A RELIABILITY STUDY OF THE CAHPER FITNESS-PERFORMANCE TEST

by

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ABSTRACT

The reliability of each of the six test items of the CAHPER Fitness-Performance Test was examined in this study. Subjects were 80 grade eight boys with a mean age of 166 months as of May 1, 1970.

The study was divided into two parts. The first determined the reliability coefficients by a test-retest procedure for each of the items when administered in the manner prescribed by the manual. The second part attempted to increase the reliability coefficients by varying the administrative technique and attempting to increase motivation.

In addition to calculating reliability coefficients two other points were investigated. First, the means of the test and retest scores were examined to determine whether or not there had been any practice effect. Second, an analysis of variance was performed to test for order effects resulting from different orders of administering the test items.

Four of the test items, administered in conformity with the instructions of the test manual, produced test reliabilities below the level of .80 considered acceptable for use in individual measurement. Part II obtained increases in the reliability coefficients of all but one item. Only three, however, equalled or exceeded .80. Practice effects were not discernible in either part of the study and the order of rotation through the events did not affect the scores achieved.

The experimental findings are discussed in terms of the use of the

test battery by physical educators and in terms of their possible implications for further research.

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CHAPTER I

INTRODUCTION

The physical fitness of Canadians has been of concern for a number of years. One has only to note the numbers of persons riding bicycles, jogging, or hiking to see the effects of such interest. More and more articles on the topic are appearing in journals, magazines, and newspapers. The federal government, through its Department of Health and Welfare, has this year instituted the Canadian Fitness Award scheme. This program offers fitness awards, in the form of crests, for several levels of fitness for children between the ages of seven and seventeen. The test battery used for the program, is that of the CAHPER Fitness-Performance Test which is the subject of the research in this study.

Physical Fitness

Hand in hand with the emphasis on fitness in youth has come the necessity for methods of evaluating the state of the human body. It is necessary, however, to first attempt to agree upon a definition for motor or physical fitness. There are almost as many different descriptions of the term as there are authors on the subject. Clarke suggests that fitness is "the ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies."[1] He goes a step further

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[1] H. Harrison Clarke, Application of Measurement to Health and Physical Education (fourth edition; Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1967), p. 14.

when he differentiates between physical and motor fitness. The former, he contends, is concerned with muscular strength, muscular endurance, and circulo-endurance. Motor fitness includes these three attributes with the addition of muscular power, agility, speed, and body balance.[2] Larson and Yocum describe the state of fitness as being "...the nature and degree of adjustment (or adaptation) in activities requiring muscular effort."[3] Fleishman, another author well known in this particular area, concerns himself with three strength aspects of fitness - explosive, dynamic, and static.[4] His test battery, however, consists of such a large number of items that it is impractical for school use.

Weiss and Phillips state that "motor and physical fitness is the status of the body with respect to muscular strength and endurance, speed, agility, and flexibility."[5] The Department of National Health and Welfare takes the stand that physical fitness, is "...the ability to undertake daily physical tasks and engage in a favorite sport, without undue fatigue."[6]

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[2]H. Harrison Clarke, Application of Measurement, p. 221.

[3]Leonard A. Larson and Rachael Dunaven Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education (St. Louis: The C.V. Mosby Company, 1951), p. 156.

[4]Edwin A. Fleishman, The Structure and Measurement of Physical Fitness (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964), pp. 29-30.

[5]Raymond A. Weiss and Marjorie Phillips, Administration of Tests in Physical Education (St. Louis: The C.V. Mosby Company, 1954), p. 131.

[6]Department of National Health and Welfare, Get Fit - Keep Fit (Ottawa: Queen's Printer, 1967), p. 7.

There appears, then, general agreement that the term fitness is related to achievement in performance tests involving muscular strength and endurance, cardiovascular-respiratory endurance, muscular power, flexibility, speed, agility, and balance.

Evaluation of Fitness

In order to examine the value of a particular training program, as a precautionary measure in certain vigorous activities, and to determine required remedial areas, some form of evaluation is necessary. As the definitions have shown, the term fitness is an elusive subject which seems to defy scientific description. Evaluation methods are not easily formulated. Without fully equipped and staffed laboratories it is extremely difficult to test all of man's motor functions. In the school situation it is financially impractical. In lieu of testing all phases of fitness, most available test batteries seek to estimate overall fitness by using simple tests to examine skills assumed to be related to it.

School Requirements. