A PROGRESSIVE STEP TEST FOR ELEMENTARY SCHOOL GIRLS

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PREFACE

There is a vital need in this age of sedentary living to be able to determine accurately the condition of an individual at any given time. One's physical condition varies according to the demands placed upon the body. The individual body mechanism must be in adequate physical condition to respond to the circumstances of the moment.

This could be the endurance required by the housewife to keep up with her young children. It could be the stamina needed by a young Scout to hike five or ten miles, canoe for several days, or adjust to skiing in the mountains. It could be the extra push needed to win a race. Or it could even be the difference between life and death should disaster strike necessitating extended effort on the individual's part.

The most effective way to call to the attention of an individual this need for keeping physically fit is to accurately measure his present condition and compare it with his peers.

The writer is indebted to Dr. Aix B. Harrison for his guidance and assistance during the testing and preparation of this thesis.

Appreciation is also expressed to the girls who were so willing and interested in taking part in this research.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

One of the accepted objectives in physical education is the development of physical fitness. This area is thought of as a portion of one's total fitness which would include social, emotional and mental fitness. Physical fitness has been defined as the capacity to work hard over a long period of time without diminished efficiency.

Dr. Cureton using factor analysis has over the years narrowed the facets of physical fitness into the following categories: strength, balance, power, flexibility, agility and endurance.[1] The endurance phase includes neuro-muscular endurance as well as cardio-vascular or cardio-respiratory endurance. Endurance emphasizes the capacity for continuous exertion with partial recovery during exercise. Another manner of stating it is the ability to continue work.

Kasch states that cardiovascular endurance is the ability of the body's circulation to maintain a metabolic equilibrium over a period of sustained physical effort. This includes the transport of oxygen, carbon dioxide, and other metabolites.[2]

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[1]T. K. Cureton, "Unfitness of Young Men in Motor Fitness", Journal of the American Medical Association, CXXIII (1943), p. 69.

[2]F. W. Kasch, "New Evidence of Cardiovascular Endurance Training", Proceedings of the National College Physical Education Association for Men; January, 1965, p. 43.

There are two factors which determine the extent to which an individual can or will exert himself. One is physiological. The other is psychological. The physiological threshold of man is greater than the psychological. The limits of the former have not been reached to date.

There are two phases in total work capacity. The first is the aerobic phase, in which the oxygen supply to the body tissues covers adequately the requirements. The second phase is the anaerobic phase. In this phase the oxygen requirements exceeding the aerobic capacity are met by the body's ability to incur a certain amount of oxygen debt. The aerobic phase is in effect for work intensities up to the "crest load". The oxygen requirement increases continuously as the work increases. Once the oxygen requirement is larger than the oxygen intake the body goes into oxygen debt. Oxygen debt can be incurred only once during an exercise period.

A person with cardiovascular endurance is one whose hemeostatic mechanism is geared to make rapid adjustments as the metabolic demands on the body are increased. His blood circulates more freely and his pulmonary ventilation keeps up with the gaseous exchange requirements, which allow a higher threshold or higher level of steady work.

In other words, the fit individual usually shows the following physiological advantages over the unfit person performing the same piece of moderate work which both can sustain in a steady state: lower oxygen consumption, slower pulse rate during work, larger stroke volume of the heart, lower blood lactate during work and faster return of blood pressure and heart rate to normal after work.[3] He carries on a

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[3]Arthur H. Steinhaus, "Chronic Effects of Exercise", Physiological Review, XIII (1933), p. 103.

given grade of moderate work with less displacement of his physiological equilibria. He can establish steady states or physiological equilibria at higher grades of work.

The measurement of cardiovascular endurance is often accomplished by estimates of the cardiac output of the ventricles. This is not an easy procedure, therefore maximum oxygen intake is substituted. This method can be performed routinely in the laboratory and is most easily reproduced. It is also the most critical measurement available at present.

Teachers or physicians wanting to know the cardiovascular fitness or endurance of their students or patients may obtain it by measuring the crest load oxygen intake during sub-maximal exercise. The cardiovascular function or crest load or threshold as it is sometimes called, can easily be pinpointed by blood pressure and pulse rate measures. The physiological effect is estimated from the magnitude of the heart rate changes during exercise and from the rapidity of return of the heart rate to normal following the exercise. It will then be known how much stress can be placed on the student or patient or how much can be expected of him.

Dr. Balke has developed a treadmill test for measuring crest load which is generally accepted among physiologists and physical educators. He uses a treadmill moving at 3.6 m.p.h., elevating the treadmill to increase the work load. The subject walks on the treadmill for at least a ten minute period. The criteria is how long the individual can walk until anerobic work is reached.[4] This test has been used with adults as

[4]Bruno Balke, A Simple Field Test for the Assessment of Physical Fitness (Civil Aeromedical Research Institute, Oklahoma City, Oklahoma, 1963), p. 5.

well as with high school boys. Balke and Nagle correlated adult tread-mill results with those on a portable stepping device test they designed for this purpose and found a high relationship.[5]

Dr. A. B. Harrison and John Bayless of Oklahoma State University developed the test procedure used for testing children in the research they conducted on elementary school boys in 1965. Mr. Bayless is currently studying the validity of this test and the establishing of tentative norms for elementary school boys. It had been theorized by Balke and others that children respond differently from adults to this type of test in pulse rate and blood pressure patterns.

STATEMENT OF THE PROBLEM

The primary purpose of this study was to validate the step-test procedure for elementary school girls and to determine if there are greatly divergent reactions to tests of endurance between elementary school girls and those of boys at the same age. This study was undertaken to compare the reactions of upper elementary school boys and girls while performing on the portable stepping device. There was a need to see if separate norms for girls at the fourth, fifth, and sixth grade were necessary.

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[5]Nagle, F. J., Letter to Dr. A. B. Harrison, Oct., 1964.

Sub-problems of this study include:

1. determination of net oxygen debts
2. pulse rates reached at crest load
3. maximum systolic blood pressures at the crest load of intake
4. a determination of the time the girls could continue the exercise before reaching the crest load cut off or stopping point
5. measurement of energy costs in caloric usage
6. oxygen consumption at various work loads.

It is significant at this time to point out that there is a need for an endurance work capacity test for children. There are laboratory techniques in use but these are expensive and time consuming so are not practical for widespread use. The 600 yard walk-run is termed an endurance test in the AAHPER and Fleishman Fitness Tests. However, this area of each test has never been successfully validated.

The testing procedure using the portable stepping device and the monitoring of pulse rates could be the bridge between the laboratory type tests and the unvalidated endurance tests in use at present. This procedure has the validity and reliability of a laboratory test but is inexpensive and not as time consuming. A limitation of such a procedure is that it must be administered individually.

LIMITATIONS OF THE STUDY

A limiting factor in the interpretation of the data would be the number of subjects involved. Due to the great amount of time involved in accurately testing each individual, the number of subjects had to be kept small.

Random selection was not used in choosing the subjects. Individuals from each age category were asked by the writer to take part in the research.

There were not sufficient numbers tested to establish norms for future use of this test which could be used with complete confidence.

The exposure to the laboratory setting with strange equipment and the excitement of a new experience undoubtedly had a tendency to affect the resting data and possibly other periods during the testing procedure.

CHAPTER II

REVIEW OF LITERATURE

Step tests have been in use for two decades for determining work capacity of individuals. The first test of this type developed and used somewhat universally was the Harvard Step Test. This is a five minute test developed during World War II at the Harvard University Fatigue Laboratory by Dr. Lucien Brouha and his associates.[1] It is designed to measure cardiovascular fitness for muscular work and the ability to recover. The test consists of stepping onto a bench twenty inches high at a rate of thirty steps/minute for five minutes. Three pulse counts are taken following exercise at ½ minute intervals. The Index of Physical Efficiency is computed by the following formula:

$$\text{Index of PE} = \frac{100 \times \text{duration of exercise}}{2 \times \text{total pulse counts in recovery}}$$

They devised a chart to indicate the level at which the individual was operating contingent upon his pulse rate following exercise and the length of time he continued the test.

above 90 = excellent
80-89 = good
65-79 = high average
55-64 = low average
below 55 = poor physical condition

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[1] L. Brouha, A. Graybiel, and C. W. Heath, "Step Test", Revue Canadienne de Biologie, II (1943), pp. 86-91.

Theirs was a group type application for speed and simplicity of use with large numbers of subjects, but a great deal of accuracy was sacrificed. The twenty inch step is so high that is tends to penalize short men. It also involves to some extent the factor of agility as well as general fitness. However, when a lower step was used the work was too easy, greatly increasing the errors and impairing the value of the test.[2]

This test was originally validated using adult males as subjects. Later adaptations include a short form developed by Johnson and Robinson in which only one pulse count is taken.[3]

Gallagher and Brouha modified it for use with boys aged twelve to eighteen by lowering the bench to eighteen inches, reducing the time to four minutes, and by considering the body surface calculated from height and weight.[4]

A variation used with high school girls developed by Gallagher and Brouha entailed a bench height of sixteen inches and an exercise time of four minutes.[5]

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[2]C. E. Willgoose, Evaluation in Health Education and Physical Education (New York, New York, 1961), p. 117.

[3]E. C. Schneider and Peter V. Karpovich, Physiology of Muscular Activity (Philadelphia, Pennsylvania, 1953), p. 270.

[4]J. R. Gallagher and Lucien Brouha, "A Simple Method of Testing the Physical Fitness of Boys," The Research Quarterly, XIV (1943), pp. 23-30.

[5]Lucien Brouha and J. R. Gallagher, "A Functional Fitness Test for High School Girls," Journal of Health, Physical Education and Recreation, XIV (1943), p. 517.

College women were tested using an eighteen inch bench and four minutes exercise duration.[6]

Later elementary school boys and girls under twelve were tested by Brouha and Ball with a fourteen inch bench and a time of two minutes for those under seven; three minutes for children eight to twelve.[7]

The step test was originally validated by comparing heart performance with muscular endurance, however other investigations have shown that the coorelation is low and that heart-lung efficiency seems to be a separate item in over-all physical fitness.

As Dr. Brouha indicates in his studies at the Harvard Fatigue Laboratory, physical fitness for hard muscular work can be measured only if certain physiological reactions of the subject to hard work are known. Reactions to moderate exercise are unreliable because the easier the work, the smaller are the differences between the fit and the unfit.[8]

An adequate estimate of a man's fitness can be obtained by exposing him to a standard exercise that no one can perform in a "steady state" for more than a few minutes, taking into account the length of time involved and the recovery of his heart rate following exercise.

Any type of exercise which requires no unusual skill and that puts

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[6]Harriet L. Clarke, "A Functional Fitness Test for College Women," Journal of Health, Physical Education and Recreation, XIV (1943) pp. 358-359.

[7]Lucien Brouha and M. V. Ball, Canadian Red Cross Society's School Meal Study, (Toronto, Canada, 1952), pp. 55-56.

[8]L. Brouha, Revue Canadienne de Biologie, II pp. 86-91.

the cardiovascular and respiratory systems under real stress by making use of large muscle groups can be used as long as the subject is working in proportion to his body weight.[9]

Among the tests which have been used for this purpose are:

1. pedalling on a bicycle ergometer against a load proportionate to the body weight

2. rowing against a heavy load

3. pulling a "stoneboat" loaded so that the subject pulls horizontally 1/3 of his body weight over a flat smooth course 1 yd/sec/5 min.

