2. The best combination of measures to differentiate extreme physical fitness of trained athletes as indicated by performance is initial pulse rate and pulse recovery after exercise. Middle and long distance runners exhibited low pulse rate and relatively slow recovery.

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[18] 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.

3. Breath holding was somewhat related to performance in distance running.

4. Right and left hand grip did not show a high degree of relationship to any of the events.[19]

A similar study by Adams was undertaken to determine the effects of a season of track and field training and competition on several physical fitness measures that have been shown to be significantly different in athletes as compared to non-athletes. The study also sought to determine if there were any differences in training effects among various groupings of the team according to the different patterns of training pursued, i.e. distance runners, 440 yard runners and intermediate hurdlers, sprinters and high hurdlers, jumpers, and throwers. Skinfold measurements, vital capacity, maximum breathing capacity and pulse recovery counts after a five minutes bench step test were taken on thirty-three members of a varsity track and field team before, in the middle, and at the end of a season of training and competition. Analysis of the data yielded the following conclusions:

1. There was no significant difference in body weight, several girth measurements, estimated body density, vital capacity, and maximum breathing capacity as a result of three months of training and competition for college track and field.

2. A significant reduction in post bench-step pulse recovery counts was noted, while no significant reduction in resting or post bench-step terminal heart rate was observed.

3. In no instance were significant differences observed between parameters measured at midseason and at the end of the season.

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[19] Glen Cunningham, "The Relation of Selected Cardiovascular and Strength Measures to Physical Fitness of Outstanding Athletes," (Unpublished Doctoral dissertation, New York University, 1938).

4. The distance runners group was the only team subgroup to show significant reduction in step test recovery pulse rate.

5. The throwers' group differed materially from the other team subgroups in virtually all parameters.[20]

The frequency of running necessary to effect improvement in cardiovascular efficiency has been explored by several investigators. Zigler tested fifteen major and graduate students enrolled in the College of Physical Education and Athletics at the Pennsylvania State University. The purpose of the study was to determine the effects of maximum performance bouts, of stationary bicycle riding at a set tension and rate of speed; once a week, twice a week and three times a week respectively, upon the development of endurance. The basic weakness of the study was the inability to determine objectively whether each subject had persisted to an ultimate performance level during each training period. Within the limitations of the study it was concluded that all out bouts of exercise, once, twice, or three times per week produce a significant increase in endurance. All out bouts of exercise two times per week seem to achieve a greater percent of increase between pre-test and the post test. However, the differences among the groups on the post test were insignificant.[21]

Obrien tested the effects of frequency of running on the cardiovascular conditioning of two matched groups of subjects. They trained

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[20] W.C. Adams, "Effects of a Season of Varsity Track and Field on Selected Anthropometric, Circulatory and Pulmonary Function Parameters," Research Quarterly, 39:5-15, March, 1968.

[21] R.G. Zigler, "The Frequency of Maximum Effort Most Favorable for Development of Endurance in College Students," (Unpublished Masters thesis, Pennsylvania State University, University Park, 1960).

for seven weeks by interval training methods of running. One group trained four times a week while the other group trained twice weekly. Comparison of pre and post training test scores indicated that training either two or four times per week produces significant improvement in vital capacity, 880 and 220 yard running times, and the Harvard Step Test index. Training four times weekly produces greater improvement in cardiovascular responses to exercise. No significant differences were found between the groups before or after training. It was concluded that within the limits of the study, training twice a week is just as beneficial as four times per week for cardiovascular conditioning over a seven week period.[22]

The purpose of a study by Jackson, Sharkey and Johnston was to compare the effects of various training frequencies on the level of cardiovascular endurance in college men. The subjects were twenty undergraduates from the University of Montana's Physical Education service program. Improvement was measured by pre and post administration of the Balke Treadmill Test, the Astrand-Rhyming Test of physical fitness, the Buskirk and Henschel Test of maximal oxygen intake and by maintaining a record of the number of training sessions completed. The training consisted of treadmill running at seven miles per hour for ten minutes. The grade of the treadmill was elevated when a subject was able to complete a previous day's training. Four training groups trained either one, two, three, or five days a week. The control group

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[22] R.F. Obrien, "The Effects of Frequency of Training on Cardiovascular Conditioning," (Unpublished Doctoral dissertation, Ohio State University, 1967).

participated in a volleyball program that met three times per week.

