THE RELATIONSHIP BETWEEN THE NORTH CAROLINA FITNESS TEST AND SELECTED CARDIOVASCULAR INDICES: BLOOD PRESSURE HARVARD STEP TEST, AND ENDURANCE RUN

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by
Jill Laughridge Barr
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J.L.B.

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

Physical education strives to promote social, physican and mental development of every individual. In the physical area of this aim, physical education endeavors to bring about certain desirable physiological changes through programs of exercise and activities designed to increase the physical fitness of the individual. To determine the degree of physical fitness resulting from physiological changes, there should be ways of measuring these changes. Tests have been devised to measure strength, endurance, agility, and speed by construction of general motor fitness tests.[1] In the area of physiological testing, tests have been developed in an attempt to measure the condition of the cardiovascular system, oxygen utilization, and respiration.[2]

Exercise, which is obtained in the physical education program benefits two physiological areas simultaneously.

> During vigorous exercise, the blood circulation quickens--blood and lymph stream through the muscles, supplying the cells with oxygen and nutrition and

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[1]Charles Mc Cloy and Norman Young, Test and Measurements in Health and Physical Education (New York: Appleton-Century-Crafts, Inc., 1954), pp. 208-225.

[2]Harrison Clarke, Application of Measurement to Health and Physical Education (Englewood Cliffs: Prentice Hall, Inc., 1959), pp. 94-119.

> removing waste products. The heart's activity is accelerated, exercising and strengthening its own fibers, as well as pumping the blood and stimulating its circulation. Muscles are enlarged and their endurance is increased through strenuous exercise. The gain in endurance of a muscle, however, is out of all proportion to its size. Therefore, the quality of contractions must be improved through such factors as: fuel is made available in greater amount; oxygen is more abundant, owing to improved circulation of the blood through the muscle; better coordination of the individual muscle fibers and more complete use of all muscle fibers are realized. Thus, the cardiovascular system performs a vital service in the performance of sustained muscular activity.[3]

I. THE PROBLEM

Statement of the problem. It was the primary purpose of this study to determine the relationship between the North Carolina Fitness Test and a selected cardiovascular index. The secondary purpose was to determine the relationship between the North Carolina Fitness Test and each of the cardiovascular tests: (1) blood pressure, (2) modified form of the Harvard Step Test, and (3) a 200 yard endurance run.

Importance of the study. Since this investigator found little material available which indicates a relationship between the cardiovascular system and general motor fitness, it seemed important to try to determine the degree of relationship between the two.

If a significant degree of relationship exists, one

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[3] Ibid., p. 94.

area of physiological testing could be substituted for the other area. Therefore, the North Carolina Fitness Test could be used as a measure of cardiovascular functions or the cardiovascular tests, separately or as a unit, could be used to measure general motor fitness.

This study may be of interest to physical educators who are interested in the relationship between the test of general motor fitness and the cardiovascular tests which were used in this study. It may be of interest to the persons responsible for the construction of the North Carolina Fitness Test.

II. DEFINITION OF TERMS USED

Cardiovascular. The function of blood flow through the heart and blood vessels in order to provide fuel and oxygen and remove waste products, water, and carbon dioxide.[4]

Cardiovascular tests. Measurements which are used to estimate the nature of efficiency of circulation and respiration. Included in these are blood pressure, pulse rate, vital capacity, breath holding, oxygen consumption,

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[4]Leonard Larson and Rachel Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education (St. Louis: C. V. Mosley Company, 1951), p. 45.

basal metabolic rate, respiratory rate, respiratory quotient, cardiac output, and blood analysis for hemoglobin, red cells, ph, glucose, and lactate.[5]

Systolic pressure. The maximum pressure caused by the systole of the heart or pressure during the contraction period.[6]

Diastolic pressure. The minimum pressure in the artery between heart beats or the pressure at the end of the diastole or during relaxation.[7]

Pulse pressure. The difference between systolic and diastolic pressure. It is the pressure beyond the minimum (diastolic) which is one of the factors causing blood flow.[8]

Pulse. The pulse is the swelling of the arteries due to the rhythmic rise in arterial pressure from the intermittent contractions of the left ventricle during the heart's systole.[9]

Physiological. Characteristic of or promoting

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[5]Ibid., p. 42.

[6]Ibid., p. 46.

[7]Ibid.

[8]Ibid.