4. treadmill

5. running up hill

6. step tests.

Activities such as chinning cannot be used for this purpose since the arms become fatigued before the rest of the body. Rope climbing would also be eliminated because of the special skill involved.[10]

The term physical fitness as used here has nothing to do with any particular strength or skill, although a certain amount of coordination is necessary to perform the test properly.

Most of the tests now in use can be criticized because the amount of exercise is not accurately standardized or it is not hard enough to show significant differences between those who are fit and unfit.

The step test is reported to measure dynamic or functional

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[9]R. E. Johnson, L. Brouha, and R. C. Darling, "A Test of Physical Fitness for Strenuous Exertion," Revue Canadienne de Biologie I (1942) pp. 491-503.

[10]Ibid, p. 500.

fitness or the ability to do strenuous work as distinct from medical or static fitness or from fitness to do specific skills.

Step tests scores are apparently independent, for all practical purposes, of structural measurements according to the results of Bookwalter and Seltzer.[11]

Work performance itself cannot be predicted from step test scores, but there is considerable evidence that the Fitness Index does reflect the relative state of fitness of the cardiovascular system.

It was found that there was a very high correlation between the first pulse count and the sum of the three counts following exercise. Therefore it is felt there would be no appreciable loss in validity if only the first pulse count were used.[12]

The Harvard Step Test is useful in rapidly dividing a large number into homogeneous groups for the purpose of training. It can also be used to evaluate the progress made by individuals during a fitness training program. Admittedly the results are not as accurate as those obtained with laboratory equipment, but are a useful criteria for large groups of healthy normal individuals where it is desirable to separate the best, worst and average.[13]

In any of the tests used for working hard or working to exhaustion, the subject is asked to continue as long as possible but is stopped after five minutes of strenuous exertion. Of course a thorough

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[11]Henry J. Montoye, "The Harvard Step Test and Work Capacity," Revue Canadienne de Biologie, XI (1952) pp. 491-499.

[12]Ibid.

[13]Brouha, Revue Canadienne de Biologie, II p. 88.

medical examination should precede any activity that requires working to exhaustion. In all performance tests the subject must cooperate. If he stops before he is tired, the score is an understatement of his physical capacity. For many jobs will power is as important as physical ability, so it is well to be able to detect those who are not willing to push themselves.[14]

As has been mentioned previously, procedures for determining human working capacity in the laboratory make use of equipment such as treadmills, bicycle ergometers, or stepping devices for providing desirable and reproducible levels of work intensity. These laboratory conditions allow for a continuous monitoring of the circulatory and respiratory responses to exercise which is essential for the recognition of an individual's capacity for coordinating a complexity of organic functions.

Most tests involving physical exertion are too dependent on the individual's motivation and tolerance for pain and discomfort. Therefore, on the spot physiological measurements are necessary during the fitness test to ascertain if the subject is performing within or beyond his physiological limitations.

A field test used for screening purposes in determining physical competence should engage a familiar type of physical exercise which calls upon the large muscle groups and the general functional responses within and up to the limits of capacity.

Dr. Balke states that in using walking or running as a functional capacity test the distance of the run or the time involved must be set to obtain an optimum pace. A sufficient time interval is essential in

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[14]Johnson, Revue Canadienne de Biologie, I p. 495.

order to permit either a steady pace at the functional crest load or an alternating pace, in which the aerobic component, when running too fast, is compensated for by adequate recovery in slowing down.[15]

It was found that the correlation between preformances on a running field test and the laboratory treadmill test was very close.

Dr. Balke found that within the range of aerobic work capacity a practically linear relationship exists between running velocities and oxygen requirements in relation to body mass.

From the results of his testing, a fifteen minute run over a definite distance was set up as a field test for Federal Aviation Agency employees as well as others who wanted to evaluate their state of physical fitness.[16] Dr. Balke describes the maximum oxygen intake attainable as the most adequate criterion of work capacity. It was Dr. Balke who developed the motorized stepping device used in the present research. He worked with adult males at the Federal Aviation Agency in Oklahoma City, Oklahoma, when conducting this research.[17]

Dr. A. B. Harrison of Oklahoma State University used the same mechanism in research with adult males at the University in 1964. In this research the test started with the step at eight inches instead of the four inches used with elementary children in the present research.

In adults the functional limitations are apparent as the heart rate approaches one hundred eighty beats/minute. At this critical frequency, the time for sufficient ventricle filling with blood between

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[15]Balke, p. 8.

[16]Ibid, p. 17.

[17]Ibid.

contractions becomes too short. There is a reduced blood volume and the pulse pressure drops. This is the point where man usually reaches his maximal breathing capacity. At this point the aerobic process ceases and anaerobic process begins resulting in oxygen debt. Since oxygen debt can be incurred only once, it is well to be able to determine how much an individual must pace himself in order to let the body processes adapt to the demands on the body.[18]

Greater development of cardiovascular endurance and better training methods are largely responsible for the setting of new athletic achievement records constantly. Astrand has shown that the oxygen intake is almost constant for men from seven to thirty-three. Women perform at eighty percent of men at age fourteen to twenty-nine. Loss of circulatory function occurs primarily because of lack of use of the heart and circulation. This does not include old age when it diminishes rapidly.[19]

Kasch states that the best developer of cardiovascular function is running. Other excellent developers include: cycling, rowing, swimming, cross-country skiing, and mountain climbing.[20]

Many coaches and athletes erroneously assume that most sports develop cardiovascular fitness. Cureton and Kasch have found that the oxygen intake of sportsmen was average when compared for age, sex and weight. They also found that it could be increased with specific

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[18]L. E. Morehouse and A. T. Miller, Physiology of Exercise, (St. Louis, 1953), pp. 29-37.

[19]P. O. Astrand, Experimental Studies of Physical Working Capacity in Relation to Sex and Age, (Copenhagen, 1952).

[20]Kasch, p.43.

endurance training.[21]

Cardiovascular fitness contributes to mankind by: improving the performance of most athletes, aiding the prevention of injuries, improving the cardiovascular system for longer, more active lives, and in helping to prevent coronary heart disease.

An endurance test of another type which has recently been used extensively in elementary and secondary schools is the 600 yard run-walk. This is an integral part of the AAHPER Youth Fitness Test as well as the Fleishman Fitness Test Battery.[22] The 600 yard run-walk is identical in both testing procedures and is administered in the same manner. The individual starts in a standing position; on the signal to begin he runs the 600 yard distance. This period may be interspersed with periods of walking. The time of completion to the nearest second is recorded and interpreted from the norm tables which have been made.[23]

The drawback in the continued use of this test as an endurance test is that there is little evidence of validation of the above mentioned test item. It is felt by some that this does not accurately measure cardiovascular endurance. This is one of the reasons for continued research in the field of endurance measurement.

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[21]Ibid.

[22]E. A. Fleishman, The Structure and Measurement of Physical Fitness, (1964), p. 158.

[23]AAHPER Youth Fitness Test Manual, American Association for Health, Physical Education and Recreation, 1958.

CHAPTER III

METHODOLOGY

Twelve subjects were used in this research. Each was asked by the writer to take part in the study after an explanation of the procedure was completed. Four subjects were in the fourth grade, four in the fifth grade and four in the sixth grade at Westwood Elementary School, Stillwater, Oklahoma. Following a preliminary explanation of each piece of equipment, each girl's resting blood pressure, pulse rate and exhaled air sample were taken with the subject sitting quietly in a chair.

A sphygmometer was attached to the arm for reading blood pressures. A stethescope was placed on the inside of the arm just below the elbow for the purpose of monitoring both blood pressures and pulse rates. The stethescope was wrapped onto the arm in order to keep it in place during the exercise time.

The mouthpiece and nose clip were fastened in place. This mouthpiece consisted of a Collins Plastic one-way "J" valve which allowed the subject to breath in only outside air and to expire only into the spirometer. The valve was attached to the face protector of a football helmet which supported the weight of the hose during exercise on the stepping apparatus. The subject was asked to test the functioning of the apparatus before commencing the test by blowing into the mouthpiece and attempting to exhale through the nose to determine leakage around the nose clamp. The resting volume of exhaled air was collected in a Collins 120 liter spirometer and the volume recorded on the kymograph for a period of three minutes. Samples of the exhaled air were taken from the spirometer into rubber bags and analyzed after the test was completed on a Fisher Gas Chromatograph.

Following this the subject was instructed to step up and down on the motorized stepping device in rhythm to the metronome set at 120/min. The height of the step at the start was four inches. During the last 15 seconds of each minute of exercise, the step was raised mechanically one inch, which of course increased the work output. Each minute during the test the pulse rate and blood pressure were taken. Exhaled air samples were collected in the spirometer for a fifteen second period at the end of each minute of exercise. The amount of exhaled air in each sample was recorded by a kymograph on the spirometer. Samples were taken from the spirometer after the 2nd and 4th minutes and each minute thereafter for gas analysis later.

The subject continued the work until a drop in systolic blood pressure was noted indicating that the individual was going into oxygen debt. In most cases the subject continued an extra minute after the blood pressure drop in order to obtain further metabolism data for validation purposes. The test was then stopped and the subject seated immediately for a three minute recovery period. The blood pressure apparatus and breathing valves were left in place during recovery. After each minute of recovery, a 15 second sample of exhaled air was collected in the 120 liter spirometer so that resting and recovery ventilation rates could be compared. The recovery air volumes were also recorded on the kymograph. During the recovery period pulse and blood pressure readings were also taken each minute.

At the completion of the test each of the exhaled air samples was analyzed for oxygen, carbon dioxide and nitrogen by gas chromatography. The study dictated separate gas analysis for the resting state, during exercise, and recovery. The expired air samples were fed into a Fisher V-25 gas partitioner which partitioned off the amounts of oxygen, nitrogen and carbon dioxide in the sample. These amounts of each element were recorded on a recorder connected to the partitioner.

Since this was a submaximal test there was not undue strain placed on the subjects at any time regardless of their condition at the time.

Computations were then made to determine the utilization of oxygen, energy cost and oxygen debt. Calculations of data were made according to procedures outlined in Consolazio's Metabolic Methods.[1]

Four subjects were given complete retests and this data was compared with the original data to check the validity and reliability of the testing procedure.

Following the computations the data collected was put into the charts, tables, and graphs incorporated into this paper and analyzed to check validity, to determine the average time this group of elementary school girls could continue until the drop in blood pressure was noted, and to ascertain from the compiled data what the crest load or cut-off point should be. The determination of average blood pressures, both systolic and diastolic, as well as average oxygen consumption and

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[1]Consolazio, C. F., R. E. Johnson, and E. Marek, Metabolic Methods, (1951), pp. 331-341.

carbon dioxide production was made. From the compilation of data tentative norms or ranges of fitness were ascertained. The results from the girl's testing was compared to results from previous testing of the same type for boys and a comparison was also made with adult figures on a similar test.

CHAPTER IV

RESULTS

The results of the tests gave a range sufficient to indicate that a cross-section of girls representing various levels of physical condition took part in the test. The following table presents these ranges.