The Balke Test indicated significantly greater improvement for those in the five day group. The other methods of measurement favored either the two or three day groups. It seems that training two or three times a week may have been as beneficial as the five day program. The investigators indicate that the four methods used to assess improvement provided somewhat ambiguous results and suggest that future studies in this area would benefit by allowing separate analysis of those in various stages of cardiovascular endurance.[23]

Several investigators have been concerned about the amount of running necessary to effect a gain in cardiovascular efficiency. Cooper states that:

> If the exercise is vigorous enough to produce a sustained heart rate of 150 beats per minute or more, the training-effect benefits begin about five minutes after the exercise starts and continue as long as the exercise is performed. If the exercise is not vigorous enough to produce or sustain a heart rate of 150 beats per minute, but is still demanding oxygen, the exercise must be continued considerably longer than five minutes, the total period of time depending on the oxygen consumed.[24]

A study by Sharkey and Holleman at the University of Montana tested the effects of six weeks of training exercise eliciting either 120, 150 or 180 heart rates. The training consisted of walking on a motor driven treadmill for ten minutes a day, three days a week.

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[23] J.H. Jackson, B.J. Sharkey, and L.P. Johnson, "Cardio-respiratory Adaptations to Training at Specified Frequencies," Research Quarterly, 39:295-299, May, 1968.

[24] Cooper, *op. cit.*, p. 23.

Adjustment of the grade of the treadmill was the method used to maintain the specific heart rate. Highly 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. Analysis of the group differences revealed that the 180 training group's improvement was significantly different from all the other groups in both tests. The 150 group was found to be significantly different from the 120 group and control group in the Balke Test analysis. The study supports the idea that intense activity is necessary to bring about the changes associated with cardio-respiratory endurance.[25]

Hilton found that a program of progressive jogging would significantly improve cario-respiratory functions in married women.[26]

Milton compared four methods of developing cardiovascular efficiency in 463 college males at Kansas State Teachers College, Emporia, Kansas. The subjects were administered the Harvard Step Test as the initial measure of cardiovascular efficiency and were assigned to four training groups. Each session group one ran ten minutes; group two ran twenty minutes; group three ran thirty minutes; and group four engaged in isometric exercises. All groups trained four days a week for

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[25] B.J. Sharkey and J.P. Holleman, "Cardiorespiratory Adaptations to Training at Specified Intensities," Research Quarterly, 38:698-703, December, 1967.

[26] S.L. Hilton, "Cardiovascular and Respiratory Changes in Married Women after a Twelve Week Program of Progressive Jogging," (Unpublished Masters thesis, University of Oregon, Eugene, Oregon, 1966).

seven weeks, after which a second Harvard Step Test was administered. Comparison of the mean pulse recovery rates on the initial and final Harvard Step Test revealed the following:

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 improvement.

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 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 the thirty minute 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.[27]

Bogard's study represents an attempt to further answer the question of how much running is necessary to improve cardiovascular

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

efficiency in college males. The study compared the effects of motivational running two, four, six, or eight minutes a day, four days a week, for six and one-half weeks on the improvement of cardiovascular efficiency of 120 college males enrolled in required physical education at Kansas State Teachers College, Emporia, Kansas. The subjects were administered an initial and post training Harvard Step Test as the measure of cardiovascular efficiency. The findings of the study were as follows:

> 1. The only group that produced significant cardiovascular efficiency gains was the two minute running group.
>
> 2. The eight minute running group produced a significant gain. None of the other training programs produced significant cardiovascular efficiency gains.
>
> 3. 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.[28]

III. STUDIES RELATED TO THE DEVELOPMENT OF CARDIOVASCULAR EFFICIENCY BY VARIOUS OTHER TRAINING METHODS

Investigators have tested the effect of a variety of training and activity programs to determine their effect on the development of cardiovascular efficiency.

Maxwell, Hodgson, and Sorenson equated two groups of subjects

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[28] W.G. Bogard, "The Effects of Four Running Programs on the Development of Cardiovascular Efficiency," (Unpublished thesis for the Degree Specialist in Education, Kansas State Teachers College, Emporia, Kansas, 1967).

on the basis of the modified Harvard Step Test. The experimental group participated in circuit training twice a week for four weeks. The control group took part in the regular service program consisting of badminton and volleyball. At the conclusion of the experimental period, all subjects were retested. The experimental group showed a statistically significant improvement over the four week period. The control group did not show a significant gain. The final test between the groups did not show a significant difference.[29]

Woods[30] at the University of North Carolina and Mowrer[31] at the University of California found that endurance swimming would significantly improve cardiovascular efficiency in college women. Mowrer also found that the group in the regular intermediate swimming instruction class significantly improved in cardiovascular efficiency.

