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CHAPTER I

ORIENTATION TO THE STUDY

> Throughout all history, one contribution of physical education has been utilized--that of physical fitness for survival. In this sense physical education existed with primitive peoples; for survival in obtaining food through the hunt; for survival from the perils from enemies, whether beast or man or hostile environment; for survival in war, whenever organized warfare took place. Strength, stamina, skill, speed--those are the assets of a physical fitness program.[1]

The quest for physical fitness throughout the ages has varied with environmental factors, religious creeds, social demands and personal desires. Physical fitness provided the test of primitive man's ability to meet the challenges for survival. Survival of the fittest became a realization through man's ability to obtain food and to protect himself from beasts and hostile enemies.[2]

The physical educator's role in physical fitness is a historic one. In the United States, physical education was originally patterned to resemble the systems of certain European countries, especially those devised in Germany and Sweden to develop a strong citizenry for national defense.[3] By 1860, physical education activity programs followed designs

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[1]Emmett A. Rice, _A Brief History of Physical Education_ (New York: A. S. Barnes and Company, 1935), p. 3.

[2]_Ibid._

[3]H. Harrison Clark, "Physical Fitness and Exercise," Address delivered at joint session of the American Academy of Physical Education and the Society of State Directors of Health, Physical Education and Recreation, Cincinnati, Ohio, April 4, 1962.

to meet the physical fitness needs of the individual. Between the Civil War and World War I the leading physical educators were trained in medicine and began to recognize the totality of man and the contributions of physical education to the individual's mental, emotional and social effectiveness.[1] Physical education after World War I abandoned its biological heritage and permitted physical fitness to be subordinate to other educational objectives.[2]

According to Oberteuffer, the United States is now in the fourth discernible period of intensified interest in physical fitness: Oberteuffer lists these four periods as:

> (1) Theordore Roosevelt's advocacy of the vigorous life to make our nation strong; (2) draft statistics following World War I; (3) the all-out effort during World War II to prepare our populace to wage total war; and (4) action taken to establish and continue a President's Council on Physical Fitness.[3]

Concern for the physical condition of the American people produced speculation as to the meaning and determinants of physical fitness. Gallagher and Brouha[4] state that the three primary aspects of physical fitness are: (1) medical or static fitness, (2) functional or dynamic fitness, and (3) that type of fitness having to do with specific skills, muscle coordinations, and strength. The object of most school and

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[1]Delbert Oberteuffer, "The Role of Physical Education in Health and Fitness," Address delivered at joint session of the Sections on Maternal and Child Health, School Health, and Nutrition of the American Public Health Association and the American School Health Association, November 14, 1961.

[2]Ibid.

[3]Ibid.

[4]Lucien Brouha and J. Roswell Gallagher, "A Functional Fitness Test for High School Girls," Journal of Health, Physical Education and Recreation, Volume 14 (December, 1943), p. 517.

community physical education programs has been the development of that type of fitness which emphasizes the acquisition of skills, strength and coordination. While this type of fitness is undoubtedly a sound premise, recent scientific research indicates that the improvement of functional or dynamic fitness is of equal importance.[1]

Functional or dynamic fitness has to do with operational status and the ability to do strenuous work with physiological efficiency. The emphasis on dynamic fitness places great importance upon physical education activity programs which are designed to improve physiological functioning. It is in this respect that cardiovascular efficiency and methods of testing it have become vitally significant.

The Relationship of Oxygen-Transport to Cardiovascular Efficiency

Holmgren defines cardiovascular efficiency as "the oxygen-forwarding capacity of the cardiorespiratory system."[2] Two convective systems--the pulmonary ventilation and the blood circulation, along with two diffusing systems--the alveolar-capillary and tissue-capillary cell systems forward the oxygen from the surrounding atmosphere to the site of oxidative metabolism. Physical fitness as defined above depend, therefore, on the net transport capacity for oxygen of this system.[3]

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[1] Jean Hodgkins and Vera Skubic, "Cardiovascular Efficiency Test for Girls and Women," Research Quarterly, Volume 34, Number 2 (March, 1963), p. 191.

[2] A. Holmgren, "Cardiorespiratory Determinants of Cardiovascular Fitness," International Symposium on Physical Activity and Cardiovascular Health, Volume 96, Number 12 (March 25, 1967), p. 697.

[3] Ibid.

The determinants of the oxygen-transport are divided into groups of dimensional factors or functional capacities. The dimensional factors refer to the influence of the size of the organs that comprise the transport line of the system. The functional capacity is related to the dimensions of the component and to its optimal function. The functional capacity of the cardiovascular system is described as the maximal cardiac output and the stroke volume that is maintained during maximal work.[1]

The dimensional factor is said to be the determinant of the inter-individual variations of the oxygen-transport while the functional factor accounts for day-to-day variations.[2] It is with the functional aspect of the oxygen-transport, therefore, that the physical educator is concerned. An objective of the physical education activity program thus becomes one of promoting the achievement and maintenance of a hyperkinetic circulation, a condition in which oxygen is forwarded with a larger than normal cardiac output.[3]

Measurement of Cardiovascular Efficiency

Various tests which have been devised to measure cardiovascular efficiency developed not only from the need to evaluate activity programs and to detect organic dysfunctions, but often primarily for the purpose of classification. Some of the earlier cardiovascular tests were based on breath holding, but most of the tests required a pulse rate or blood pressure

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[1] *Ibid.*, p. 699.

[2] *Ibid.*, p. 701.

[3] *Ibid.*

measurement. The basic principle underlying all of the cardiovascular tests of fitness was that with the increase in muscle tone, power, and endurance, an increase in functional ability would be reflected in all organic systems of the body.[1] Improved efficiency was reflected especially in the heart and lungs because the total cardiac output increased and the blood lactate concentration decreased. The result was a slower rate of breathing and a corresponding economy in respiration.[2]

Tests requiring blood pressure measurement utilize a mercury manometer and a stethoscope to determine systolic and diastolic pressure. Tests that utilize heart rate measurements provide information concerning the functional capacity of the cardiovascular system. Andersen explains this measurement by stating that

> Heart rate at a steady state or taken at the end of a few minutes exercise period is closely and linearly related to the oxygen uptake. This characteristic is different in men and women, and changes with training. In a homogeneous group of sedentery subjects of the same sex, the relationship is remarkably similar, and not much affected by age . . . . the use of the heart rate recordings throughout a working day offer a possibility to evaluate the stress placed upon the cardiovascular system, because the heart rate, with certain exceptions follows closely the oxygen uptake and the cardiac output.[3]

Ricci discusses the functional capacity of the cardiovascular system and the use of maximum heart rate measurements in the following manner:

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[1]Carl E. Willgoose, Evaluation in Health Education and Physical Education (New York: McGraw-Hill Book Company, Inc., 1961), p. 106.

[2]Ibid.

[3]K. Lange Andersen, Exercise Physiology (Ed.) Harold Falls, (Academic Press, 1968), p. 96.

> Individuals exhibiting good cardiovascular-pulmonary response to work not only possess larger stroke volumes, but also possess lower heart rates than their less trained counterparts. Because of its relative ease of monitoring, much data has been accumulated on maximum heart rates.[1]

Pulse rate measurements can be taken manually in a number of ways by using either the carotid or radial pulse. Electronic counting equipment is also available for pulse rate measurements.

The Carlson Fatigue Curve Test utilizes the pulse rate measurement.[2] It is particularly useful in measuring differences between persons in relatively good condition. Another test of particular interest is the Harvard Step-Test.[3] The test was developed by Brouha during World War II at the Harvard University Fatigue Laboratory to measure fitness for muscular work and ability to recover. The basis for evaluation of cardiovascular efficiency was the recovery pulse rate taken at various intervals after five minutes of stepping.[4] Karpovich explains the principles in evaluation of recovery pulse rates in the following manner:

> The time required for the pulse rate to return to normal after exercise depends upon the intensity of the exercise and the condition of the individual. Increasing the intensity of the exercise increases the time required for recovery, on the otherhand, better physical condition tends to shorten the period of recovery.[5]

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[1]Benjamin Ricci, Physiological Basis of Human Performances (Philadephia: Lea & Febiger, 1967), p. 107.

[2]H. C. Carlson, "Fatigue Curve Test," Research Digest, Volume 16 (October, 1945), pp. 72-78.

[3]Lucien Brouha, "The Step-Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," The Research Quarterly, Volume 14 (March, 1943), pp. 31-36.

[4]*Ibid.*

[5]Peter V. Karpovich, Physiology of Muscular Activity (Philadelphia: W. B. Sanders Company, 1965), p. 171.

From the Harvard Step Test, which was designed for use with male university students, evolved a series of modified step tests by which young boys, young girls, and, finally, high school and college women could be tested. One factor inherent in all step tests is that the entire body weight is involved in the exercise and not simply an isolated muscle group. Another important factor contributing to the popularity of the step test as a measurement of cardiovascular efficiency is that the stepping exercise is familiar enough to avoid the necessity of special training, and the modified form is well accepted by the subjects because it does not lead to an unpleasant feeling of exhaustion.[1]

The available information correlating various physical education activities and their possible relationship to the development of cardiovascular fitness of women students is not extensive. The present study was undertaken in part, therefore, as an attempt to supplement the available knowledge concerning this problem, and in part as a result of the investigator's interest in the possible relationship of selected physical education activities and the development of cardiovascular efficiency.

Statement of the Problem

The investigator studied the relationship of selected physical education activities and changes in cardiovascular endurance by administering the Hodgkins-Skubic Test to approximately sixty-eight women subjects enrolled in the required physical education program at the University of Arkansas, Fayetteville, Arkansas during the academic year

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[1]Holmgren, *op cit.*, p. 734.

of 1967-1968. The test was administered prior to, at the mid-point, and after the completion of a one-semester course in swimming, tennis, and modern dance, respectively.

Definitions and/or Explanations of Terms

The following definitions and/or explanations of terms were used throughout the present study:

Cardiovascular Endurance.--A. Holmgren defines cardiovascular endurance in the following manner:

> Cardiovascular endurance is the oxygen-forwarding capacity of the cardiorespiratory system.[1]

Post-exercise Pulse Rate.--Hodgkins and Skubic define the post-exercise pulse rate as

> A thirty second pulse count, beginning sixty seconds after the completion of a prescribed activity.[2]

Hodgkins-Skubic Cardiovascular Efficiency Test.--Hodgkins and Skubic describe the test by stating that

> The test for cardiovascular efficiency consists of stepping up and down on an eighteen-inch bench at the rate of twenty-four steps per minute for three minutes. Following the exercise, subjects rest for one minute in a sitting position; the pulse is then counted for thirty seconds. The pulse is taken at the carotid artery by the palpation method. For subjects who are unable to complete three minutes of stepping, the total time of stepping is noted and their recovery pulse is counted after one minute of rest.[3]

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[1]Holmgren, op cit., p. 697.

[2]Jean Hodgkins and Vera Skubic, "Cardiovascular Efficiency Test Scores for College Women in the United States," Research Quarterly, Volume 34, Number 4 (December, 1963), pp. 454-461.

[3]Ibid.

Purpose of the Study

The purpose of the study was to evaluate the relationship between participation in selected physical education activities and changes in cardiovascular endurance as measured by the Hodgkins-Skubic Test.

Basic Hypotheses

The hypotheses of the present study are as follows:

A. Participation in a one-semester course in swimming does not significantly change the level of cardiovascular endurance as measured by the Hodgkins-Skubic Test.

B. Participation in a one-semester course in tennis does not significantly change the level of cardiovascular endurance as measured by the Hodgkins-Skubic Test.

C. Participation in a one-semester course in modern dance does not significantly change the level of cardiovascular endurance as measured by the Hodgkins-Skubic Test.

Delimitations of the Study

The present study was subject to the following delimitations:

1. Sixty-eight freshman and sophomore college women who enrolled in the required physical education program at the University of Arkansas, Fayetteville, Arkansas, during the academic year of 1967-1968.

2. Women students who chose the activities of swimming, tennis and modern dance.

3. Reliability of the pulse counting technique in determining the cardiovascular endurance of the subjects during the administration of the Hodgkins-Skubic Test.

4. Eighteen weeks of instruction consisting of two forty minute meetings per week and practice in required physical education classes in swimming, tennis and modern dance.

Survey of Related Literature

A review of the pertinent literature related to the present investigation which was of greatest assistance to the investigator follows:

Brouha[1] completed a study in which he developed a test to measure fitness for muscular work and the ability to recover, utilizing 2,200 Harvard University students. The test consisted of stepping up and down on a twenty-inch platform thirty times a minute for five minutes. A modification of the five-minute step test was used to rate subjects who could not step for the full five minutes.

The testing procedures require the subject to step on the platform for five minutes continuously. When the subject is seated the recorder delays the pulse count for one minute and then records the pulse counts during the intervals from 1 to 1 1/2, 2 to 2 1/2, and 3 to 3 1/2 minutes after the subject stops working. The fitness index is determined by the formula:

$$\text{Index} = \frac{\text{Duration of Exercise in Seconds X 100}}{\text{2 X Sum of Pulse Counts in Recovery}}$$

Brouha found that athletes outperformed nonathletes and increased their scores with additional training. Taddonio and Karpovich,[2] using

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[1]Brouha, "The Step Test," op cit., pp. 31-35.

[2]Dominich A. Taddonio and Peter V. Karpovich, "The Harvard Step Test as a Measure of Endurance in Running," Research Quarterly, Volume 22, (October, 1951), pp. 381-384.

the Brouha Test, obtained a coefficient of correlation of .62 between the step test and the order in which college men finished a cross-country race.

A variation of the Harvard Step Test was developed by Brouha and Gallagher[1] for high school girls. The principal changes incorporated were that the height of the platform was reduced to sixteen inches, and the duration of the test was limited to four minutes. The Harvard Step Test was later modified by Clarke[2] for use with college women. The platform was reduced to eighteen inches and the exercise duration set at four minutes.

Hodgkins and Skubic[3] developed another variation on the Harvard Step Test in order to reduce the length of the currently available test to three minutes. The test was found to be a valid measure of cardiovascular efficiency for women and showed a clear differentiation among highly trained, active, and sedentary subjects. The investigators assumed that the three-minute step test is sufficiently strenuous to be classified as hard work for girls and women. By the test-retest method, the Hodgkins-Skubic Test demonstrated a reliability coefficient of .820.

Hodgkins and Skubic[4] later conducted a nationwide study to survey cardiovascular efficiency scores for college women in the United States

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[1]Brouha and Gallagher, op cit., p. 517.

[2]Harriet L. Clark, "A Functional Fitness Test for College Women," Journal of Health, Physical Education and Recreation, Volume 14 (September, 1943), pp. 358-359.

[3]Jean Hodgkins and Vera Skubic, "Cardiovascular Efficiency Test for Girls and Women," Research Quarterly, Volume 34, Number 2 (March, 1963), pp. 191-197.

[4]Jean Hodgkins and Vera Skubic, "Cardiovascular Efficiency Test Scores for College Women in the United States," op cit., pp. 454-461.

and develop national standards for cardiovascular efficiency. The study utilized 2,360 women students enrolled in sixty-six college and universities representing the six districts of the American Association of Health, Physical Education and Recreation

The results showed that the mean recovery pulse rate for the 2044 women completing the three minutes of stepping was 64.43. Three hundred and sixteen women were unable to complete three minutes of stepping. A formula was devised to apply to the scores of those unable to complete the test. Those subjects were scored by the following formula:

$$\frac{\text{No. of Sec. Completed X 100}}{\text{Recovery Pulse X 5.6}}$$

This investigation resulted in 929 subjects of the 2,360 subjects being rated as in fair condition. It was found that subjects from the Eastern District made better scores than those from any other district. The subjects in the Southern District made poorer scores than those from any other district. The study indicated that the height of the subjects did not affect scores but there was a clear indication that the heavier women made lower scores than the lighter women. The study also indicated that physical education majors were more fit from a cardiovascular standpoint than any other group studied. The education majors were less fit than all other major groups.

Sloan[1] completed a study to ascertain the effect of various training programs on physical fitness of women students. Subjects comprised sixty-one women students enrolled at the Cape Town Training College, Cape Town, South Africa.

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[1]A.W. Sloan "Effect of Training on Physical Fitness of Women Students," Journal of Applied Physiology, Volume 16 (March, 1961), pp. 167-169.

The modified Harvard Step Test was given at the beginning of the academic year and again at the end of the fourth and ninth month, respectively. Subjects were divided into three groups. Group one received training in gymnastics, dance, and games. The second group participated in gymnastics alone and the third group received no physical training whatever.

The results showed an improvement of cardiovascular efficiency scores in group one. Group two showed no change in cardiovascular efficiency scores. Group three showed a decrease in cardiovascular efficiency scores.

The present study differs from those previously reviewed in that the subjects comprised sixty-eight freshman and sophomore women students enrolled in separate required physical education programs at the University of Arkansas, Fayetteville, Arkansas. The subjects were divided into three groups: one group received eighteen weeks of training in swimming; the second group received eighteen weeks of training in tennis; the third group received eighteen weeks of training in modern dance.

Cardiovascular efficiency scores were obtained by means of the Hodgkins-Skubic Test which was administered in the first, ninth, and eighteenth week of instruction.

Summary

In this chapter the investigator presented a brief explanation of the meaning and determinates of physical fitness. It was noted that the importance of physical fitness throughout the ages varied according to environmental factors, religious creeds, social demands and personal desires.