[9]Ibid.

normal, or healthy, functioning.[10]

Motor ability. The present level of skill performance.[11]

Motor ability tests. Tests which measure the motor educability and achievement of an individual.[12]

Correlation. Expression of the degree of relationship between two or more variables in the form of coefficients of correlation.[13]

Coefficient of correlation. Correlation is expressed by several numerical expressions or indices. The term is most frequently used as applying to the index obtained by the Pearson product-moment method.[14]

Motor fitness. A limited phase of general motor ability, with emphasis placed on the underlying elements of

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[10]Webster's New Twentieth Century Dictionary of the English Language (2nd ed.), (Cleveland and New York: The World Publishing Company, 1961), p. 1483.

[11]Larson and Yocum, op. cit., p. 24.

[12]M. Gladys Scott and Ester French, Evaluation in Physical Education (St. Louis: The C. V. Mosley Company, 1950), pp. 191-193.

[13]Irene Palmer, Tests and Measurements (New York: A. S. Barnes and Company, 1932), p. 33.

[14]Ibid., p. 135.

vigorous physical activities, but does not include the primary elements of coordination and skills.[15]

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[15]Clarke, op. cit., p. 221.

CHAPTER II

REVIEW OF THE LITERATURE

The literature reviewed was limited to that pertaining to cardiovascular testing and the relationship between cardiovascular tests and tests of strength and endurance. All literature reviewed by the investigator was limited to the Appalachian State Teachers College Library.

I. LITERATURE RELATED TO THE RELATIONSHIP BETWEEN CARDIOVASCULAR TESTS, ENDURANCE, AND STRENGTH

There have been studies conducted which indicate a relationship between general strength and cardiovascular functions and between general endurance and cardiovascular functions.

Flannagan[1] conducted a study attempting to measure endurance by using a cardiovascular test, the Pulse-Ratio Test. This test was correlated with an Endurance Index, which consisted of the speed on a 60 yard run divided by the speed on a 220 yard run. A correlation of .888 ± .031 was obtained which showed a strong relationship between the endurance of a sprinter and his physical efficiency as

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[1]Kenneth Flannagan, "The Pulse-Ratio Test, A Measure of Athletic Endurance in Sprint Running," Supplement to the Research Quarterly, Vol. VI, No. 3 (October, 1935), pp. 46-50.

determined by the Pulse-Ratio Test. Flannagan concluded that the Pulse-Ratio Test is a reliable criterion for endurance.

Henry and Kleeberger[2] conducted a similar experiment and obtained a coefficient of correlation of .46 between the Pulse-Ratio Test and endurance in sprint running when the influence of speed is held constant. They concluded from their study that general muscular endurance is probably not a determining factor in the Pulse-Ratio Test and that initial strength may be a small positive factor.

Rifenberick[3] studied the relationship between cardiovascular test scores and strength by using the Pulse-Ratio Test and the Roger's Physical Fitness Index (PFI). The subjects were seventh and eighth grade boys to whom the tests were administered in the fall and in the spring. The coefficients secured for the eighth grade were .80 in the fall and .83 three months later in the spring. The seventh grade coefficients were .94 in the fall and .90 in the spring. The data were computed by the use of the Spearman-Brown-Rank Difference Correlation.

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[2]Franklin M. Henry and Frank L. Kleeberger, "The Validity of the Pulse-Ratio Test of Cardiac Efficiency," Research Quarterly, Vol. IX, No. 1 (March, 1938), pp. 32-46.

[3]Robert H. Rifenberick, "A Comparison of Physical Fitness Ratings as Determined by the Pulse-Ratio and Rogers Test of Physical Fitness," Research Quarterly, Vol. XIII, No. 1 (March, 1942), pp. 95-100.

According to Rifenberick:

> Investigators have been experimenting for a great many years with tests and measures for rating physical conditions and efficiency. Many of these have been useful within limits but still admittedly limitations exist with all. No test of this type can be accepted as an infallible tool with which physical or athletic ability could be predicted without error.
>
> However, the results have considerable value when properly weighed and considerations are given to them.[4]

Contrary to the preceeding study, Cureton and Whickens[5] experimented with a cardiovascular test and its relationship between strength and endurance and obtained quite different results. They obtained a coefficient of .06 between the Center of Gravity Test and the Mc Curdy-Larson Test of organic endurance. In this same study a coefficient of correlation of .506 was obtained between the Rogers Strength Test and the Center of Gravity Test and a coefficient of correlation of .75 between the Rogers PFI and the Center of Gravity Test.

Cureton and Whickens concluded from this study:

> That muscular strength is not correlated with organic endurance condition, a quality probably more dependent upon the strength of the circulatory system, condition of vessels, the blood, and by suppleness.[6]

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[4] Ibid.

[5] Thomas K. Cureton and J. Stuart Whickens, "The Center of Gravity Test and Its Relation to Posture, Physical Fitness, and Athletic Ability," Supplement to the Research Quarterly, Vol. VI, No. 2 (May, 1935), pp. 93-105.

[6] Ibid.

Clarke[7] indicated that a study by Sambolin resulted in a significant correlation between Schneider, Crampton, and Mc Cloy's cardiovascular tests and the PFI battery.

Rogers[8] conducted a study between the relationship of effective conditions of voluntary muscle tissue and the organic conditions. A grip strength type of test was administered on a subject on several occasions. Rogers indicated that the grip strength test had a reliability coefficient of over .90.

There were two significant statements from this study pertaining to the relationship between strength and cardiovascular functions:

> Experiences are multiplying which reveal beyond preadventure, the truth of the following rule: Practically every change in the condition or functioning of the vital organs has a corresponding change in the condition or functioning of voluntary muscles.
>
> The corollary to the rule stated above---strength tests when scores therefore are statistically combined in the Physical Index reveal organic fitness or lack of fitness with remarkable degree of validity---has been established objectively.[9]

From this literature, it can be concluded that there

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[7]Harrison Clarke, Application of Measurement to Health and Physical Education (Englewood Cliffs: Prentice Hall, Inc., 1959), p. 112.

[8]Frederick Rogers, "The Significance of Strength in Revealing Physical Condition," Research Quarterly, Vol. V (October, 1934), pp. 43-46.

[9]Ibid.

are conflicting reports concerning the relationship of cardiovascular test and test of general strength and endurance. The results ranged from a coefficient of correlation of .89 to a seemingly insignificant coefficient of .06. Evidence indicates some relationship between cardiovascular functions and general strength and endurance.

II. LITERATURE RELATED TO THE CARDIOVASCULAR TESTS USED IN THIS STUDY

A study of blood pressure by Schwarts, Britton, and Thompson[10] revealed a coefficient of reliability of .65 for the systolic pressure, .46 for the diastolic pressure, and a .46 for the pulse pressure. To obtain these correlations, two sets of blood pressure measurements, using the same subjects and conditions, were made six months apart and correlated with each other to establish a coefficient of reliability.

McCurdy and Larson conducted a similar study and found a much higher degree of reliability. They stated that "the coefficient of reliability represents the correlation between two sets of measurements of blood pressure which have been made by the same examiner, using the same instruments, and under precisely the same 'experimental

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[10]Clarke, op. cit., p. 96.

conditions.'"[11] The purpose of their study was to find out if a measurement of blood pressure could be used as an index of physical condition. Larson obtained a coefficient of .952 for the systolic pressure, .718 for the diastolic pressure, and .932 for the pulse pressure. McCurdy obtained a coefficient of .853 for the systolic pressure, .813 for the diastolic pressure, and .905 for the pulse pressure.

McCurdy and Larson concluded that the low coefficients reported by Schwartz, Britton, and Thompson on their blood pressure tests were due to "experimental conditions." Schwartz and his associates measured the blood pressure in February and a second time in June. According to McCurdy and Larson "true reliability for the blood pressure measurement can only be obtained when the 'experimental conditions' are so arranged that there will be no fluctuation in the pressure."[12]

Brouha and his colleagues developed a test in the Harvard Fatigue Laboratories during World War II. Testing Harvard undergraduates they found that the scores of the individual improved under training and decreased after termination of the training. "This test is considered to be

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[11] J. H. McCurdy and L. A. Larson, "The Reliability and Objectivity of Blood Pressure Measurements," Supplement to the Research Quarterly, Vol. VI, No. 2 (May, 1935), pp. 3-10.

[12] Ibid.

useful in separating the least fit from the fit, and the fit from the very fit to provide each group in turn with conditioning programs to meet its needs."[13]

Morehouse and Miller[14] indicate several uses of the Harvard Step Test. It has been used to detect alterations in physical condition in subjects who were on a reduced calorie intake, and on subjects with a restricted vitamin B complex diet. Modification of the test has been used in programs of rehabilitation and convalescence in a study of neurocirculatory asthenia. For physical education the test may be an indicator for a program of physical training. It may determine if the optimal amount of training is sufficient, if segregated classes are needed for the students so as not to over work or under work them, and if a student has improved enough to be transferred to other classes where he can be receiving optimal training.

The literature dealing with cardiovascular tests and general motor fitness tests is quite extensive. There have been several studies which have indicated the relationship between cardiovascular function and general strength and endurance. However, there does not seem to be any test

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[13]John Bovard, Frederick Cozen, and Patricia Hagman, Test and Measurements in Physical Education (Philadelphia: W. B. Saunders Company, 1950), p. 76.

[14]Laurence E. Morehouse and Augustus Miller, Physiology of Exercise (St. Louis: C. V. Mosley Company, 1953), p. 265.

which measures general motor fitness and cardiovascular functions at the same time.

CHAPTER III

PROCEDURES

I. SELECTION OF TESTS

Four tests were needed to measure characteristics pertinent to this study---general motor fitness, condition of the circulatory system, compensation of the heart, and an endurance run measurement.

The North Carolina Fitness Test, complied by the North Carolina Association for Health, Physical Education, and Recreation, was chosen to measure motor fitness. This test was published near the time this study was begun.

Information concerning this test was published in the form of a test manual by the North Carolina Association for Health, Physical Education, and Recreation.[1]

To measure the condition of the circulatory system three tests were used. This writer thought the blood pressure measurement would give a general indication of the heart force and the blood vessels. Instruments for conducting this test, a spring manometer and a stethscope, were available with a competent person to give the instruction for their use. Also, there was sufficient time made

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[1]Harold Barrow and Rosemary McGee, North Carolina Fitness Test (Minneapolis:Burges Publishing Company, 1961), pp. iii-4.

available for practice before using the instruments for obtaining blood pressure data.

The Harvard Step Test was selected for measuring the ability of the heart force to compensate for exercise. The test was adapted for administration to high school girls.[2]

Endurance was measured by administration of a 200 yard run. This distance was decided upon after reviewing the literature and conferring with the writer's committee chairman.

The scores obtained from the combined cardiovascular indices, blood pressure, Harvard Step Test (modified form), and endurance run, were used as one variable and the scores from the North Carolina Fitness Test were used as the other variable in computing the coefficient of correlation needed for prediction of this study.

Each of the tests used in this study is included in Appendix "A".

II. TESTING PROCEDURES

The subjects used for this study were freshman and sophomore girls in the required physical education classes

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[2]Peter V. Karpovich, Physiology of Muscular Activity (Philadelphia: W. B. Saunders Company, 1955), pp. 270-271.

at Appalachian High School, Boone, North Carolina. One hundred and thirty girls were tested at the beginning of this study, but due to absences from school, one hundred girls completed all of the testing program. The data secured from testing those one hundred girls were used.

The test items in each of the test areas were explained and demonstrated to the group before each test was administered. The subjects were encouraged to do their best.

Blood pressure. The blood pressure measurements were taken during the class period devoted to health education for each group, prior to administration of any other test. Ordinary street clothes were worn by the group. The adjoining office of the health classroom was used for administering the test wherein the instruments, a spring type manometer and a stethoscope, were set up. The writer measured the blood pressure of each subject and an assistant recorded the readings. The writer, the assistant, the subject taking the test, and a waiting subject were in the office at one time. The waiting subject was required to sit to allow the circulatory system to reach a resting level. The blood pressure measurements were completed in one day.

The North Carolina fitness test. This test was administered the day following the blood pressure

measurement. The subjects wore one piece gym uniforms and gym shoes. The test was conducted in the gymnasium of the high school. This testing area was divided into four test stations, one area for each of the four test items to be administered. Each station was given the number of 1, 2, 3, or 4 as directed by the test manual. After the test at each station was completed, a signal was given by the investigator, and each group proceeded to the next numerical station.

At each test station an instructor was assigned to give instructions, to demonstrate the test items, to state the rules, and to administer that particular test item. The class was divided into four groups, and students were paired within the group. Each subject was given a score card to take to each station for recording her scores.

Sit-ups. The equipment needed for this test was a watch with a second hand. The group was divided into two units, with one unit being rested for thirty seconds and the partner keeping score. The units then reversed their position and followed the same procedures. The partner related the score of the subject to the instructor, who recorded it on the score card.

Side stepping. This item required a watch with a second hand for timing the subjects and two strips of tape

to mark off an area of eight feet in which the subject performed. The same procedures were used as in the sit-ups. One unit performed the test item for thirty seconds, with their partners keeping score, and then the units reversed their positions and the same procedures were followed.

Standing broad jump. Each subject was given three jumps. A strip of tape was used to indicate the base line for the beginning of the jump and several small strips of tape were used to mark the distance of 4, 5, and 6 feet from the base line. The inches were measured by the instructor with a tape measure from the small strip of tape nearest the jump. The best of the three jumps was recorded.

Squat thrust. At this station, the group was again divided into two units. The first unit performed the test for thirty seconds, while the second unit was assigned as their partners to keep score. The same procedures were followed for the second unit to perform the test with their partners from the first unit keeping score. The instructor recorded the scores as related to her by the partner of each subject.

The four test items of the North Carolina Fitness Test were completed in one day.

The Harvard Step Test. A modified form of this test

was used for high school girls. The test consisted of twenty-four steps per minutes onto a bench sixteen inches high. The cadence of up, two, three, four was recorded on a magnetic record tape. The recording was played each time the test was given in order to insure a regular cadence.

The subjects were dressed in their regular gym uniforms and gym shoes. This test was administered in the high school gymnasium during a period of two days.

Four benches were used with one participant and one instructor at each bench. Two members of the divided groups sat on either end of the bench for support. On the signal to begin, the tape was started, and each of the four subjects began stepping up and down in time with the cadence on the tape.

After the five minute period, each of the subjects was seated on the bench with the instructor recording the time the subject endured the test. When one minute had elapsed after the subject had been seated, the instructor took the pulse count for thirty seconds and multiplied it by two, and the results were recorded on the subject's card. The pulse was taken again after two minutes and again after three minutes had elapsed, following the same procedure as above.

Those subjects who could not endure the five minute period were seated immediately after they stopped stepping,

and their pulse was taken three times by the same procedure as for those who endured the test for five minutes.

When all four subjects had been tested, and the three pulse counts had been recorded, four different subjects would take their place with the same procedure being followed as used for the previous group.

The index of fitness for this test was the time they stepped in seconds, multiplied by 100, and divided by two times the sum of the three counts of the pulse. This score was recorded on the cards.

Endurance run. The Appalachian State Teachers College Football Field was used for the 200 yard endurance run. The subjects ran 100 yards down the field and then back up the field to the starting point. Each class was divided into four groups, each group forming a line, with an instructor to record the time the subjects required to finish the run. The investigator stood in the center of the four groups and gave the signal to start. As the first runner approached the end of the 200 yard run, the investigator started counting aloud the seconds that had elapsed, and each instructor recorded, to the nearest second, the time for her runner. This procedure continued until all the subjects had been tested. The test was completed in one day.

The administration of the four tests used in this

study was completed in one week and a half. Two factors caused the time devoted to testing to be longer than desired: (1) unavailability of testing areas, and (2) time was allowed for the subjects to overcome any soreness of the muscles before the next test began.

CHAPTER IV

ANALYSIS OF DATA

I. ORGANIZATION AND COLLECTION OF DATA

The data were recorded on 5 by 7 inch cards, one for each individual. On one side of the card, space was available for the cardiovascular index. This included the diastolic and systolic readings, pulse pressure, endurance run in seconds, and the score for the Harvard Step Test. On the other side of the card, the scores made on the North Carolina Fitness Test were recorded. The name, height, weight, and class of each student were recorded at the top of the card.

II. SELECTING METHODS FOR TREATING RAW DATA

The methods of treating the raw data described below were chosen.

The raw scores for each test were unrelated and therefore they were converted to standard scores to facilitate interpretation of these data. T-scores were used as the standard scores.

T-scores were obtained for the four items in the North Carolina Fitness Test, the Blood Pressure Test, the modified form of the Harvard Step Test, and the Endurance

TABLE I

T-SCORES AND CORRESPONDING RAW SCORES FOR THE CARDIOVASCULAR TESTS: BLOOD PRESSURE, HARVARD STEP TEST AND ENDURANCE RUN

T-Scores	Raw Scores			T-Scores	Raw Scores		
	B.P.[1]	H.S.T.[2]	E.R.[3]		B.P.	H.S.T.	E.R.
87	67			44		32	
86				43	42	31	
85				42	41	30	36
84				41		29	
83				40	40	28	35
82				39	39		
81	66			38		27	
80				37	38		34
79	65			36		25	
78	64			35	37	24	33
77		59		34	36	23	
76	63			33			
75	62		48	32	35		32
74				31	34	21	
73	61		47	30			
72	60			29	33	19	31
71				28	32	18	
70	59	53	46	27			
69				26	31	17	
68	58	51		25			
67	57	50	45	24	30		
66				23	29		
65	56	49		22			
64	55	48	44	21			
63		47		20		12	
62	54	46	43	19		11	
61	53	45		18			
60				17		9	
59	52	44	42				
58		43					
57	51	42					