Mary Life studied the effects of supplementary isometric exercises with swimming and golf on muscular strength, physical fitness and cardiovascular efficiency of college women. Four groups of college women enrolled in physical education basic skills classes were given initial and final physical fitness and cardiovascular

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[29] L.H. Maxwell, J.L. Hodgson, and T.J. Sorenson, "Effects of Circuit Training on the Modified Harvard Step Test," Research Quarterly, p. 154, May, 1963.

[30] M. 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 Masters of Education thesis, Women's College, University of North Carolina, Greensboro, 1958).

[31] N.J. Mowrer, "Some Effects of Distance Swimming Upon Selected Fitness Measures," (Unpublished Masters thesis, University of California, Berkley, 1962).

efficiency tests. The designation of the groups were swimming, golf, swimming with isometric exercises, and golf with isometric exercises. All groups showed significant improvement in physical fitness index. Cardiovascular efficiency was improved significantly by groups participating in swimming without isometrics, swimming with isometric exercise and golf with isometric exercise. Golf, as taught in the program did not improve cardiovascular efficiency.[32]

Alexander investigated the effects of a four week program of training and resistive exercises on certain measures of strength, endurance and cardiovascular fitness. The experimental group engaged in a prescribed program of resistive exercises, using a device similar to the Exer-Genie, in addition to Karate class workouts. The control group participated only in the Karate class. Both groups displayed small gains in cardiovascular fitness as measured by the Balke-Ware Treadmill Test.[33]

The purpose of one investigation by Waddle was to compare the effectiveness of a training program utilizing the Exer-Genie with that of training programs using isotonic and isometric exercises on the development of muscle strength and cardiovascular endurance among

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

[33] J.F. Alexander, S.L. Martin, and K. Metz, "Effects of a Four Week Training Program on Certain Physical Fitness Components of Conditioned Male University Students," Research Quarterly, 39: 16-24, March, 1968.

college men. The subjects were eighty-four male students from the required physical education classes at Florida State University. They participated in the training programs three days per week for eight weeks. Cardiovascular endurance was measured by using the Harvard Step Test with a seventeen inch bench. The results showed that there were significant differences between the pre and post training test for cardiovascular endurance resulting from the eight week training program using the Exer-Genie, isotonics exercises, and isometric exercises. There were no significant differences between cardiovascular endurance resulting from the three training programs.[34]

Shires found that wrestling and soccer contributed significantly to improvement in cardiovascular endurance. Neither sport appeared superior to the other.[35]

Baker's study indicated that a daily ten minute program of rope skipping or a thirty minute program of jogging will significantly improve the cardiovascular efficiency of male college students. He concluded that the ten minute program of rope skipping was just as efficient as a particular thirty minute daily program of jogging for improving cardiovascular efficiency as measured by the Harvard

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[34]B. Waddle, "A Study Comparing the Effectiveness of a Training Program Utilizing the Exer-Genie with Two Conventional Training Programs on the Development of Muscle Strength and Cardiovascular Endurance," (Unpublished Doctoral dissertation, Florida State University, 1967).

[35]T.E. Shires, "A Comparative Study of Wrestling and Soccer with Regard to Physical Fitness and Cardiovascular Endurance," (Unpublished Masters thesis, University of Florida, 1963).

Step Test.[36]

IV. SUMMARY OF THE REVIEW OF LITERATURE

The three categories under which the related literature was classified were: (1) the response of the hearts of youth to strenuous exercise; (2) studies pertaining to the development of cardiovascular efficiency by running programs; and (3) studies related to the development of cardiovascular efficiency by various other training methods.

The literature relative to the reaction of the normal heart to strenuous exercise indicates the following:

1. The heart responds with a rapid primary rise as exercise begins. There is a second and slower rise which appears to be directly proportional to work rate in submaximal exercise.

2. The trained heart increases about as many beats for a given load as the untrained heart but it has the advantage of starting at a lower rate.