TABLE I

CREST LOAD DATA

Test Item	Range	Mean
Systolic blood pressure	103-140	116
Pulse rate	156-188	174 beats/min.
Time in minutes	4-9	6.8
Carbon dioxide production	2.2-4.3	3.2 %
Oxygen consumption	16.0-18.6	17.1%
Respiratory quotient	.53-1.21	.84
Exercise metabolism/resting metabolism	1.2-5.9	3.7
Net oxygen debt	-.15-.99	.42 liters
Daily calorie consumption	792-2064	1511 calories/24 hrs.
VO_2/ml/kg	19-41	29 ml/kg

The systolic blood pressure mean of 116 mm at crest load was lower than the adult mean on similar tests as was expected.[1] This is one of the reasons for the necessity of separate norms for children.

The variance of 3 mm in blood pressure between boys' and girls' as in Figure 5, seems not enough to warrant separate norming procedures.

In the five subjects who were retested a difference of at least five mm in systolic blood pressure was recorded at the crest load times. This indicates that a variation of several mm could be expected in this test. Several factors could bring this about. Among these could be the condition of the individual at the time of the test, the reading of blood pressures, excitement or other psychological factors, and that this variation is the normal range for each individual.

The steady increase of systolic blood pressure means on both the first and second tests up to the crest load mean of seven minutes is characteristic if accurate results are obtained in such a procedure. Most of the retest means were within 1 or 2 mm of the results on the first test upholding the reliability of the test.

The diastolic blood pressure means minute by minute for the retest subjects varied from 2 to 4 mm, which is within the normal variation range since the diastolic pressure has no definitely set pattern.

In considering the mean of 174 beats/minute on the crest load pulse rate, there was a variance of 6 beats/minute when compared to the critical 180 beats/minute found previously for adults at crest load on similar type tests.[2] The difference of 8 beats in the means of the

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[1]Nagle, (1963), p. 361.

[2]Balke, (1963), p. 7.