The main text of this chapter concerned cardiovascular efficiency as a component of physical fitness. Cardiovascular efficiency was defined and its relationship to oxygen-transport was presented. The determinants of oxygen-transport were divided into groups of dimensional factors or functional capacities.

Various methods of measuring cardiovascular efficiency were described. It was noted that most of the tests of cardiovascular efficiency require a pulse rate or blood pressure measurement. The basic principle underlying all of the cardiovascular tests of fitness was that with the increase in muscle tone, power, and endurance, an increase in functional ability was reflected in all organic systems of the body.

The present study was concerned with the relationship of selected physical education activities and changes in cardiovascular endurance. The test selected for the study was the Hodgkins-Skubic Test. The subjects were sixty-eight women students enrolled in the required physical education program at the University of Arkansas, Fayetteville, Arkansas.

This chapter of the study also included the definition of terms, the purpose of the study, the delimitations of the study, and a survey of related studies.

The procedures used in the development of the present study are presented in chapter II.

Chapter II

PROCEDURES FOR THE DEVELOPMENT OF THE STUDY

The present study evolved as a result of the writer's interest in the relationship between selected physical education activities and changes in cardiovascular endurance. The procedures used in the development of the study are presented in this chapter.

Sources of Data

The data used in this study were obtained through two sources, human and documentary. The human sources were sixty-eight freshman and sophomore women enrolled in the required physical education program at the University of Arkansas, Fayetteville, Arkansas, during the academic year of 1967-1968. Other human sources were selected staff members of the College of Health, Physical Education and Recreation at the Texas Woman's University in Denton, Texas, and selected staff members of the Department of Health, Physical Education and Recreation at the University of Arkansas in Fayetteville, Arkansas.

In order to collect data for inclusion in Chapter I of the study, the investigator undertook a thorough documentary analysis of the contents of books, periodicals, and published and unpublished studies relating to all aspects of the study.

Selection of Test

Barrow and McGee explain four aspects of test selection that should be considered by a researcher.[1] One must determine first, if ". . . the

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[1]Harold M. Barrow and Rosemary McGee, Measurements in Physical Education, (Philadelphia: Lea and Febiger, 1964), p. 53.

product of education (student), or the process (program) is to be measured."[1] Second, an investigator must ". . . have in mind the purpose for which the results will be used, such as classification, grading, or diagnosis."[2] The third criterion to be considered in selecting a test is that of procedure with respect to ". . . the time available, the size of the group, the number of qualified leaders, the difficulty in administering the test, and the amount of equipment and facilities which are on hand."[3] Fourth, the tests must necessarily have the high standards of objectivity, utility, and norms.[4]

After an investigation of numerous test the Hodgkins-Skubic Test was selected in accordance with the criteria established. The selected test was found to be both valid and reliable, demonstrating a reliability coefficient of .820 by the test-retest method.[5] The easily administered test provided a short and accurate means of measuring cardiovascular efficiency without the need for elaborate testing equipment.

Selection of Subjects

Permission was obtained from the Director of the Department of Health, Physical Education and Recreation at the University of Arkansas,

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[1] Ibid.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Hodgkins and Skubic, op cit. "Cardiovascular Efficiency Test for Girls and Women." p. 197.

Fayetteville, Arkansas, to conduct the study utilizing students enrolled in the required physical education program. The sixty-eight subjects participating in the study were freshman and sophomore women comprising three physical education activity classes. Twenty-six subjects were enrolled in modern dance; twenty-three were enrolled in tennis; and nineteen were enrolled in beginning swimming.

Selection and Training of Assistants

Four student assistants were selected to assist the investigator in administering the test and recording the scores. The assistants were members of a graduate research class and were selected on the basis of their ability to understand the testing procedures and their accuracy in the pulse rate count technique. All four assistants had had previous experience in taking pulse rate counts; the training program, therefore, consisted of a demonstration of the correct testing procedures followed by a review and practice of the counting technique.

Administration of the Test

The relationship of participation in selected physical education activities and changes in the cardiovascular efficiency was determined by the Hodgkins-Skubic Test. The equipment necessary for the administration of the test included an eighteen inch platform, a stop-watch, and a metronome. The three groups were tested prior to, at the midpoint, and at the completion of the semester.

The test consisted of stepping up and down on an eighteen inch platform at the rate of twenty-four steps per minute for three minutes. Subjects rested for sixty seconds in a sitting position and the pulse was then counted by the assistants for thirty seconds. The pulse was taken at the carotid artery by the palpation method. At the end of each test, the assistants recorded on individual tabulation forms the total time of stepping and the thirty second pulse rate count. For the subjects who were unable to complete the test, the total time of stepping was recorded and their recovery pulse was counted after one minute of rest.

Treatment of the Data

The nature of the data collected by means of the administration of the Hodgkins-Skubic Test for cardiovascular endurance was such that it yielded to statistical analysis. The Duncan Multiple Range Test[1] was selected for application because it provided statistical analysis of a multiple group design. The test, extended by Kramer,[2] was also applicable when each group represented a different number of subjects.

The selected statistical technique was applied to determine significant differences within the group on test one, test two, and test three and also to determine the significance of the differences between the means of each group.

Summary

In chapter II, the procedures for the development of the study were presented. Data used in the study were obtained through both human and documentary sources.

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[1]Allen D. Edwards, Experimental Design in Psychological Research, (New York: Holt, Rinehart and Winston, 1964), pp. 136-140.

[2]Duncan, D.B., "A Simples Bayes Solution to a Common Multiple Comparisons Problem." Institute of Statistics, Mimeograph Series No. 223, University of North Carolina, April, 1959.

Following an investigation of numerous tests the Hodgkins-Skubic Test was selected in accordance with the criteria established for use in the present study. The selected test was both valid and reliable and provided a quick, accurate means of measuring cardiovascular efficiency.

Subjects for the present study were sixty-eight freshman and sophomore women enrolled in the required physical education program at the University of Arkansas, Fayetteville, Arkansas. Twenty-six subjects were enrolled in modern dance; twenty-three were enrolled in tennis; and nineteen were enrolled in swimming.

In preparing for the administration of the test, the investigator developed tabulation forms, organized the equipment, and selected and instructed assistants. The three groups of subjects were tested prior to, at the midpoint, and at the completion of the semester.

The data collected from the three administrations of the test were treated statistically by means of the Duncan Multiple Range Test. The selected statistical technique was applied to determine significant differences within the group on test one, test two, and test three, and to determine the significance of the differences between the means of each group.

The analysis and interpretation of the findings are presented in chapter III.

CHAPTER III

PRESENTATION OF FINDINGS

Presented in this chapter are the results of the study to determine the relationship between selected physical education activities and changes in cardiovascular efficiency as determined by the Hodgkins-Skubic Test. The data obtained from the administration of the test to sixty-eight freshmen and sophomore women enrolled in the required physical education program at the University of Arkansas, Fayetteville, Arkansas, were subjected to statistical treatment, and the results are presented in table form.

Duncan Multiple Range Test

The Duncan Multiple Range Test was applied to determine significant differences within each group on test one, test two and test three. A variation of the Duncan Multiple Range Test designed to facilitate analysis of groups comprising unequal numbers was applied to determine the significance of the differences between the means of each group.

Post-exercise Pulse Rate Scores

All scores presented in the following tables represent a thirty-second pulse rate count taken at the completion of three minutes of exercise and one minute of rest. Subjects unable to complete the three minutes of exercise were scored by the following formula:[1]

$$\frac{\text{No. of Seconds Completed X 100}}{\text{Thirty Second Recovery Pulse X 5.6}}$$

These scores were then entered on a table and converted to recovery pulse rate scores.[2]

Within Group Variance Analysis

The post-exercise pulse rate scores of nineteen subjects taken at the beginning, midpoint and completion of a one-semester activity course in beginning swimming at the University of Arkansas, Fayetteville, Arkansas are presented in Table 1 on page 22.

The error variance for the three tests is listed in Table 2 on page 22. The error variance was found by the following formula:[3]

$$Se = \frac{SSa+SSb+SSc}{3(n-1)}$$

The degrees of freedom was found to be 54 and the value of rp was 2.98. The appropriate rp was found by entering Table 9.2[4] (Values of rp for Duncan's Range Test at the five per cent level of confidence).

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[1]Jean Hodgkins and Vera Skubic, "Cardiovascular Efficiency Test Scores for College Women in the United States," Research Quarterly, Volume 34, Number 4 (December, 1963), p. 461.

[2]Ibid.

[3]F. N. McGuigan, Experimental Psychology, (New Jersey: Prentice-Hall, Inc., 1963), p. 175.

[4]Ibid.

TABLE 1

INITIAL, MIDPOINT, AND FINAL RECOVERY PULSE RATE SCORES OF SUBJECTS ENROLLED IN SWIMMING

SUBJECT	INITIAL TEST (S1)	MIDPOINT TEST (S2)	FINAL TEST (S3)
1	66	65	66
2	76	69	65
3	73	60	72
4	72	70	78
5	74	69	78
6	65	60	64
7	65	69	70
8	89	100	117
9	117	117	106
10	114	78	80
11	69	65	70
12	78	80	77
13	70	68	70
14	79	72	71
15	118	85	117
16	103	94	94
17	89	74	89
18	62	63	64
19	117	117	75
TOTALS ΣX	1596	1475	1523

TABLE 2

ESTIMATED ERROR VARIANCE OF MEAN RECOVERY PULSE RATE SCORES OF SUBJECTS ENROLLED IN SWIMMING

TEST	MEAN $\overline{X}$	SUM OF SQUARES ΣX^2	SUM OF SQUARES $\div$ BY NUMBER $(\Sigma X)^2/N$	SUMMATION OF SQUARES SS
Initial (S1)	84	141150	134064	7086.
Midpoint (S2)	77.63	120009	114506.5	5502.5
Final (S3)	80.16	127190	122080.47	5110.53

After the error variance, degrees of freedom and the value of rp were defined, the formula for RP was applied as follows:[1]

$$Se = \sqrt{\frac{17699.027}{54}}$$

$$Se = 18.104$$

$$df = 57 - 3 = 54$$

$$rp = 2.98$$

$$RP = (Se)\ (rp)\ \sqrt{1/N}$$

$$RP = (18.104)\ (2.98)\ \sqrt{1/19}$$

$$R_3 = 12.3045$$

Mean difference = 6.37

The significance of the differences among the recovery pulse rate means was found by first comparing the extreme means. The highest mean was 84 and the lowest was 77.63. The difference was 6.37 and did not exceed the value of R_3, therefore, the difference was not significant. Because the difference between the extreme means did not differ significantly, the lesser differences cannot be significant.

The post-exercise pulse rate scores obtained from the administration of the Hodgkins-Skubic Test to students enrolled in beginning tennis are presented in table 3 on page 24. The identical procedures were followed in the statistical treatment of scores made by subjects in a one-semester course of tennis at the University of Arkansas, Fayetteville, Arkansas. The estimated error variance is presented in Table 4 on page 25.

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[1] *Ibid.*

TABLE 3

INITIAL, MIDPOINT, AND FINAL RECOVERY PULSE RATE SCORES OF SUBJECTS ENROLLED IN TENNIS

SUBJECT	INITIAL TEST (T1)	MIDPOINT TEST (T2)	FINAL TEST (T3)
1	68	69	69
2	71	60	70
3	68	70	61
4	83	80	110
5	117	117	117
6	87	76	79
7	82	80	79
8	73	70	67
9	72	69	70
10	64	68	78
11	67	66	69
12	76	70	70
13	75	75	74
14	80	62	75
15	117	117	117
16	68	70	68
17	66	86	75
18	69	63	87
19	68	67	71
20	76	92	76
21	62	67	71
22	92	87	74
23	81	75	83
TOTALS	1782	1756	1800

TABLE 4

ESTIMATED ERROR VARIANCE OF MEAN RECOVERY PULSE RATE SCORES OF SUBJECTS ENROLLED IN TENNIS

TEST	MEAN $\overline{X}$	SUM OF SQUARES ΣX^2	SUM OF SCORES SQUARED / BY NUMBER $(\Sigma X)^2/N$	SUMMATION OF SQUARES SS
Initial (T1)	77.48	142758	138066.26	4691.74
Midpoint (T2)	76.35	139126	134066.78	5059.22
Final (T3)	78.26	147618	140869.57	6748.44

$$Se = \sqrt{\frac{16499.40}{66}}$$

$$Se = 15.81$$

$$df = 69 - 3 = 66$$

$$rp = 2.98$$

$$RP = (Se)\ (rp) \sqrt{1/N}$$

$$RP = (15.81)\ (2.98) \sqrt{1/23}$$

$$R_3 = 9.98$$

Mean Difference= 1.91

When the extreme means were compared, the difference was 1.91. The difference did not exceed the R_3; therefore, significant differences did not exist among any of the three test means.

The post-exercise pulse rate scores of twenty-six subjects enrolled in a one-semester course in modern dance at the University of Arkansas, Fayetteville, Arkansas are presented in Table 5 on page 26.

Using identical statistical procedures employed in the two previously mention groups, the influence of the dance training on the pulse rate scores was then examined. The estimated error of variance is presented in Table 6 on page 27.

TABLE 5

INITIAL, MIDPOINT, AND FINAL RECOVERY PULSE RATE SCORES OF SUBJECTS ENROLLED IN MODERN DANCE

SUBJECT	INITIAL TEST (D1)	MIDPOINT TEST (D2)	FINAL TEST (D3)
1	79	68	70
2	72	61	67
3	85	85	77
4	100	71	73
5	59	58	68
6	63	52	67
7	74	70	71
8	63	61	69
9	70	63	69
10	79	73	81
11	73	64	66
12	77	62	73
13	79	67	74
14	73	69	71
15	77	70	73
16	70	55	72
17	79	49	59
18	67	67	63
19	92	62	65
20	117	60	73
21	64	62	70
22	83	79	75
23	67	67	69
24	61	58	60
25	64	62	83
26	67	59	64
TOTALS ΣX	1954	1674	1822

TABLE 6

ESTIMATED ERROR VARIANCE OF MEAN RECOVERY PULSE RATE SCORES OF SUBJECTS ENROLLED IN MODERN DANCE

TEST	MEAN $\bar{X}$	SUM OF SQUARES ΣX^2	SUM OF SCORES SQUARED / BY NUMBER $(\Sigma X)^2/N$	SUMMATION OF SQUARES SS
Initial (D1)	75.15	1954	146850.62	4155.39
Midpoint (D2)	64.38	1674	107779.85	1530.15
Final (D3)	70.08	1822	127680.15	793.85

$$Se = \sqrt{\frac{6479.37}{75}}$$

$$Rp = (Se)\ (rp)\ \sqrt{1/N}$$

$$Se = 9.28$$

$$R_3 = (9.28)\ (2.97)\ \sqrt{1/26}$$

$$df = 75 - 3 = 72$$

$$R_3 = 5.40$$

$$rp = 2.97$$

Mean difference= 10.77

To determine the significance of the differences between the three tests the extreme means were compared. The difference between the highest mean (D1) and the lowest mean (D2) was 10.77. The mean difference exceeded the value of R_3 which indicated a significant difference between the scores on the initial test and on the midpoint test.

Since a significant difference was found between the extreme means of the group, the statistical procedures were repeated using the next highest mean (D3) to see if further significant differences occurred.

The error variance did not change, however, the value of rp became 2.82 because the comparison involved only two groups.

$$Se = \frac{6479.39}{75} \qquad RP = (Se)\ (rp)\ \sqrt{1/N}$$

$$Se = 9.28 \qquad R_2 = (9.28)(2.82)\ \sqrt{1/26}$$

$$df = 75-3=72 \qquad R_2 = 5.15$$

$$rp = 2.82 \qquad \text{Mean difference} = 5.69$$

The value of R_2 was less than the mean difference, therefore, there was no significant difference between the midpoint test and the final test. Further comparison between lesser extremes was unnecessary.

The analysis of the variance within the group showed no significant change in cardiovascular efficiency scores among students enrolled in swimming and tennis. A significant improvement was seen from the initial test to the midpoint test in subjects enrolled in modern dance but there was no significant difference between the initial test and final test in this group. The failure to retain the significant improvement until the final test was probably due to the introduction of dance composition at the midpoint of the semester. Instruction in basic composition limited the amount of time devoted to modern dance techniques and fundamental locomotor movements which were presented during the first nine weeks of the semester.

BETWEEN GROUP VARIANCE ANALYSIS

The Duncan Multiple Range Test was again used to determine the significance of the differences between the initial, midpoint, and final tests of all three groups in order to compare the groups against each other.

The means of the initial tests in each activity were compared first to see if any significant differences existed among the groups before the course work began. The estimated error variance of the three initial tests is presented in Table 7.