3. During exercise, the trained heart pumps more blood per minute and has longer rest periods between beats.

4. After exercise, the trained heart returns to normal quicker than the untrained heart.

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[36] J.A. Baker, "Comparison of Rope Skipping and Jogging as Methods of Improving Cardiovascular Efficiency of College Men," Research Quarterly, 39:240-243, May, 1968.

5. A gain in cardiovascular efficiency will occur only when the exercise is sufficient to place the cardiorespiratory system under a condition of stress or a demand for oxygen.

6. The best measures of cardiovascular efficiency appear to be gross oxygen intake and pulse rate recovery after strenuous standard exercise.

7. The normal hearts of youth respond to exercise of graded intensity in a manner exactly like that of the normal adult heart.

8. A gradual change takes place in the physiological functions as age increases from pre-pubescent to post pubescent. The cardio-respiratory functions of the post pubescent boys are highly superior and the pre-pubescent boys are the least efficient.

9. Heart rate tests for youth are reliable but the physiological ages are significantly different and each needs norms established by which cardio-respiratory efficiency can be calculated according to his growth status.

The research studies confirm that running programs that demand oxygen will significantly improve cardiovascular efficiency. Studies indicate characteristics of running programs which will elicit cardiovascular efficiency improvement:

1. Training two and three days per week is superior to training one day per week and just as beneficial as training four or five days a week for the "unfit" and the "moderately fit." For the "already fit" training must be sufficiently demanding for increased cardiovascular efficiency to occur.

2. The intensity of exercise most effective for cardiovascular efficiency improvement is a work load or rate which elicits heart rates of 150 to 180 beats per minute.

3. Motivated distance running for ten or twenty minutes a day is superior to running thirty minutes a day for subjects of highest initial cardiovascular efficiency.

4. Motivated maximal effort running for two minutes a day produces greater cardiovascular efficiency gains than motivated maximal effort bouts of four, six, or eight minutes.

The effect of a variety of activity programs on the improvement of cardiovascular efficiency has been investigated. The studies indicate that:

1. Cardiovascular efficiency can be significantly improved with programs of endurance swimming, instruction class in intermediate swimming, swimming with a supplemental isometric exercise program, golf with a supplemental isometric exercise program, wrestling, and soccer.

2. Cardiovascular efficiency can be significantly improved by training programs involving the use of Exer-Genie, isometrics, isotonics, rope skipping, circuit training, stool stepping, and jogging.

3. Badminton, volleyball and golf as taught in the service programs of physical education do not show significant cardiovascular efficiency gains.

It appears that significant cardiovascular efficiency gains can be achieved by placing the individual under sufficient stress. The nature of the conditioning program apparently is not the important consideration as long as it is significantly strenuous.

CHAPTER III

DESIGN OF THE STUDY

I. NATURE OF THE PHYSICAL EDUCATION PROGRAM

The study took place during April and May, 1968, at Holliday Junior High School, Topeka, Kansas. All male students enrolled in the seventh, eighth, and ninth grade physical education classes were involved with the exception of those participating in the spring athletic program. The format of the daily fifty minute physical education program included a short supervised play period, a five to eight minute period for announcements and formal exercises, a short period of instruction, and the activity period, which was the culmination of the instructional program. Curriculum for the year included such activities as string football, soccer, speedball, volleyball, basketball, tumbling and gymnastics, wrestling, badminton, folk and square dancing, table tennis, track, tennis, golf, physical fitness testing and softball. During the fall and spring, the physical education classes meet five days a week. The physical education classes meet three days a week during the winter months. The other two days are devoted to health instruction.

During the four weeks preceding the study all physical education classes received instruction in track and field. The first week of the study all classes were involved with physical fitness testing. The second and third weeks of the study the physical education activity, for the seventh grade, was tennis instruction, and for the eighth and ninth grades it was golf. During the last three weeks of the study all classes participated in softball.

II. SUBJECTS

The subjects for this study were eighty-one seventh, eighth, and ninth grade males enrolled at Holliday Junior High School, Topeka, Kansas. Sixty-seven were enrolled in regularly scheduled physical education classes. Fourteen were not participating in any of the regularly scheduled physical education programs. None of the subjects were participating in the spring interscholastic athletic programs.