[1]B.P. = Blood Pressure

[2]H.S.T. = Harvard Step Test

[3]E.R. = Endurance Run

TABLE I (continued)

T-SCORES AND CORRESPONDING RAW SCORES FOR THE CARDIOVASCULAR TESTS: BLOOD PRESSURE, HARVARD STEP TEST AND ENDURANCE RUN

T-Scores	Raw Scores			T-Scores	Raw Scores		
	B.P.	H.S.T.	E.R.		B.P.	H.S.T.	E.R.
56	50	41	41				
55		40					
54	49						
53	48	39	40				
52							
51	47	37	39				
50	46						
49		36					
48	45	35	38				
47	44	34					
46		33					
45	43		37				

TABLE II

T-SCORES FOR THE CORRESPONDING RAW SCORES OF THE NORTH CAROLINA FITNESS TEST: SIT-UPS, BROAD JUMP, SQUAT THRUST, AND SIDE STEPPING

T-Scores	Sit-Ups	Broad jump	Squat thrust	Side stepping
81				15
80				
79				
78				
77				
76				
75				
74				14
73				
72		77		
71	18	76		
70		75	15	
69				
68				
67				13
66	16	72	14	
65		70		
64	15	71		
63		70		
62	14	69		
61		68	13	12
60	13	67		
59		66		
58				
57	12		12	
56		65		
55	11	64		
54		63		11
53	10			
52		62	11	
51		61		
50	9	60		
49				
48	8	59	10	
47		58		10
46	7			
45		57		
44		56		
43		55	9	

TABLE II (continued)

T-SCORE FOR THE CORRESPONDING RAW SCORES OF THE NORTH CAROLINA FITNESS TEST: SIT-UPS, BROAD JUMP, SQUAT THRUST, AND SIDE STEPPING

T-Scores	Sit-ups	Broad jump	Squat thrust	Side stepping
42	5			
41		54		9
40		53		
39		52	8	
38	4			
37		51		
36	3	50		
35		49		
34	2		7	8
33				
32	1	47		
31				
30		6		
29				
28		45		
27				7
26				
25				
24				
23				
22				
21		4		
20	39			
19				
18				
17		3		
16				
15				
14				5

Run Test by setting up frequency tables and computing the means and standard deviations. Then using the T-score formula (Appendix "B"), a T-scale was constructed by adding the ratio of the standard deviation of the T-score and the standard deviation of the distribution to the obtained T-score just above the mean. By similar consecutive additions of this ratio, the T-score equivalents of the remaining raw scores above the mean were found. Then the T-score just below the mean was computed by the T-score formula, and the remaining T-scores of the raw scores were found by consecutive subtractions of the ratio as explained above.

The T-scores for the North Carolina Fitness Test and the Cardiovascular Index were obtained by adding the T-scores of each item in the tests for a total score, as indicated in the tables on the preceeding pages.

Pearson product-moment. A means of obtaining a coefficient of correlation between the tests was used to determine the relationship between the variables. The Pearson product-moment method was chosen because constructed charts could be purchased at a minimum cost, and the product-moment has become a standard method for computing correlations.

> There are various methods of computing correlations, but the standard method is known as the product-moment, and is signified by the symbol 'r,' also known as the

'Pearson-r,' after its originator.[1]

Four coefficients of correlation were computed by the product-moment method in order to determine the degree of relationship. Using the T-scores, the North Carolina Fitness Test was correlated with (1) blood pressure, (2) Harvard Step Test, (3) endurance run, and (4) the Cardiovascular Index. From each of these procedures a coefficient of correlation and a standard error of correlation were found.

The t-test. The t-test or t was used to determine the significance of the product-moment coefficient of correlation. The level of significance was obtained from a table of t.[2]

III. RESULTS OBTAINED FROM THE SELECTED METHODS

A coefficient of .65 or higher indicates statistically a significant degree of relationship between any two variables.[3]

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[1]Harrison Clarke, Application of Measurement to Health and Physical Education (Englewood Cliffs: Prentice Hall, Inc., 1959), p. 450.