TABLE 7

ESTIMATED ERROR VARIANCE OF MEAN RECOVERY PULSE RATE SCORES OF ALL SUBJECTS ON THE INITIAL TEST

GROUP		MEAN $\bar{X}$	NUMBER N	SUM OF SQUARES ΣX^2	SUM OF SCORES SQUARED / BY NO. $(\Sigma X^2)2/N$	SUMMATION OF SQUARES SS
Swimming	(S1)	84	19	141150	134064	7086
Tennis	(T1)	77.48	23	142758	138066.26	4691.74
Modern Dance	(D1)	75.15	26	151006	146850.62	4155.39

The following formula was used to compare groups with unequal numbers:[1]

$$RP=(Se)(rp)\sqrt{1/2(1/N_a+1/N_b)}$$

Se= 15933.13

Se=15.64

dr=65-3=62

rp=2.98

$RP=(Se)(rp)\sqrt{1/2(1/Na+1/Nb)}$

$R_3=(15.65)(2.98)\sqrt{1/2(1/19=1/26)}$

$R_3=9.95233580$

Mean difference=8.85

The difference obtained from the extreme means did not exceed R_3; therefore, no significant differences existed between the groups on the initial test which was given during the first week of the semester.

[1] Ibid.

The midpoint and final tests of all three groups were compared simultaneously to determine the significance of the differences occurring after the initial test. The estimated error of variance is presented in Table 8.

TABLE 8

ESTIMATED ERROR VARIANCE OF MEAN RECOVERY PULSE RATE SCORES OF ALL SUBJECTS ON MIDPOINT AND FINAL TESTS

GROUP & TEST	MEAN X	NUMBER N	SUM OF SQUARES ΣX^2	SUM OF SCORES SQUARED / BY NUMBER $(\Sigma X)^2/N$	SUMMATION OF SQUARES SS
Swimming (S2)	77.63	19	120009	114506.5	5502.5
Swimming (S3)	80.16	19	127191	122080.47	5110.53
Tennis (T2)	76.35	23	139126	134066.78	5059.22
Tennis (T3)	78.26	23	147618	140869.57	6748.44
Modern Dance (D2)	64.38	26	109310	107779.85	1530.16
Modern Dance (D3)	70.08	26	128474	127680.15	793.85

$$Se = \sqrt{\frac{SS+SS+SS+SS+SS+SS}{(N_1-1)(N_2-1)(N_3-1)(N_4-1)(N_5-1)(N_6-1)}} \qquad Se=13.80$$

The mean recovery pulse rate scores of the midpoint and final tests for all three groups were ranked from highest to lowest.

(S3)	(T3)	(S2)	(T2)	(D3)	(D2)
80.16	78.26	77.63	76.35	70.08	64.38

The extreme means of the six groups were compared. When a significant difference was found between two means, the next extremes were compared. This process continued until the difference between the means did not exceed the RP. The results of this comparison are presented in table 9.

TABLE 9

VARIANCE ANALYSIS OF MIDPOINT AND FINAL TESTS FOR THREE GROUPS

GROUPS COMPARED LOW	HIGH	(rp)	(RP)	MEAN DIFFERENCE	SIGNIFICANT AT .05 LEVEL OF CONFIDENCE *
D2	S3	3.15	9.24	15.77	*
D3	S3	3.09	9.00	10.08	*
T2	S3	3.02	8.74	3.81	-
D2	T3	3.09	8.62	13.88	*
D3	T3	3.02	8.43	8.18	-
D2	S2	3.02	8.89	13.25	*
D3	S3	2.92	8.60	7.55	-
D2	T2	2.92	8.15	11.96	*
D3	T2	2.77	7.93	6.27	-

Between group analysis showed no significant differences between the means of the swimming, tennis and modern dance groups on the initial test. The recovery pulse rate scores obtained from the midpoint test of subjects enrolled in modern dance were significantly lower than the midpoint and final test scores of all groups. The final test scores of thoses subjects enrolled in modern dance were significantly lower than the final test scores of those subjects enrolled in swimming.

Summary

In this chapter of the thesis, the investigator submitted an analysis and interpretation of the data collected. It was found that students enrolled in a one-semester course in swimming and tennis did not make significant gains in cardiovascular efficiency scores as determined by the Hodgkins-Skubic Test. It was also found that students enrolled in a one-semester course in modern dance had made significant gains in cardiovascular efficiency scores at the midpoint of the semester but did not retain this significant gain at the close of the semester. The group comprised of modern dance students showed significantly lower recovery pulse rate scores on the midpoint test than any other group tested.

In chapter IV of this thesis, the investigator will present a summary of the study, conclusions based upon the findings, and recommendations for further studies.

CHAPTER IV

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Cardiovascular efficiency is defined by Holmgren as "the oxygen-forwarding capacity of the cardiorespiratory system."[1] Two convective systems -- the pulmonary ventilation and the blood circulation, along with two diffusing systems -- the alveolar-capillary and tissue-capillary cell systems forward the oxygen from the surrounding atmosphere to the site of oxidative metabolism. Physical fitness depends on the net transport capacity for oxygen of this system.[2]

The functional capacity of the oxygen-transport is described as the maximal cardiac output and the stroke volume that is maintained during maximal work. Hyperkinetic circulation, a condition in which oxygen is forwarded with a larger than normal cardiac output, thus becomes a prime concern to the physical educator and an important objective of the physical education activity program.

The present study was undertaken to determine the relationship between selected physical education activities and changes in cardiovascular efficiency as determined by the post-exercise pulse rate count. The study entailed the administration of the Hodgkins-Skubic

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[1]A. Holmgren, "Cardiorespiratory Determinants of Cardiovascular Fitness," International Symposium on Physical Activity and Cardiovascular Health, Volume 96, Number 12 (March 25, 1967), p. 697.

[2]Carl E. Willgoose, Evaluation in Health Education and Physical Education (New York: McGraw-Hill Book Company, Inc., 1961), p. 106.

Test to three groups of college women enrolled in the required physical education program at the University of Arkansas, Fayetteville, Arkansas, during the academic year of 1967-1968. The test was administered to sixty-eight subjects prior to, at the midpoint, and after the completion of a one-semester course in swimming, tennis and modern dance respectively.

A survey of literature concerning the relationship between selected physical education activities and changes in cardiovascular efficiency revealed no investigation identical to the present study.

The data collected from the administration of the Hodgkins-Skubic Test were treated statistically to determine significant differences within each group and between the three groups. The Duncan Multiple Range Test[1] was selected and applied because of the advantage it affords in analyzing group data when the groups are of unequal number.