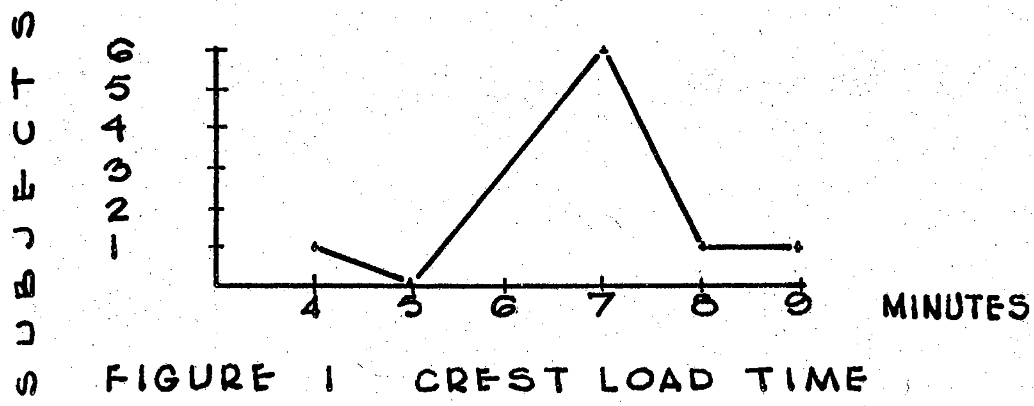

FIGURE 1 CREST LOAD TIME

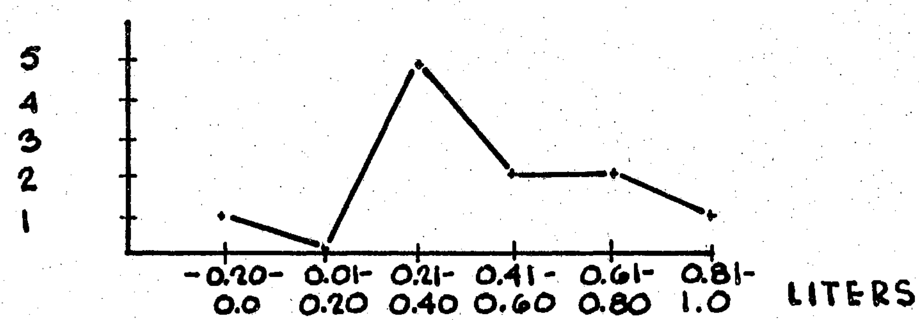

FIGURE 2 NET OXYGEN DEBT

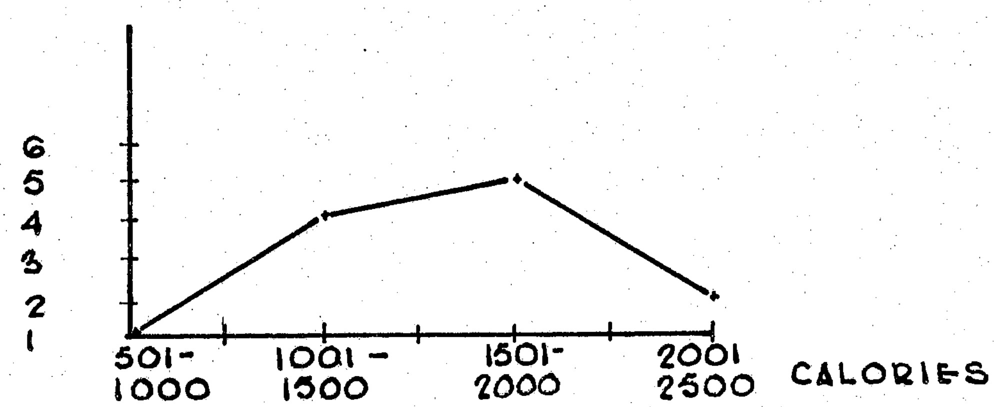

FIGURE 3 DAILY CALORIC USAGE

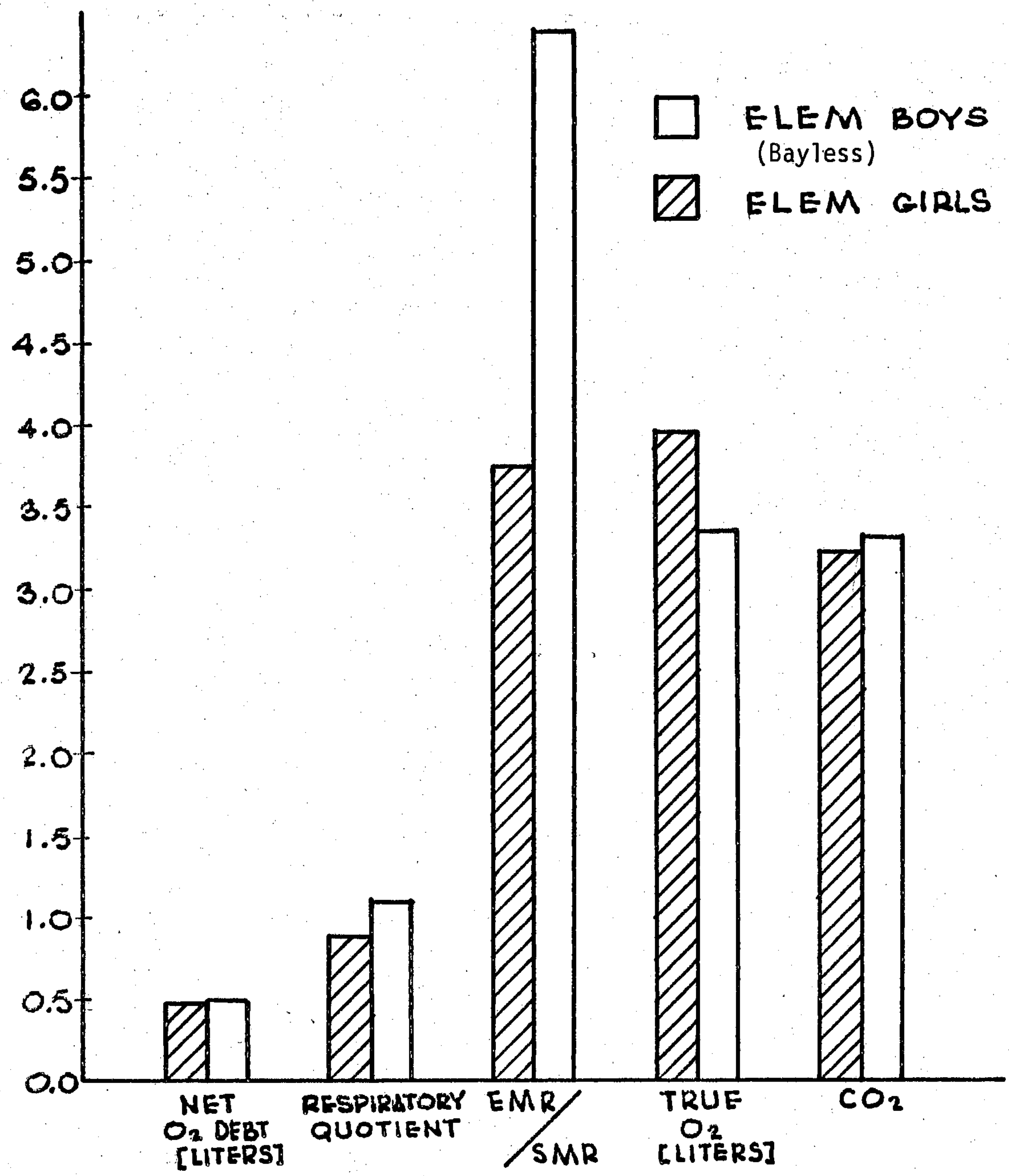

FIGURE 4 MEANS AT CREST LOAD

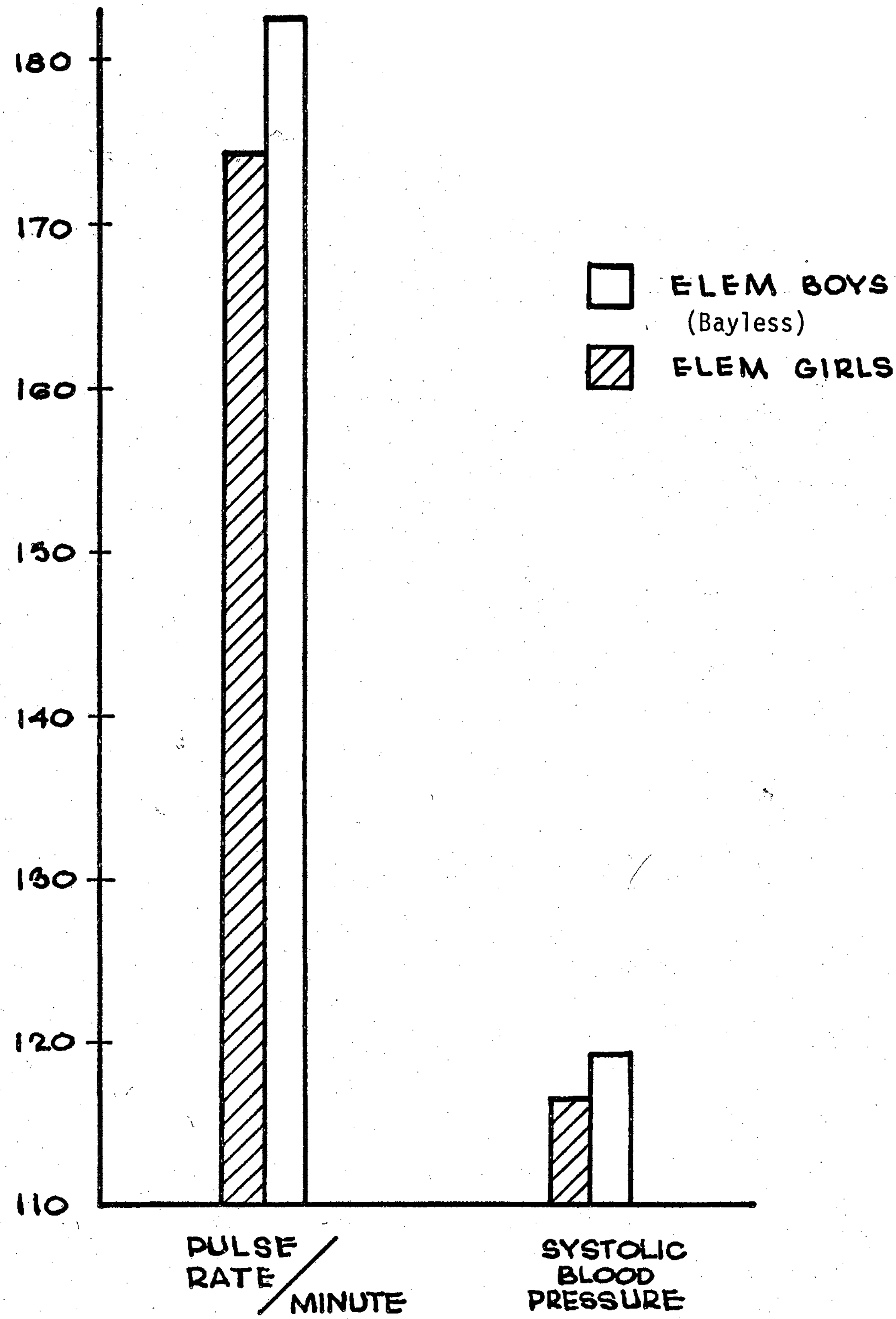

FIGURE 5 MEANS AT CREST LOAD

girls compared to the elementary boys on the same test as shown in Figure 5, is perhaps significant enough to indicate the need for separate norms for boys and girls at the same age.[3]

There was a steady rise in pulse rates minute by minute during the progress of the test. Figure 8 shows the mean pulse rates for the first and second tests on the retest subjects. This shows a steady rise in pulse rates on the second set of tests as well as the first. This again upholds the validity of the results and reliability of the testing procedure. Previous research has indicated that there is a straight line relationship between pulse rate and oxygen intake or work load up to a pulse rate of 180 beats/minute.[4]

The mean time before reaching the cut-off point was 6.8 minutes. The cut-off or crest load point for the computations was determined by examining graphically not only the drop in systolic blood pressure but also all other factors under consideration. In most cases there was a definite breaking point in oxygen consumption, carbon dioxide production, pulse rate, and metabolism rate. This is shown clearly on the individual graphs in the Appendix.

In order to reach the mean crest load cut-off point, the elementary boys continued an average of 8 minutes. As has been mentioned previously, the boys' mean blood pressure and pulse rates were also

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[3]John Bayless, "The Establishment of a Metabolic Functional Capacity Test for Elementary School Boys," (Unpublished Doctoral Thesis, Oklahoma State University, 1966).

[4]Peter V. Karpovich, Physiology of Muscular Activity, (1965), p. 75.

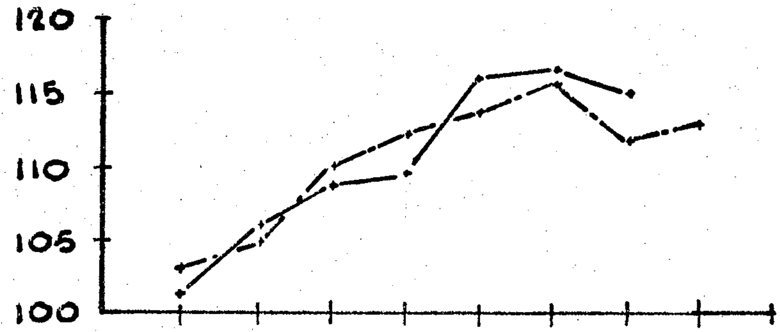

FIGURE 6 SYSTOLIC BLOOD PRESSURE MM

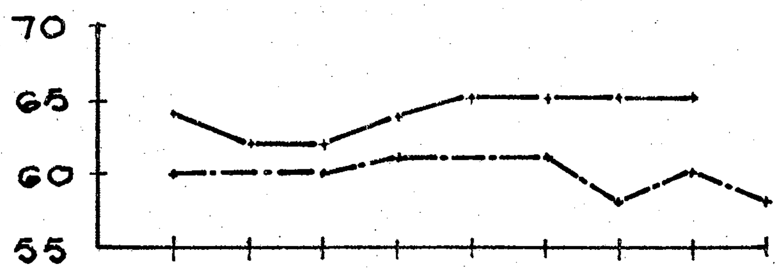

FIGURE 7 DIASTOLIC BLOOD PRESSURE MM

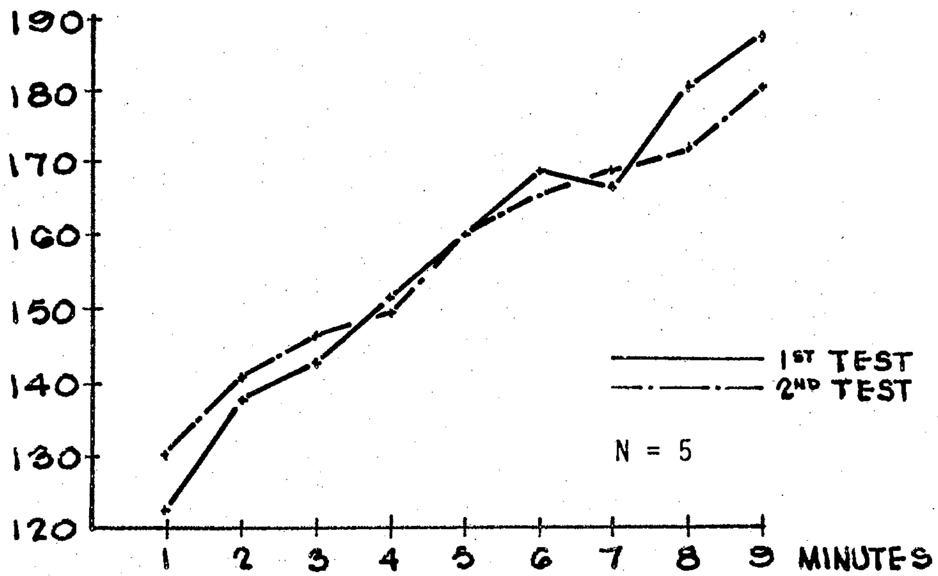

FIGURE 8 PULSE RATE / MINUTE

TEST - RETEST MEANS

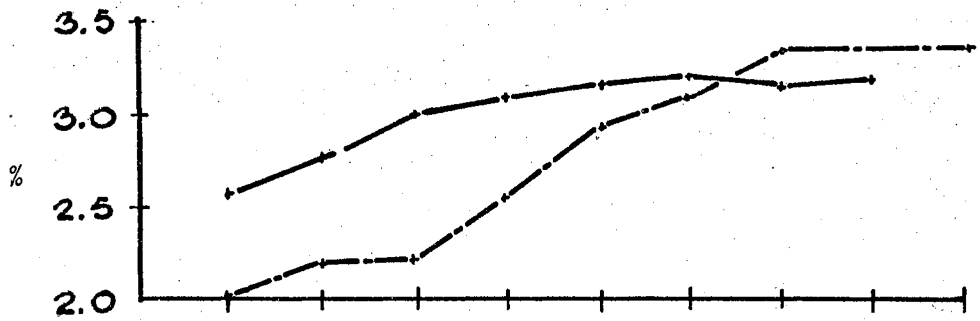

FIGURE 9 CO_2

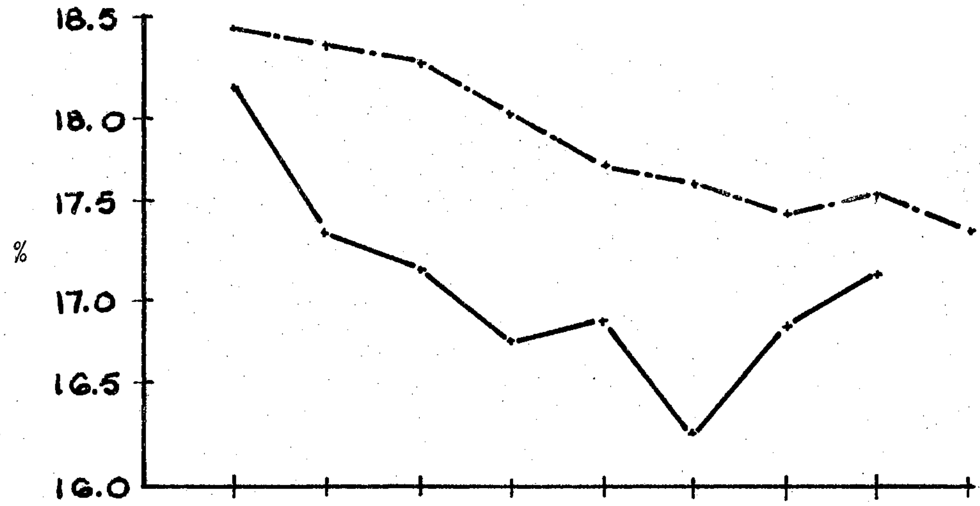

FIGURE 10 O_2

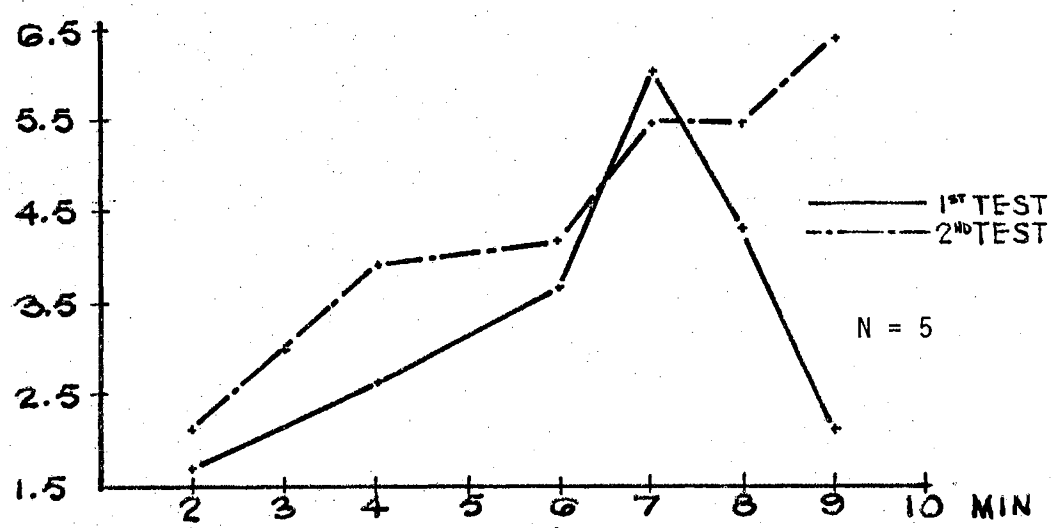

FIGURE 11 EMR / SMR

TEST-RETEST MEANS

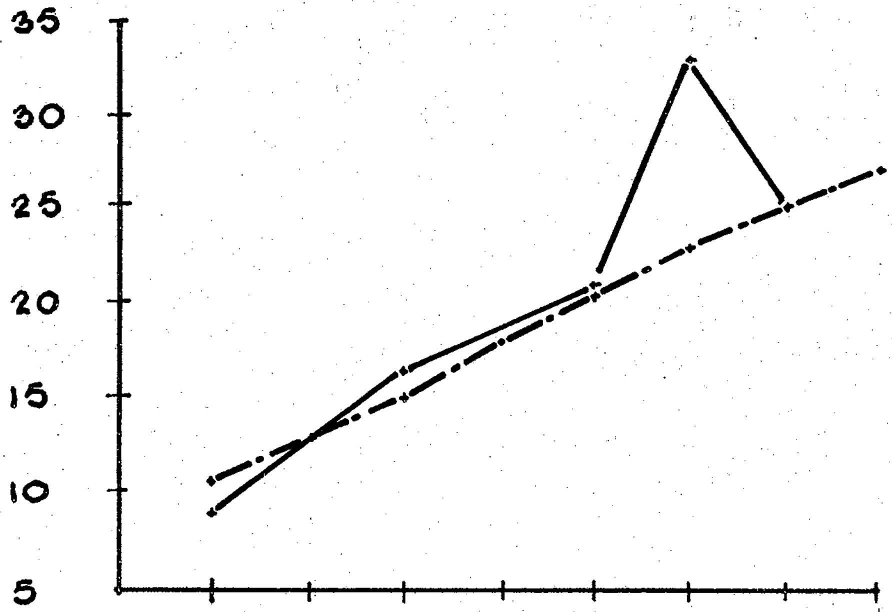

FIGURE 12 VO2 ML/KG

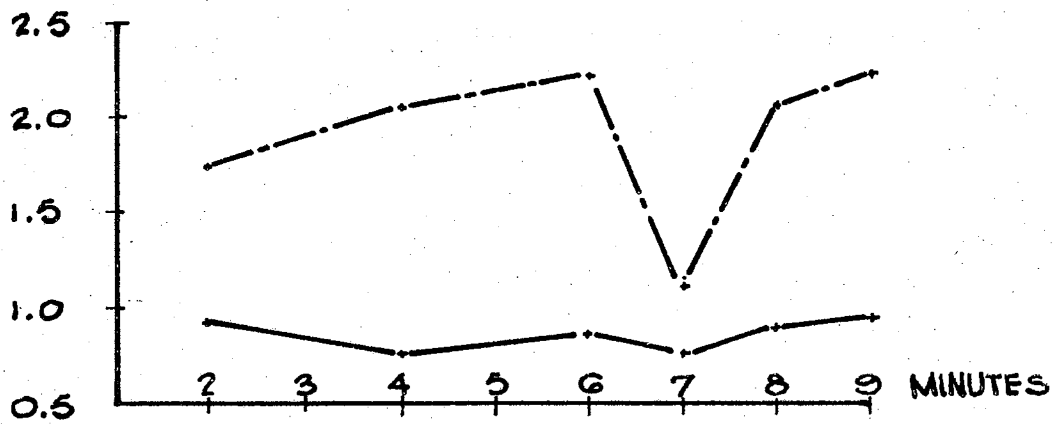

FIGURE 13 RQ

1ST TEST
2ND TEST

N = 5

TEST-RETEST MEANS

slightly higher than the girls'.[5] The adults tested by Dr. Balke reached a similar crest load point after 14 minutes of exercise and at a height of 12 inches.[6]

Areas of very slight differences between boys and girls were in the carbon dioxide production, oxygen consumption, true oxygen, and net oxygen debt means as presented in Figure 4.

This was a submaximal test. Therefore high oxygen debts were not expected. As Table I portrays, this held true during the testing procedure. The highest oxygen debt was .99 liters. Most of the oxygen debts which were incurred were repaid within the 3 minute recovery period. This is indirectly indicated by the return of pulse rates and blood pressures as well as metabolism rates to near normal during the recovery period.

Subject #6's first test resulted in a -.15 liters net oxygen debt. In this case there must have been a slight error in measurements, recording of data or analysis of the samples. The second test resulted in a net oxygen debt of only .03 liters, which is very slight and indicates that this subject apparently incurred a minimal amount of oxygen debt with the work load imposed by this test.

The oxygen percentage in expired air showed a steady decline while the carbon dioxide production steadily increased during the progress of the test as the work load increased. There was also a steady increase in the mean VO_2 utilization.

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[5]Bayless, (1966).

[6]Nagle, (1964).

TABLE II

STEP TEST (120 STEPS/MINUTE)

Minute	Step Height (inches)	Number of Subjects	Pulse Rate Mean	Systolic Bl. Pres. Mean	VO_2ml/kg Mean	$\frac{EMR}{SMR}$	True O_2 Mean (liters)
1	4	11	128	101			
2	5	11	137	105	12.6	1.66	2.55
3	6	2	146	109	15.5	2.09	2.75
4	7	12	154	110	18.4	2.44	3.32
5	8	4	162	116	23.2	3.44	3.54
6	9	11	166	115	25.5	3.53	3.88
7	10	8	174	115	32.0	4.40	3.61
8	11	7	184	113	29.0	4.11	4.08
9	12	4	185	107	28.0	4.20	3.68
10	13	2	182	100	33.0	5.30	3.98

Table II shows that at the mean crest load time of 7 minutes with the step height at 10 inches, the volume of oxygen per body weight mean is 32.0 ml/kg. This would be comparable to the 14 minute level for adults tested by Dr. Balke under similar circumstances. At this time during his testing procedure the step height was at 28 cm which would be approximately 12 inches since he started his test with the step at 2 cm. The adult mean oxygen consumption at this time was 31.7 VO_2ml/kg. On Dr. Balke's fitness rating this would be at the poor fitness level.[7] This would show that the children at this age level are not able to take in and use as much oxygen as adults.

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[7]Ibid.

The slight drop in VO_2 consumption following the 7 minutes may indicate that these subjects had gone into oxygen debt. The subjects had been encouraged to continue an extra minute after reaching the cut-off point to aid in checking the validity of the data. In other words they were actually using less oxygen at 8 and 9 minutes while expending more energy. The two subjects who continued the test through 10 minutes show an increase in VO_2ml/kg.

The EMR/SMR ratio also increased steadily for each individual as the test progressed. The 2.65 variance in the ratio of exercise metabolism/sitting metabolism rates between boys and girls shown in Figure 4, seems to indicate that the girls tested are able to carry on the hard work required on the test without undue strain and that they were accomplishing the work with relatively less expenditure of energy than the boys. The EMR/SMR at the peak or crest load mean of 7 minutes indicated in Table II as 4.40 as compared to the adult EMR/SMR of 9.1 would be approximately ½ the ratio. The comparison bears out the evidence previously mentioned that a separate norming procedure is needed for adults and children. The metabolic ratios are used to indicate the level of work loads. This is expressed in terms of hard work, moderate work or submaximal work. It was mentioned by Dr. Karpovich and is the same ratio used in Dr. Balke's studies.[8]

The results of the test substantiate the reliability and validity of the testing procedure. If a classroom teacher desired to use this procedure in the field, the same stepping device could be used. Both blood pressure readings and pulse rates could be monitored if the

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[8]Karpovich, p. 75.

individual were experienced in taking blood pressure readings. A stethescope taped to the subject's chest could be used to take 15 sec. pulse counts during the progress of the test. The step should start at 4 inches in height and be raised 1 inch each minute during exercise until a pulse rate of 180 beats/minute was reached. The time required for the subject to reach the 180 beats/minute point would be the indicator for the physical condition of that subject. From the recommended table below an estimate of oxygen utilization and physical fitness rating could be made. The mean time for girls is 7 minutes and the mean time for boys is 8 minutes so there would be different relative scales for boys and girls.

TABLE III

RECOMMENDED FITNESS SCALE FOR GIRLS
(estimates)

Classification	Time (minutes)	VO_2ml/kg
Superior	10 and above	40 and above
Above Average	8-9	36-39
Average	6-7	26-35
Below Average	4-5	18-25
Very Poor	3 and below	17 and below

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

On the basis of the data collected the following conclusions seem warranted:

1. There is not a wide enough difference between the results for the elementary school girls and boys to conclude that they reach the crest load capacity at different physiological levels of cardiovascular and metabolic measures.

2. There apparently is a variation between boys and girls on the time that each can continue the test before reaching the crest load.

3. Seven minutes is the average time elementary school girls can continue the test before the crest load is reached and the individual goes into anaerobic type work.

4. If the test were administered to elementary school children using only pulse rate counts as a crest load indicator, 180 beats/minute should be the cut-off point for stopping the test.

5. This is definitely a submaximal test as brought out by the data collected.

6. The data proved the test to be valid as supported by blood pressure and oxygen consumption results.

7. The testing procedure was generally a reliable one as shown in the test-retest data.

8. The mean energy cost at crest load was 29 VO_2ml/kg with a ratio of 3.7 $\frac{EMR}{SMR}$.

9. The mean net O_2 debt as measured in a three minute recovery period was .42 liters.

RECOMMENDATIONS

1. Further testing in this area should be done with greater numbers of subjects for the purpose of checking this data and in the establishment of norm tables. This could be done without the full metabolism data collected in this procedure. The use of pulse rates as a cut-off indicator could be used.

2. Anyone using this test with pulse rates only could tape a stethescope to the chest of the individual to use in counting pulse rates.

BIBLIOGRAPHY

AAHPER Youth Fitness Test Manual. American Association for Health, Physical Education and Recreation, Washington, D. C., 1958.

Astrand, P. O., Experimental Studies of Physical Working Capacity in Relation to Sex and Age. Musksgaard, Copenhagen, 1952.

Balke, Bruno, A Simple Field Test for the Assessment of Physical Fitness. Civil Aeromedical Research Institute, Oklahoma City, Oklahoma, 1963.

Bayless, John, "The Establishment of a Metabolic Functional Capacity Test for Elementary School Boys," (Unpublished Doctoral Thesis, Oklahoma State University, 1966).

Brouha, L. A., A. Graybiel, and C. W. Heath, "Step Test." Revue Canadienne de Biologie. II (1943), 86-91.

Consolazio, C. Frank, R. E. Johnson, and Evelyn Marek, Metabolic Methods. St. Louis: C. V. Mosby Company, 1951.

Cureton, T. K., "Unfitness of Young Men in Motor Fitness." Journal of the American Medical Association, CXXIII (1943), 68.

Fleishman, E. A., The Structure and Measurement of Physical Fitness. Englewood Cliffs: Prentice-Hall Inc., 1964.

Henry, F. M., "The Oxygen Requirement of Walking and Running." Research Quarterly, XXIV (1953), p. 169.