[2]E. F. Lindquist, Statistical Analysis In Educational Research (Boston: Houghton Mifflin Company, 1940), pp. 53, 211.

[3]Irene Palmer, Test and Measurements (New York: A. S. Barnes and Company, 1932), p. 39.

The highest relationship found from this study was between the North Carolina Fitness Test and the endurance run. The coefficient was .40 with a standard error of .084. Although this correlation was not significant, it did indicate a moderate degree of relationship. This coefficient is significant beyond the .01 level of confidence.

TABLE III

TESTS CORRELATED WITH THE NORTH CAROLINA FITNESS TEST: CARDIOVASCULAR INDEX BLOOD PRESSURE, HARVARD STEP TEST, ENDURANCE RUN

Tests correlated with the North Carolina Fitness Test	Coefficient Correlation	Standard error	t /	Level of significance
Harvard Step Test	.30	.091	3.07	1%
Cardiovascular Index	-.07	.099	.69	50%
Blood Pressure	-.08	.099	.79	40%
Endurance Run	.40	.084	4.26	1%

As indicated in Table III above, the second highest relationship was between the North Carolina Fitness Test and the Harvard Step Test. The coefficient of correlation was .30, and the standard error was .091. This correlation indicated some degree of relationship and was significant at the .01 level of confidence.

The North Carolina Fitness Test and the Blood Pressure Test produced a -.08 coefficient of correlation and .099 standard error. This indicates no significant relationship between the two variables.

The lowest relationship, as revealed in Table III, was a coefficient of correlation of -.07 and a standard error of .099 between the North Carolina Fitness Test and the Cardiovascular Index. This indicates no significant relationship between the two variables.

CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY

The primary purpose of this study was to determine the relationship between the North Carolina Fitness Test and a selected Cardiovascular Index. The secondary purpose was to determine the relationship between the North Carolina Fitness Test and each of the cardiovascular indices: (1) blood pressure measurement, (2) modified form of the Harvard Step Test, and (3) a 200 yard endurance run.

If a significant degree of relationship existed, one area of physiological testing, general motor ability, could be substituted for the other area, cardiovascular functions. Therefore, the North Carolina Fitness Test could be used as a measure of cardiovascular functions or the Cardiovascular Index could be used to measure general motor ability.

The literature reviewed was limited to that pertaining to cardiovascular testing and the relationship between the cardiovascular tests and tests of strength and endurance. All the literature reviewed by the investigator was limited to that available in the Appalachian State Teachers College Library.

The instruments of measure used in this study were

the North Carolina Fitness Test, the modified form of the Harvard Step Test, blood pressure measurement, and a 200 yard endurance run. The subjects used for this study were freshmen and sophomore girls in the required physical education classes at Appalachian High School, Boone, North Carolina. The testing took place in the gymnasium and health classroom of the high school and on the Appalachian State Teachers College Football Field. All the tests used were completed in one week and a half.

The data were recorded on 5 by 7 inch cards, one for each individual. The raw scores were converted onto T-scores as the standard score used in finding a relationship.

The Pearson product-moment coefficient of correlation, and the t-Test were used in determining the relationships and the levels of statistical significance.

The relationships obtained were (1) between the North Carolina Fitness Test and the endurance run a coefficient of .40, a standard error of .084, and a .01 level of significance, (2) between the North Carolina Fitness Test and the Harvard Step Test a coefficient of correlation of .30, a standard error of .091, and a .01 level of significance, (3) between the North Carolina Fitness Test and the blood pressure a coefficient of -.08, a standard error of .099, and a .40 level of significance, and (4) between the

North Carolina Fitness Test and the Cardiovascular Index a coefficient of -.07, a standard error of .099, and a .50 level of significance.

II. CONCLUSIONS

Following are conclusions from this study:

1. The results obtained within the limitations of this study did not prove a significant relationship between any of the variables: North Carolina Fitness Test, modified form of the Harvard Step Test, Blood Pressure Test, and a 200 yard Endurance Run Test.
2. The North Carolina Fitness Test cannot be a predictor of cardiovascular functions and the Cardiovascular Index cannot be a predictor of general motor fitness.
3. The Harvard Step Test and the endurance run may be of value in further research that is trying to establish cardiovascular tests which can be used as a predictor of general motor fitness. The Harvard Step Test and the endurance run indicated a moderate degree of relationship when correlated with the North Carolina Fitness Test, revealing a coefficient of correlation of .30 and .40 respectively.
4. Because of the low coefficient of correlation obtained between the blood pressure measurement and the North Carolina Fitness Test, in comparison with the higher

relationship found between the other two variables and the North Carolina Fitness Test, it was assumed by this writer that the blood pressure measurement affected the low coefficient of correlation between the North Carolina Fitness Test and the Cardiovascular Index. If this assumption is true, this can be tested by omitting blood pressure from the Cardiovascular Index and then correlating the remaining items in the Cardiovascular Index with the North Carolina Fitness Test.