Twenty-seven seventh grade male students participated in the study. They were enrolled in required physical education classes which met one fifty minute period per day five days a week. Forty eighth and ninth grade male students enrolled in physical education, as an elective, participated in the study. They were enrolled in classes which met one fifty minute period per day five days a week. Fourteen eighth and ninth grade male students who were not enrolled in physical education agreed to participate in the study. They met immediately after school five days a week for their running program.

The subjects dressed in regular physical education uniforms, which consisted of a T-shirt, boxer trunks, and tennis or gym shoes.

III. RUNNING GROUPS

The subjects were randomly divided into three running groups. Each subject's name in each class was placed on a three by five inch card. After the cards were thoroughly mixed they were drawn and placed in one of three groups which represented the three experimental running groups.

The three experimental groups participated in maximal effort running five days a week for six weeks. Group one ran for thirty seconds, group two ran for fifty-five seconds, and group three ran for sixty seconds. Group four, the eight and ninth grade subjects who were not enrolled in physical education, ran thirty, forty-five or sixty seconds as they were randomly assigned.

IV. EQUIPMENT AND FACILITIES

The shuttle run course. The sixty foot shuttle run (diagram, Appendix B, page 55) was chosen as the running course because this was the greatest distance that was safe to use in the gymnasium. The course was also marked on an asphalt surface on the physical education field. The availability of the two shuttle run courses enabled the running program to continue during any weather conditions.

The course for the shuttle run consisted of an area bounded by two parallel lines sixty feet apart. One line was designated as a starting line; the other line was designated as the end line. A center line was included only to facilitate the counting and recording of the distances run.

The running groups were started and stopped by the signal of a whistle. The groups were timed with a stop watch.

Equipment for the modified Harvard Step Test. The modified Harvard Step Test was used as the measure of cardiovascular efficiency. The commands were recorded on tape. A seventeen inch bench was used for the exercise phase of the test. Stop watches were used to time the thirty second pulse counts. The pulse rates were recorded on record sheet for the modified Harvard Step Test. (Appendix A, page 53) The modified Harvard Step Test was administered to each of the subjects both before and after training.

V. PROCEDURE

Instruction and orientation to the study. Three class periods were used for instruction and orientation to the study and the administration of the initial modified Harvard Step Test. During these three periods the subjects met in the gymnasium.

The first of the orientation periods was devoted to a discussion of the relationship of running programs to physical fitness and the nature of the study. The subjects were informed that their participation in the study would determine part of their grade in physical education. They were then assigned to subgroups of three. The modified Harvard Step Test was explained and the subjects were given two chances to locate the radial artery, count the pulse, and practice the step test.

During the second orientation period the subjects were assigned to their running groups and acquainted with the procedure of the shuttle run. The procedures of the modified Harvard Step Test were reviewed and each subject had two practice trials in locating the radial artery and counting pulse. Each subject was given two record sheets for the modified Harvard Step Test. (Appendix A, page 53) They were instructed to write one of the two subjects' names in their group on the top line of each of the record sheets, and to write their own name on both sheets where it indicated the name of the tester.

The third orientation period was devoted to the administration of the initial modified Harvard Step Test to all subjects.

The training program. The shuttle run was used as the method of training for all running groups with each group running its specified time. The training program began on April 16, 1968, and continued five days a week for six weeks. Emphasis was placed on the contribution of running to the development of physical fitness and the subjects were instructed to exert themselves to the limits of their abilities at all times in the running program.

During each class period, the subjects in each running group ran at the same time. They lined up side by side along the starting line spaced at least one yard apart. Instructions were to run in a straight line to the end line, pivot, return along the same path to the starting line, pivot, and repeat the procedure as rapidly as they could in the time allotted for this particular running group. The signal to start was a whistle blown by the investigator. A second whistle was the signal to stop.

Group one in each class ran first on the first day of training, followed by group two and group three. Thereafter, the groups were rotated each day in regular order.

Records of distances run were used as a motivational device and were not used in the statistical analysis. Each distance of sixty feet was counted as one point. Scores were recorded on a record card (Appendix C, page 57) to the nearest one-half length. The counting was done by the subjects in the next group to run. The first day of the training program, each member in group one was related to a member in group two and counted for him. Using the same procedure the members in group three counted for group two and the members in group one counted for group three.

The subjects were required to make up absences by running the second or third day after returning to school. Subjects absent from the morning classes made up the running after school. Subjects absent from the afternoon classes made up the running before school. In case of inclement weather the groups were taken into the gymnasium for the running program. The running procedures were identical for both inside and outside.