Johnson, R. E., L. Brouha, and R. C. Darling, "A Test of Physical Fitness for Strenuous Exertion." Revue Canadienne de Biologie I (1942), 491-503.

Karpovich, P. V., Physiology of Muscular Activity. Philadelphia: W. B. Saunders Company, 1965.

Kasch, Fred W., "New Evidence of Cardiovascular Endurance Training." Proceedings of the National College Physical Education Association for Men. (1965), 43.

Mathews, D. K., R. Bowers, E. Fox, and W. Wilgus, "Aerobic and Anaerobic Work Efficiency." Research Quarterly, XXXV: III (1963), Morehouse, L. E. and A. T. Miller, Physiology of Exercise. St. Louis: C. V. Mosby Company, (1953).

Montoye, Henry J., "The Harvard Step Test and Work Capacity." Revue Canadienne de Biologie, XI (1952), 491-499.

Nagle, F. J., "Letter to Dr. A. B. Harrison," (October, 1964).

Nagle, Francis J. and Thomas G. Bedecki, "Use of the 180 Heart Rate Response as a Measure of Circulorespiratory Capacity." Research Quarterly, XXXV: III (1963), 361.

Steinhaus, Arthur H., "Chronic Effects of Exercise." Physiological Review, XIII (1933), 103.

Willgoose, Carl E., Evaluation in Health Education and Physical Education. New York: McGraw-Hill Book Company, 1961.

APPENDIX

TABLE IV

RAW DATA

CREST LOAD DATA

Subject	Age	Blood Pressure	Pulse Beats/Minute	Time (minute)	Net O_2 Debt (liters)	EMR/SMR	VO_2 ml/kg
1	9	110/65	180	4	.30	2.85	20
2	9	103/60	180	$\boxed{9}$	.24	4.3	$\boxed{41}$
3	9	110/60	180	6	.31	3.5	36
4	9	120/70	172	7	.50	2.9	26
5	10	110/65	184	7	$\boxed{.99}$	3.4	30
6	10	110/65	168	7	-.15	1.2	19
7	10	115/70	156	7	.53	$\boxed{5.9}$	36
8	10	110/55	156	8	.31	4.03	21
9	11	128/70	$\boxed{188}$	6	.23	4.2	28
10	11	120/60	176	7	.32	5.9	36
11	11	118/70	180	7	.66	2.6	30
12	11	$\boxed{140/75}$	176	6	.69	3.38	22
Mean:	10	116/65	174	6.8	.42	3.7	29

Range: $\boxed{}$ - high

- low

TABLE IV (continued)

Subject	Age	CO_2%	O_2%	Respiratory Quotient	True O_2	Vent. Kymograph	Vent. Corr.
1	9	2.2	$\boxed{18.6}$	.96	2.35	160	21.4
2	9	3.2	17.0	.77	4.12	204	27.17
3	9	2.65	16.5	.53	4.92	168	19.87
4	9	3.1	17.3	.81	3.77	232	30.9
5	10	2.9	17.0	.69	4.18	224	29.8
6	10	3.1	17.4	.84	3.63	260	29.9
7	10	2.75	17.6	.79	3.48	220	29.3
8	10	3.15	17.6	.93	3.35	160	19.8
9	11	$\boxed{4.3}$	16.7	$\boxed{1.21}$	4.2	272	36.23
10	11	3.4	16.0	.63	$\boxed{5.33}$	204	27.17
11	11	4.1	17.0	1.16	3.5	264	35.0
12	11	3.1	17.3	.81	3.78	$\boxed{280}$	$\boxed{37.29}$
Mean:	10	3.2	17.1	.84	3.9	220	28.6

Range: $\boxed{}$ - high

- low

TABLE V

TEST-RETEST CREST LOAD DATA

Subject	Test	Time (minutes)	Net O_2 Debt (liters)	VO_2 Ml/Km
4	1st	7		
	2nd	7	.50	26
6	1st	7	-.15	19
	2nd	8	.03	28
8	1st	7	.31	12
	2nd	8	.21	21
9	1st	6	.23	28
	2nd	5	.32	37
10	1st	7	.32	36
	2nd	8	.43	25
	3rd	8	.38	34