Discussion of Findings

The analysis of the variance within the group showed no significant change in cardiovascular efficiency scores among students enrolled in swimming and tennis. This finding supports the basic hypothesis of the study in that no significant change in cardiovascular efficiency was demonstrated after the completion of a one-semester course in swimming and tennis.

A within group analysis of the variance did show a significant gain in cardiovascular efficiency scores of subjects enrolled in modern dance. The improvement was observed between the initial test to

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[1] Allen D. Edwards, *Experimental Design in Psychological Research*, (New York: Holt, Rinehart and Winston, 1964), pp. 136-140.

the midpoint test. The final test given at the completion of the semester showed that the gain in cardiovascular efficiency did not persist into the third testing period. This apparent decrease in cardiovascular efficiency after the midpoint test among students enrolled in modern dance was attributed to the introducation of dance composition involving primarily group choreography, which reduced the concentration on the dance techniques that had been stressed during the first nine weeks of instruction.

The between group analysis of the variance showed no significant differences between the initial tests of the three groups. This finding established the fact that no significant difference in cardiovascular efficiency existed between the subjects enrolled in the three activity courses at the beginning of the semester.

When the midpoint and final test scores of all three groups were compared simultaneously, it was found that the midpoint test scores obtained from subjects enrolled in modern dance were significantly lower than all other test scores. The final test scores of those subjects enrolled in modern dance were significantly lower than the final scores of those subjects enrolled in swimming.

Conclusions

The following conclusions are based upon the findings of the study:

1. A one-semester course in beginning modern dance appeared to contribute significantly to the development of cardiovascular efficiency as measured by post-exercise pulse rate count during the period in

which the class activity consisted primarily of learning and perfecting modern dance techniques.

2. A one-semester course in beginning tennis did not result in significant changes in cardiovascular efficiency scores as measured by post-exercise pulse rate count.

3. A one-semester course in beginning swimming did not produce significant changes in cardiovascular efficiency scores as measured by post-exercise pulse rate count.

4. A one-semester course in beginning modern dance did not contribute significantly to the development of cardiovascular efficiency as measured by post-exercise pulse rate count while class activity consisted of instruction and practice in dance composition.

Recommendations for Further Studies

1. The relationship between selected physical education activities and changes in cardiovascular efficiency as measured by post-exercise pulse rate utilizing electronic counting equipment.

2. A comparison of the relationship between selected physical education activities and changes in cardiovascular efficiency in men and women.

3. The relationship between beginning, intermediate, and advanced modern dance activity classes and changes in cardiovascular efficiency as measured by post-exercise pulse rate count.

4. The relationship of selected modern dance techniques and changes in cardiovascular efficiency as measured by post-exercise pulse rate count.

5. The relationship between activity courses in advanced swimming and advanced modern dance and changes in cardiovascular efficiency as measured by post-exercise pulse rate count.

6. The relationship between the activities of swimming, tennis and modern dance and changes in muscular strength.

7. The relationship between the activities of tennis and modern dance and the development of agility.

8. A comparison of the reliability of all step tests for cardiovascular efficiency.

9. The relationship between dance techniques designed by selected dance authorities and the development of cardiovascular efficiency.

TABLE 1

COURSE OUTLINE
BEGINNING SWIMMING

WEEK	DESCRIPTION
1	Introduction to breath holding, rhythmic breathing drill, floating and kick glides (front and back)
2	Propulsion (kick glides and coordinated stroking on front)
3 and 4	Practice of skills Front crawl
5 and 6	Practice of skills Coordinated stroke on the back (back crawl)
7 and 8	Review of skills Introduction of diving
9	Introduction of whip kick and elementary back stroke
10	Review and practice
11	Introduction of scissor kick and side stroke
12	Practice new strokes
13 and 14	Introduction of breast stroke and review other strokes
15 and 16	Christmas Holidays
17	Distance swimming Review of five strokes
18	Testing periods

TABLE 2

COURSE OUTLINE
BEGINNING TENNIS

WEEK	DESCRIPTION
1	Introduction to Tennis Ball - racket drills Grip Courtesy stroke (forehand)
2	Presentation of forehand stroke
3	Review forehand Presentation of backhand stroke
4 - 6	Review and practice of forehand, backhand courtesy stroke Forehand and backhand ground stroke Skill test on courtesy stroke
7	Presentation of serve
8	Review serve Lecture on rules
9	Review all shots Review of rules (film) begin game play
10 and 11	Game play Serve test
12	Net volley Game play
13 and 14	Review of all skills Dyer Backboard Skill Test Skill practice Quiz on rules Game play (begin class tournament)
15 and 16	Christmas Holidays
17 and 18	Review rules for test Tournament play Completion of skill testing Rule test

TABLE 3

COURSE OUTLINE
BEGINNING MODERN DANCE

WEEK	DESCRIPTION
1	Introduction to Modern Dance Lecture and discussion
2	Presentation of axial movement Basic warm-up techniques
3	Review of axial techniques Presentation of new techniques Introduction of one basic locomotor movements (walk with variations in style, direction and rhythm)
4 - 6	Review of all techniques Presentation of new techniques Presentation of run, skip, slide and jump Practice in combining various locomotor movements
7	Review of all basic locomotor techniques Introduction to derived movement
8	Presentation of derived movements Practice in various combinations
9	Review axial, locomotor and derived movements Skill test
10	Presentation of qualities of movement (lecture, demonstration and experimentation)
11	Experimentation in qualities of movement Introduction of factors related to movement
12	Experimentation with factors related to movement (motivation) Discussion of abstraction and distortion
13 and 14	Introduction of rhythm Lecture, discussion Movement phrases based on rhythmic devices
15 and 16	Christmas Holidays
17 and 18	Introduction to compositional form (lecture, discussion and reading assignment) Development of movement studies based on compositional form Evaluation of movement studies

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