The modified Harvard Step Test. Three ninth grade Junior Leaders in each class acted as assistant test administrators. They were instructed to assist any testee who got out of step with the cadence of the modified Harvard Step Test. They each carried a stop watch and were instructed on how to time and record the pulse rates in case any of the subjects was unable to complete the five minute test. Only three subjects during the pre-test and none during the post-test were unable to complete the five minute test period.

After a brief review of the test procedure, the two testers, sitting on each side of the testee, located the radial artery and a thirty second resting pulse rate was taken and recorded. The resting pulse rate has no relationship to the study, but provided additional opportunities to practice counting pulse rate.

Following the recording of the resting pulse rate the testee stood, faced a seventeen inch bench, and followed the directions reproduced on a tape recorder. The commands were as follows: "Ready, up, two, three, four, up, two, three, four, etc." The command "up" was repeated every two seconds. On the command of "up" the testee stepped up on the bench with one foot. On the command of "two" he stepped up on the bench with the other foot to a standing position. On the command of "three" he stepped down with the lead foot, and on the command of "four" he stepped down with the other foot to the starting position. The four counts made up one complete cycle and the testee repeated this cycle at the rate of thirty cycles per minute for a maximum of five minutes. The testee was allowed to change the lead off foot three times if he felt the need to change. At the end of the exercise period the recording gave the command, "Stop. Sit down. Relax." The testers sitting on either side of the testee, located the radial artery and prepared for the first pulse count. One minute after the exercise stopped the command to start counting was given. One and one-half minutes after exercise the command to stop and record was given. The testers quickly recorded the pulse rate without any consultation. Two minutes after exercise the second command to count was given. Two and one-half minutes after exercise the second command was given to stop and record. The third command to start counting was made three minutes after exercise and the third command to stop and record was made three and one-half minutes after exercise.

After each counting of the pulse the testers recorded the number of pulse beats on the score card without consulting with each other so that a reliable measure would be provided. The cards were then handed to the testee and collected by the Junior Leaders. The subjects then changed position so that another member of the group became the testee and the other two the counters. This procedure was followed until all students had been tested.

The two cards for each student were totaled. If the totals of the three pulse counts on the two cards for any subject varied by more than ten counts, the subject was re-tested the following day by the investigator.

An initial modified Harvard Step Test was administered before the training program began and a second modified Harvard Step Test was administered after the training program was completed.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

I. INTRODUCTION

The purpose of the study was to determine the effects of three programs of maximal effort running on the cardiovascular efficiency of junior high school males.

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.

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

In testing for the significance of mean differences 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 four groups. These data are presented in Table I for all the groups. None of the running groups had a *t* ratio which was

TABLE I

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN INITIAL AND FINAL CARDIOVASCULAR EFFICIENCY SCORES FOR THE FOUR TRAINING PROGRAMS

Group	N	Initial Mean	Final Mean	Mean Diff.	*t*	P
30 sec. and P.E.	23	149.32	149.77	.45	.11	–
45 sec. and P.E.	23	151.65	146.17	5.48	.86	–
60 sec. and P.E.	22	150.43	145.42	5.01	.85	–
Running no P.E.	14	169.43	159.14	10.29	1.79	–

t needed with 45 degrees of freedom at .05 level of probability - 2.02
t needed with 26 degrees of freedom at .05 level of probability - 2.06

significantly at the .05 level of probability. In order for groups one, two and three to reach significance a *t* of 2.02 was needed for the .05 level of probability. Group one, the thirty second running group plus physical education, regressed in mean cardiovascular efficiency score .45 between the initial and final test. Group two, the forty-five second running group plus physical education had a mean gain between the initial and final cardiovascular efficiency scores of 5.48. Group three, the sixty second running group plus physical education, had a mean gain of 5.01. Group four, the running group without physical education, required a *t* of 2.06 to be significant at the .05 level of probability. This group exhibited a mean improvement of 10.29 pulse counts between the initial and final cardiovascular efficiency scores as measured by the modified Harvard Step Test.