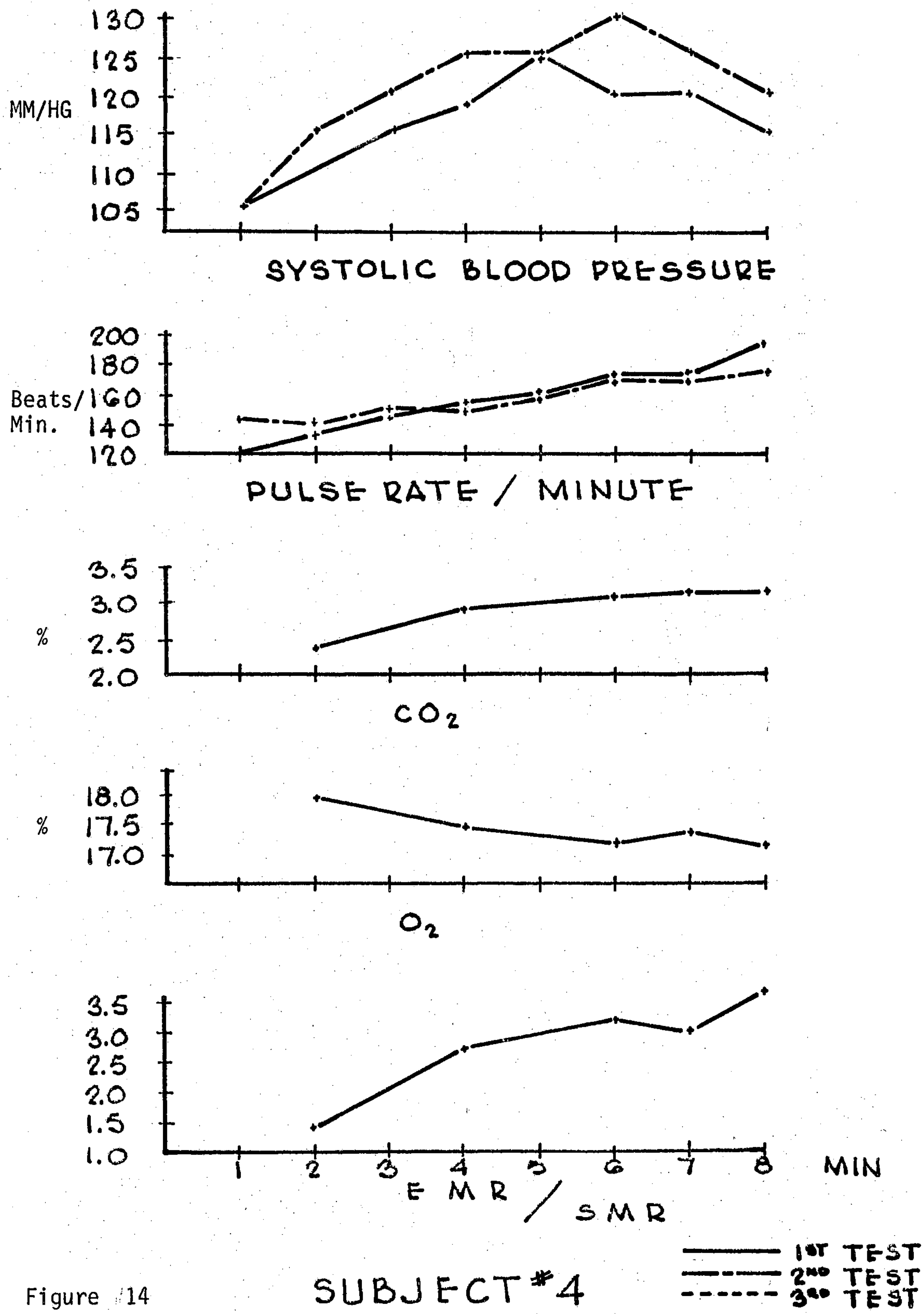

Figure #14 SUBJECT #4

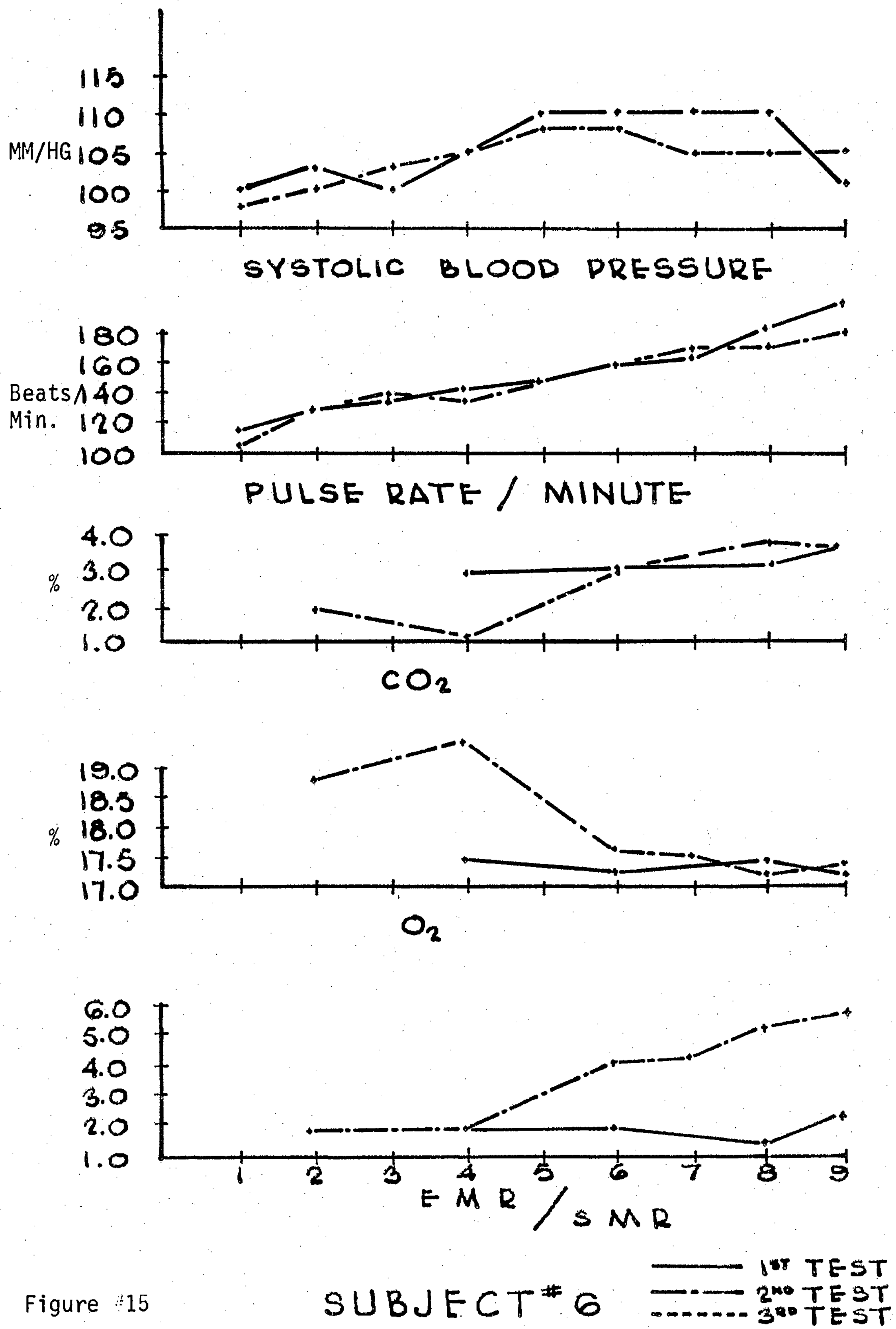

Figure #15 SUBJECT # 6

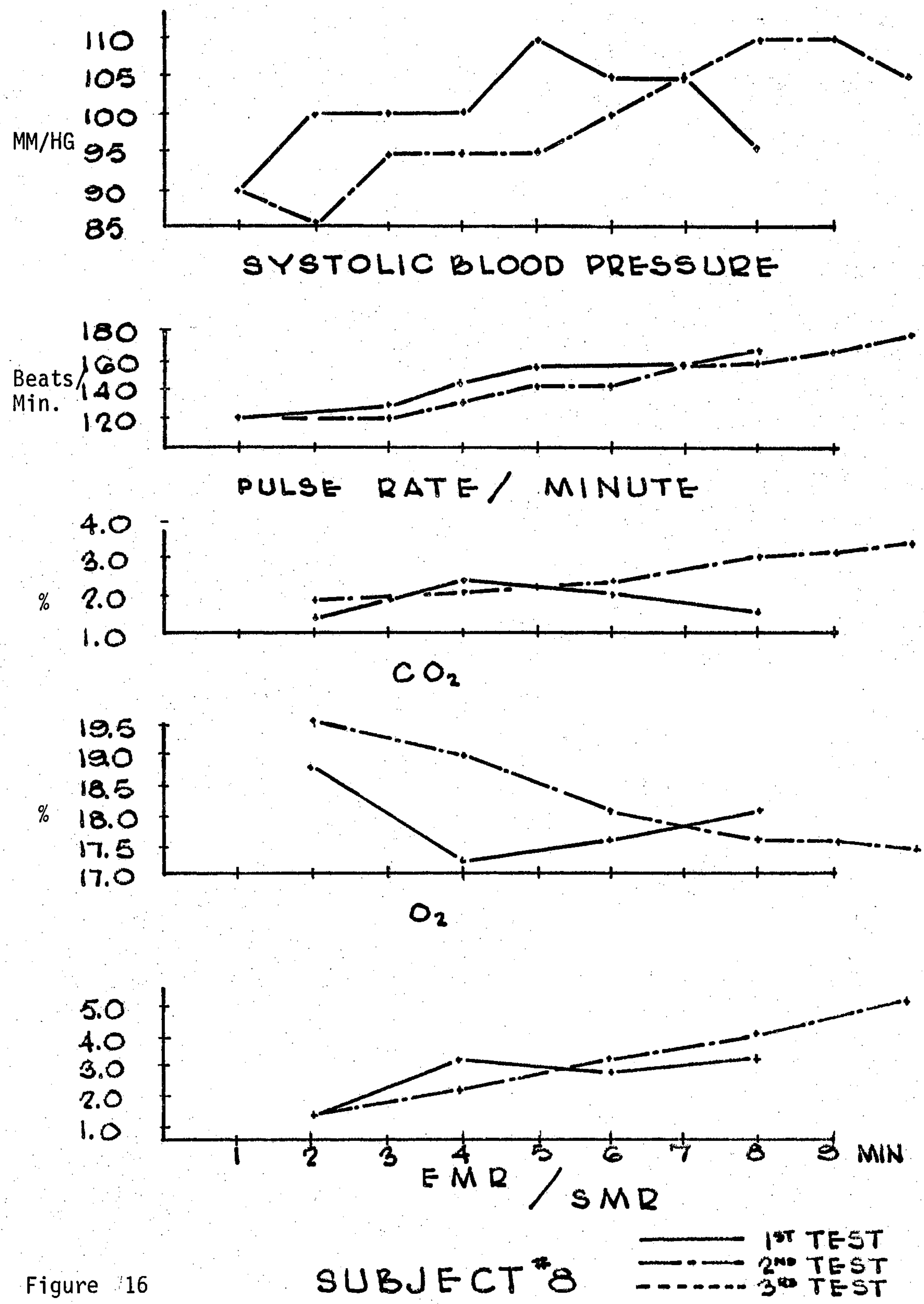

Figure 16 SUBJECT #8

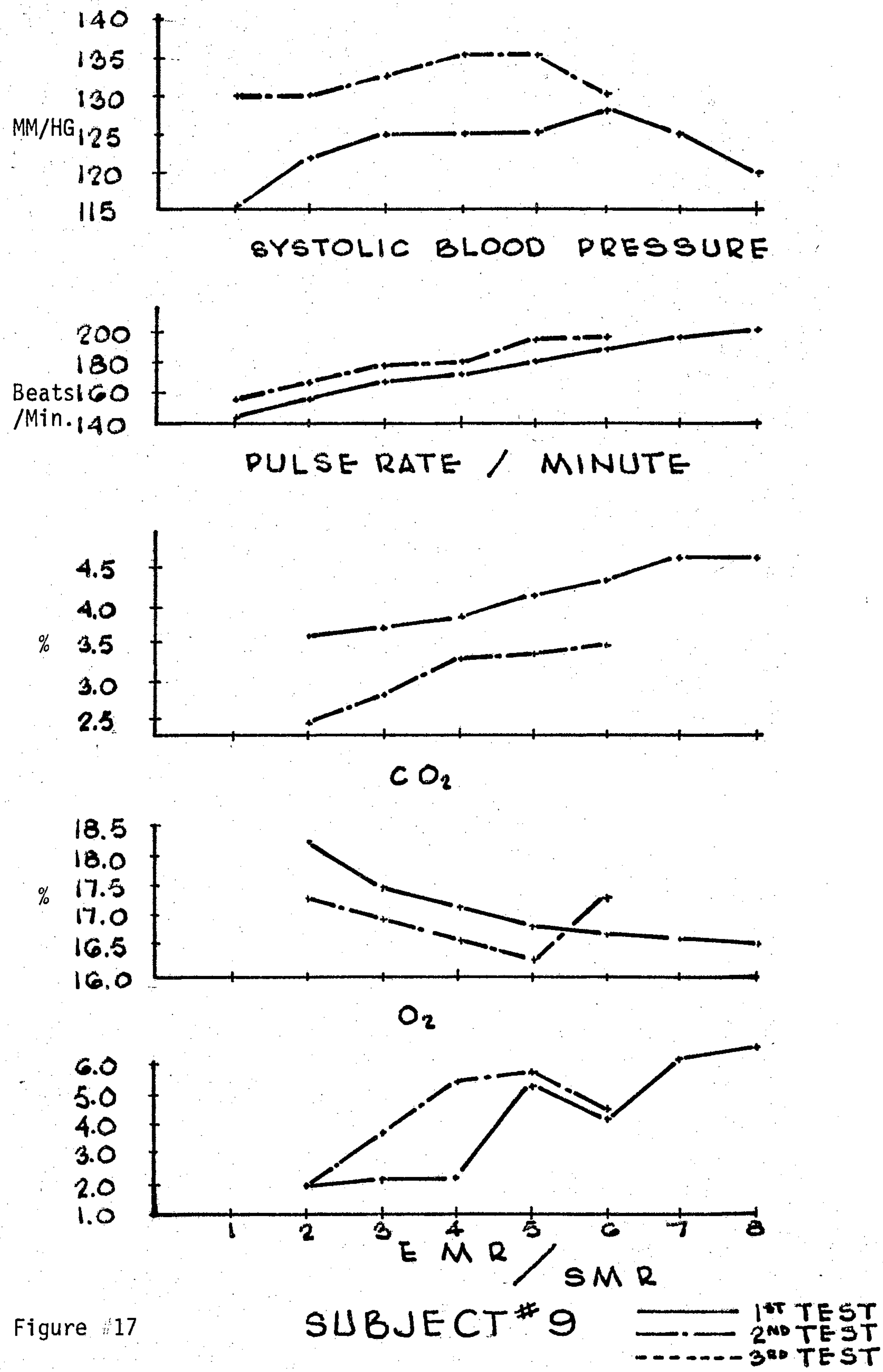
140
135
130
MM/HG 125
120
115
SYSTOLIC BLOOD PRESSURE
200
180
Beats 160
/Min. 140
PULSE RATE / MINUTE
4.5
4.0
% 3.5
3.0
2.5
CO_2
18.5
18.0
% 17.5
17.0
16.5
16.0
O_2
6.0
5.0
4.0
3.0
2.0
1.0
1 2 3 4 5 6 7 8
EMR / SMR
SUBJECT # 9
1ST TEST
2ND TEST
3RD TEST

Figure #17

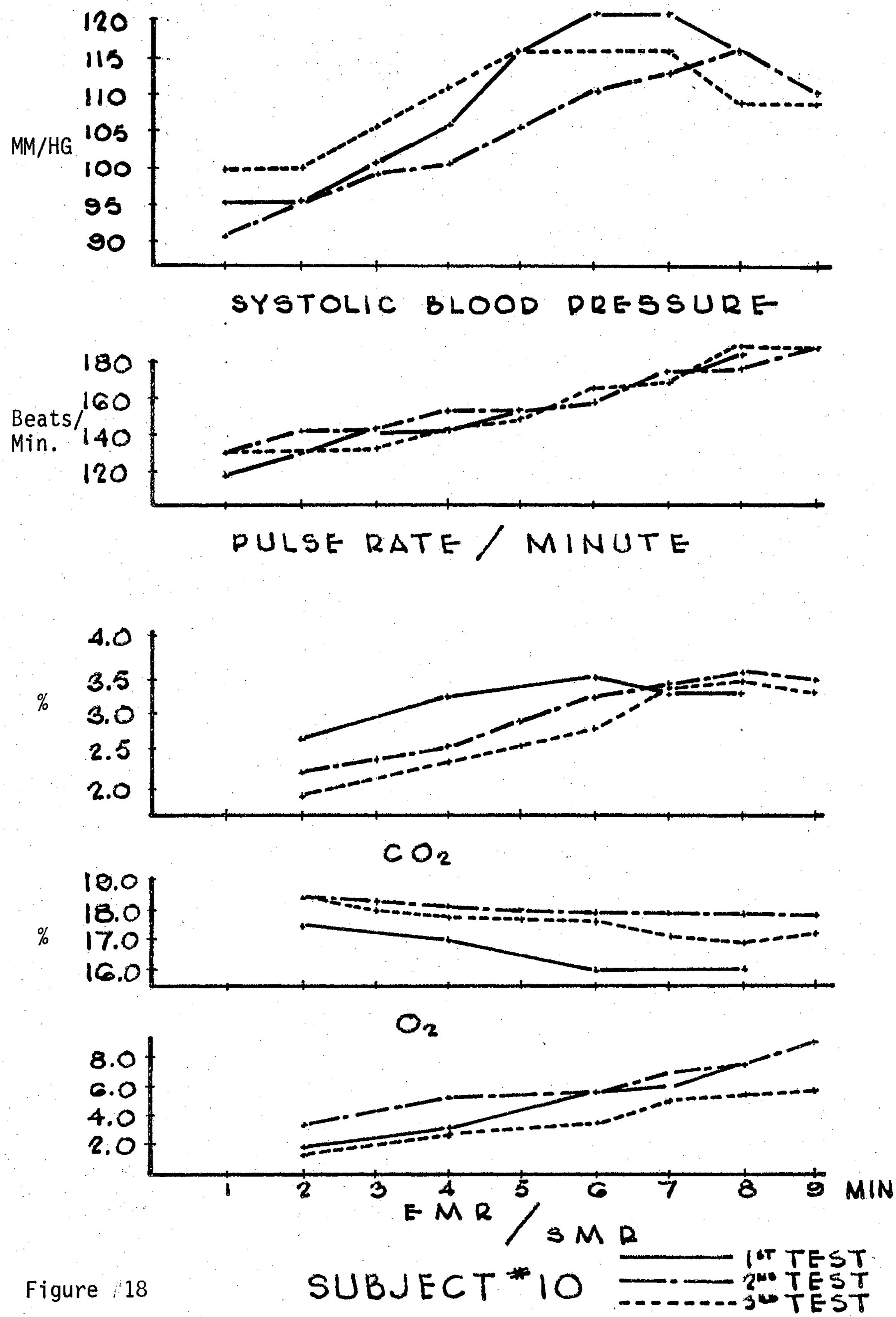
120
115
110
105
MM/HG
100
95
90
SYSTOLIC BLOOD PRESSURE
180
160
Beats/ Min.
140
120
PULSE RATE / MINUTE
4.0
3.5
%
3.0
2.5
2.0
CO_2
19.0
18.0
%
17.0
16.0
O_2
8.0
6.0
4.0
2.0
1 2 3 4 5 6 7 8 9 MIN
EMR / SMR
SUBJECT #10
1ST TEST
2ND TEST
3RD TEST