5. More research is needed to establish a relationship between test of cardiovascular functions and test of general motor ability in order to predict if one area of tests may be substituted for the other area of tests in predicting physical fitness.

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APPENDIXES

APPENDIX "A"

NORTH CAROLINA FITNESS TEST

1. SIT-UPS for Boys and Girls Age 9-17

   Description: The student lies on his back with his fingers clasped behind his neck and elbows touching the floor, his knees bent, and his feet flat on the floor pulled in close to his body. His feet are held secure by a partner. He sits up turning the trunk to the left touching the right elbow to the left knee, returns to the starting position, then sits up touching the left elbow to the right knee. The exercise is repeated as the students alternates sides.

   Scoring: One point is scored each time an elbow touches a knee. The score is the number of correct sit-ups performed in 30 seconds.

2. SIDE STEPPING for Boys and Girls Age 9-17

   Description: The student assumes a starting position with one foot touching a side line. On the signal to start he moves sideward with a side step leading with the foot nearest the line he is approaching and repeats this step until his foot has touched or gone beyond the line. He then moves to the other side line in the same manner.

Scoring: One point is scored each time the student touches a side line. The final score is the number of one way trips completed in 30 seconds.

3. STANDING BROAD JUMP for Boys and Girls Age 9-17

Description: The student should stand with his feet several inches apart and with his toes just back of the take-off mark. He may swing his arms and bend his knees in making the forward jump. The student must take off with both feet at the same time.

Scoring: The measurement is made from the take-off line to the nearest point where any part of the body touches the floor. Three trials are given and the best one is recorded in inches.

4. SQUAT THRUSTS for Boys and Girls Age 9-17

Description: The student starts in a standing position. (1) He goes to a full squat position placing the hands on the floor about shoulder width apart in front of the feet; (2) He thrusts both legs backward to a front leaning position with the body resting on both hands and toes and approximately straight from his shoulders to his feet; (3) He returns to the full squat position; (4) Then he stands erect.

Scoring: The score is the number of complete repetitions correctly executed in 30 seconds.

Step VIII.

Continue lowering the mercury column until a dull beat is heard. This is the 4th phase DIASTOLIC Reading.

Step IX.

Record blood pressure as systolic pressure of 120 and a diastolic of 70. This is recorded as 120/70.

Step X.

Remove cuff from the arm.[2]

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[2]Leonard Larson and Rachel Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education (St. Louis: C. V. Mosley Company, 1951), p. 63.

ENDURANCE RUN

The Appalachian State Teachers College Football Field was used for the 200 yard endurance run. The subjects ran 100 yards down the field and then back up the field to the starting point. Each class was divided into four groups, each group forming a line, with an instructor to record the time the subjects required to finish the run. The investigator stood in the center of the four groups and gave the signal to start. As the first runner approached the end of the 200 yard run, the investigator started counting aloud the seconds that had elapsed, and each instructor recorded, to the nearest second, the time for her runner. This procedure continued until all the subjects had been tested. The test was completed in one day.[3]

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[3]Decided on by investigator and her committee chairman.

APPENDIX "B"

TABLE IV

FORMULUS USED IN THIS STUDY

1. T-score $$T = \frac{10(X-m)}{S.D.} + 50$$

2. Standard Deviation $$S.D = i\sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2}$$

3. Mean $$m = Am + \left(\frac{fd}{N}\right)$$

4. Pearson product-moment Coefficient of correlation $$r = \frac{\frac{\Sigma X'y'}{N} - \left(\frac{\Sigma X'}{N}\right)\left(\frac{\Sigma y'}{N}\right)}{\sigma x \cdot \sigma y}.$$

5. Standard error of r $$\sigma r = \frac{1 - r^2}{\sqrt{N}}$$

6. t-Test $$t = \frac{r}{\sqrt{1-r^2}} \cdot \sqrt{N-2}$$