III. ANALYSIS OF VARIANCE

Analysis of variance was used to determine if there were significant differences among the four groups on the final modified Harvard Step Test performance. This statistical process was used rather than covariance because the coefficiency of correlation between initial status and the gain in cardiovascular efficiency scores was a plus .15. When there is a relatively low correlation between initial status and gain, it indicates that there is not a large proportion of the variability of the final scores that can be attributed to variability of the initial scores. Therefore, the use of covariance was not warranted. An analysis was made of the cardiovascular efficiency scores made on the final modified Harvard Step Test performance for the four running groups. The results are shown in Table II. The F-ratio of 2.49 was not significant at either the .05 or the .01 level of probability. To be significant at the .05 level of probability with 3 and 79 degrees of freedom, an F of 2.72 was needed. An F of 4.04 was necessary for the .01 level of probability.

TABLE II

ANALYSIS OF VARIANCE OF THE POST CARDIOVASCULAR EFFICIENCY SCORES FOR THE FOUR RUNNING GROUPS

Source of Variance	Sum of Squares	df	Mean Squares	F	P
Among	1904	3	633		
Within	22445	76	254	2.49	-
Total	21268	79			

F needed at .05 level, 2.79; at .01 level, 4.04.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS COMMENTS AND RECOMMENDATIONS

I. SUMMARY

It was the purpose of this study to compare the effectiveness of three motivated maximal effort running programs on the cardiovascular efficiency of junior high school males.

The subjects for this study were eighty-one seventh, eighth, and ninth grade males enrolled at Holliday Junior High School, Topeka, Kansas. In the spring of 1968, sixty-seven of the subjects were enrolled in physical education. Fourteen eighth and ninth grade males who were not enrolled in physical education participated in the study.

All of the subjects were given the modified Harvard Step Test the first week of the study which served as the initial measure of cardiovascular efficiency. Each class period, the subjects were randomly divided into three training groups. The volunteer group, which trained after school, was also randomly divided into three training groups. Group one trained by running for thirty seconds. Group two trained by running forty-five seconds. Group three trained by running sixty seconds. All of the training groups used the shuttle run as the method of training and trained five days a week for six weeks. At the end of the training period the modified Harvard Step Test was administered a second time to all of the subjects.

The *t* test of significance between correlated means was used to evaluate mean differences between initial and final modified 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. None of the motivated running groups produced significant cardiovascular efficiency gains.

2. Group one, the thirty second running group plus physical education, regressed in mean modified Harvard Step Test score .47 between the initial and final test.

3. Group two, the forty-five second running group plus physical education, had a mean gain in modified Harvard Step Test score of 5.48.

4. Group three, the sixty second running group plus physical education, improved 5.01 pulse counts as measured by the modified Harvard Step Test.

5. Group four, the running group without physical education,

had a mean improvement of 10.29 pulse counts between the initial and final cardiovascular efficiency test.

III. CONCLUSIONS

Within the limitations of the study, the following conclusions are justified.

1. Short interval motivated running of thirty, forty-five, or sixty seconds does not elicit sufficient stress upon the cardiovascular system of junior high school males to produce significant cardiovascular efficiency gains.

2. Participation in motivated running of forty-five or sixty seconds may improve the cardiovascular efficiency of junior high school males though the gains in cardiovascular efficiency observed in this study were not significant.

3. Cardiovascular efficiency gains, as observed in this study, were greater among junior high school males who were not enrolled in physical education or active in athletic programs.

4. The above observations indicate that as cardiovascular efficiency improves, greater stress upon the cardiovascular system is necessary to effect a gain in cardiovascular efficiency.

IV. COMMENTS

It was of particular interest to this investigator, after three quarters of a school term, that there appears to be a meaningful difference in the cardiovascular efficiency of junior high school boys enrolled in physical education and junior high school boys who are not enrolled in physical education. In reference to Table I, page 39, there is an observed mean difference on the initial cardiovascular efficiency test scores of approximately nineteen pulse counts between the running groups enrolled in physical education and the running group which was not enrolled in physical education. This suggests that further investigation may be indicated. If the observed differences are significant, those who are responsible for policy concerning physical education requirements need this information as the basis for future decisions concerning the requirement for physical education for the junior high school age group.

Generally, this investigator feels that most of the subjects ran to the best of their ability. However, a basic weakness of the study was the inability to measure objectively maximum effort. The subjective observation of this investigator indicated that those subjects who expressed interest and understanding as to the purposes of the study, appeared to exert maximal effort during each training period. They also tended to perfect the techniques of pivoting during the shuttle run in order to increase the individual distances run during each training session.