Figure #18

TABLE VI

MEANS ON TEST-RETEST SUBJECTS

Minutes:		1	2	3	4	5	6	7	8	9	10
Systolic Blood Pressure	1st:	101.2	105.4	108.6	109.6	116	116.6	116	111	108.3	
	2nd:	102.6	105.0	109.8	112.0	113.6	115.6	111.8	112.5	108.3	105
Diastolic Blood Pressure	1st:	64	62	62	64	65	65	65	65		
	2nd:	60	60	60	61	61	61	58	60	58	55
Pulse Rate	1st:	123	138	143	151	160	169	167	180	188	
	2nd:	130	140	146	150	160	166	169	172	181	176
CO_2 %	1st:		2.51	2.8	3.03	3.12	3.2	3.26	3.11	3.27	
	2nd:		2.12	2.21	2.32	2.6	2.98	3.15	3.4	3.4	3.4
O_2 %	1st:		18.2	17.4	17.2	16.8	16.9	16.3	16.9	17.2	
	2nd:		18.5		18.3		17.7	17.7	17.5	17.6	17.4

TABLE VI (continued)

Minutes:		1	2	3	4	5	6	7	8	9	10
VO_2 ml/kg	1st:		9		16.3		21.5	33	25.6		
	2nd:		11.1		15.2		21	23	25		
EMR/SMR	1st:		1.72		2.65		3.7	6.05	4.4	2.2	
	2nd:		2.1		3.9		4.2	5.5	5.5	6.4	5.8
Resp. Quotient	1st:		.90		.77		.80	.74	.82	.92	
	2nd:		1.75		2.13		2.23	1.04	2.05	2.27	

TABLE VII

MEANS AT CUT-OFF POINTS FOR BOYS
AGES 8-13 YEARS

Subj.	Syst/Diast. Blood Pres.	Pulse Beats/ Min.	CO_2%	O_2%	Resp. Quot.	True O_2 liters	$\frac{EMR}{SMR}^2$	Net O_2 Debt liters
1	105/70	168	2.91	17.05	.7	4.14	13.2	.26
2	122/70	192	2.9	17.5	.8	3.56	1.6	.80
3	130/65	156	3.5	17.8	1.15	3.04	3.08	.04
4	125/65	196	3.71	18.6	1.87	1.96	8.99	.38
5	120/60	180	2.95	18.6	1.37	2.15	5.83	.04
6	125/70	184	3.61	17.9	1.25	2.87	8.42	.38
7	110/65	184	3.1	18.5	1.36	2.25	4.17	.05
8	110/80	192	3.3	18.1	1.21	2.70	5.38	.16
9	98/70	180	2.9	18.8	1.5	1.9	5.11	.26
10	125/70	188	3.68	16.0	.69	5.30	6.48	.91
11	150/70	180	3.89	16.4	.82	4.70	7.71	.19
12	125/85	184	3.98	16.4	.84	4.69	9.33	.69
13	100/75	180	3.1	17.5	.88	3.50	4.30	
14	100/55	188	3/15	17.2	.80	3.85	4.07	1.36
15	146/70	188	3.3	17.05	.81	4.03	5.90	.83
16	135/65	200	3.4	18.5	1.55	2.19	7.10	.99
17	120/70	184	3.3	16.9	.77	4.22	4.19	.64
18	140/65	192	2.6	18.4	1.05	2.50	6.45	
19	110/55	180	3.38	17.3	.91	3.70	6.38	1.45
20	110/70	176	3.55	17.4	1.0	3.54	6.92	.65
21	105/65	176	3.15	19.7	2.7	.90	2.46	.03
22	120/55	192	3.3	16.0	.61	5.36	9.12	1.07
23	120/70	192	3.61	15.8	.65	5.49	5.77	.63
24	128/70	188	3.08	16.72	.87	4.32	2.99	.48
25	128/70	184	3.25	16.6	.69	4.62	3.50	.88
26	110/65	168	3.50	17.2	.91	3.80	10.91	.27
27	110/55	144	2.55	17.1	.60	4.19		
28	120/70	184	3.12	18.6				
29	134/70	168	3.72	18.0	1.36	2.72	9.66	.33
30	120/70	192	3.40	18.2	1.31	2.55	6.79	.07
Mean:	119/68	182	3.28	17.66	1.11	3.31	6.35	.46

LABORATORY METABOLIC CALCULATION

Subject:______________________________Date:______________________

Age:____________Somatotype No.:______________B.P. (mm. Hg.):____________

Height:_________Weight:__________O.C. Temperature:____________________

Surface Area:____________Correction factor by Harvard line chart:__________

A. Sitting (non-basal)

1. RQ = ____________(from Harvard line chart)
2. Ventilation/min.= $\frac{\_\_\_\_\_\_}{10}$ mm (from Kymograph)= _______ x 1.332=______L./min.
3. True O_2 x ventilation = $\frac{\quad x \quad}{100}$ = ________L./min. of O_2

   Corrected O_2= ______ x _______ = ________L./min. O_2 - intake
4. S.M.R. = $\frac{\quad x\ 5^*\ x\ 60}{Sq.\ m.}$ = ____________ Cal./Hr./Sq.m.

B. O_2-Debt and Rate of O_2-Debt

1. First bag of recovery gas:

   Ventilation/min.= $\frac{\_\_\_\_\_\_}{10}$ mm (from Kymograph)x 1.332 = ________Liters/min.

   True O_2 x vent.

   $\frac{\quad x \quad}{100}$ = ___________Liters or __________L./min.
2. Second bag of recovery gas:

   Ventilation/min.= $\frac{\_\_\_\_\_\_}{10}$ mm (from Kymograph) x 1.332 = ________Liters/min.

   True O_2 x vent.

   $\frac{\quad x \quad}{100}$ = __________Liters or __________L./min.
3. Third bag of recovery gas:

   Ventilation/min.= $\frac{\_\_\_\_\_\_}{10}$ mm (from Kymograph) x 1.332 = ________Liters/min.

   True O_2 x vent.

   $\frac{\quad x \quad}{100}$ = _________Liters or __________L./min.
4. Gross O_2-Debt = ________+ _______ = _______Liters
5. Net O_2-Debt = Gross - Sitting equivalent = ________-_________ = ______Liters

SAMPLE CALCULATION FOR FOR EXERCISE PHASES OF TEST

Name____________________ Date____________________

Exercise____________________ Speed__________ Height__________

Time____________________

1. RQ = __________(from Harvard line chart)
2. Ventilation/min. = $\frac{\qquad}{10}$ mm = __________ x 1.332 = ________L./min.

   Corrected ventilation = $\frac{\text{Corr. factor x vent.}}{\qquad x \qquad}$ = __________L./min.
3. Gross O_2-Intake = True O_2 x ventilation = $\frac{x}{100}$ = ________L./min.
4. E.M.R. = $\frac{x\ 5^{*}\ x\ 60}{\text{Sq. m.}}$ = __________ Cal./Hr./Sq.m.
5. Intensity of Exercise = $\frac{x\ 300}{\text{Kg.}}$ = __________ Cal./Hr./Kg.

Exercise____________________ Speed__________ Height__________

Time____________________

1. RO = __________(from Harvard line chart)
2. Ventilation/min. = $\frac{\qquad}{10}$ mm = __________ x 1.332 = ________L./min

   Corrected ventilation = $\frac{\text{Corr. factor x vent.}}{\qquad x \qquad}$ = __________L./min.
3. Gross O_2-Intake = True O_2 x ventilation = $\frac{x}{100}$ = ________L./min.
4. E.M.R. = $\frac{x\ 5^{*}\ x\ 60}{\text{Sq. m.}}$ = __________Cal./Hr./Sq.m.
5. Intensity of Exercise = $\frac{x\ 300}{\text{Kg.}}$ = __________Cal./Hr./Kg.

Exercise____________________Speed__________Height__________

Time____________________

1. RQ = __________(from Harvard line chart)
2. Ventilation/min. = $\frac{\qquad}{10}$ mm = __________ x 1.332 = ________L./min.

   Corrected ventilation = $\frac{\text{Corr. factor x vent.}}{\qquad x \qquad}$ = __________L./min.
3. Gross O_2-Intake = True O_2 x ventilation = $\frac{x}{100}$ = ________L./min.
4. E.M.R. = $\frac{x\ 5^{*}\ x\ 60}{\text{Sq. m.}}$ = __________Cal./Hr./Sq.m.
5. Intensity of Exercise = $\frac{x\ 300}{\text{Kg.}}$ = __________Cal./Hr./Kg.

VITA

Mary Lois Frye

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Master of Science

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Professional experience: Taught Physical Education and Health Education at Roseburg Junior High School, Roseburg, Oregon, 1947-1949; taught Physical Education at the junior high school and senior high school, Gallup, New Mexico, 1949-1950; taught senior high Physical Education and General Psychology, Gallup, New Mexico, 1950-1951; taught at the University of Nevada, Reno, Nevada, as an instructor in Health, Physical Education and Recreation, 1951-1954; taught at the YWCA, Oklahoma City, Oklahoma, 1955-1961; taught for the Oklahoma City Park Department 1960-1961; taught life saving and acted as Camp Chairman for the Stillwater Girl Scouts, 1964-1966; Member of the American Association for Health, Physical Education, and Recreation; member of the Oklahoma Association for Health, Physical Education, and Recreation; member of the American Camping Association.