The recording of distances run appeared to be the best motivating device. Nearly all the subjects expressed interest in achieving as well or better than their last recorded distance.

All but one of the volunteer subjects who participated in the study appeared to be highly motivated. One volunteer subject required continuous encouragement and reminding to be on time for the training sessions throughout the study.

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 similar experimental design but using junior high school females as subjects.

2. Efforts should be made to increase the motivation effect of recording distances run by marking the shuttle run course every fifteen feet and recording the scores in feet to the nearest fifteen feet.

3. A similar study should be made involving greater numbers of junior high school or high school students who are not enrolled in physical education or active in the interscholastic athletic program.

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BIBLIOGRAPHY

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APPENDIX A

HARVARD STEP TEST RECORD CARD

HARVARD STEP TEST RECORD CARD

____
Last Name First Name

Name of Tester________________________________

Resting Pulse__________ Resting Pulse__________

<u>First</u> <u>H.S.T</u>.

1 min.________________

2 min.________________

3 min.________________

Totals________________

<u>Second</u> <u>H.S.T</u>.

1 min.________________

2 min.________________

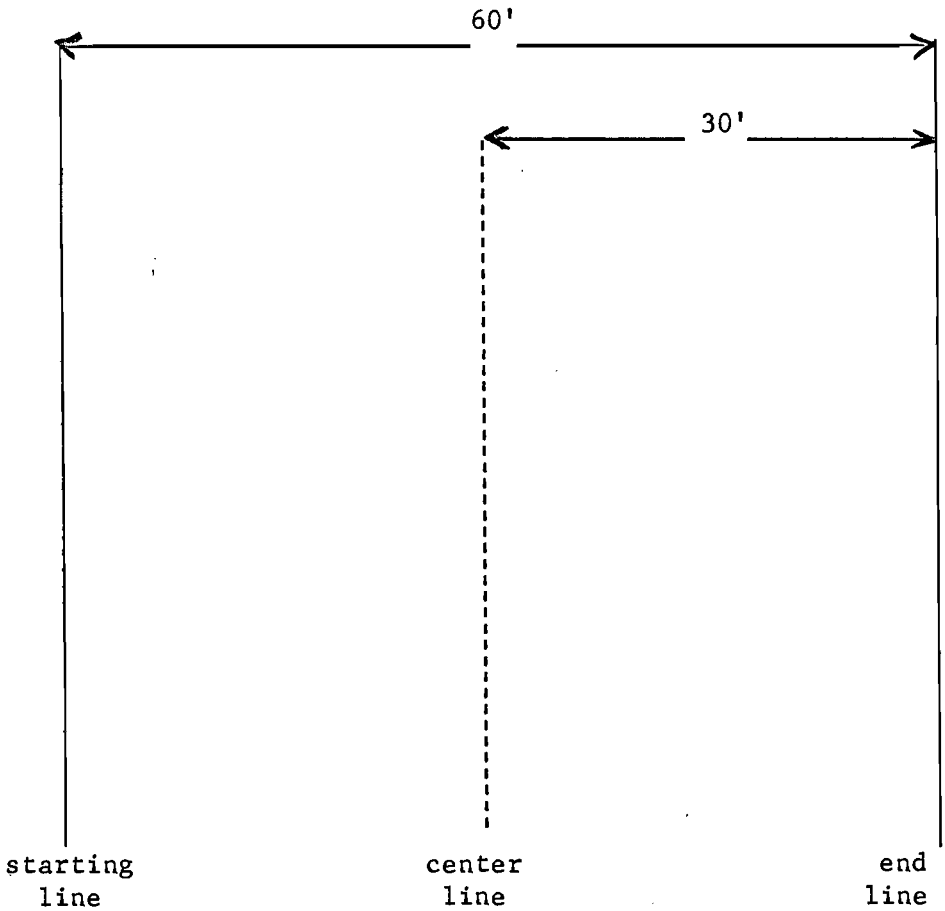
3 min.________________

Totals________________

APPENDIX B

DIAGRAM OF THE SHUTTLE RUN

DIAGRAM OF THE SHUTTLE RUN



APPENDIX C

SHUTTLE RUN RECORD SHEET

SHUTTLE RUN RECORD SHEET

First Hour

Group 1. 30 Sec. Running

	- April -											- May -												

Group 2. 45 Sec. Running

Group 3. 60 Sec. Running
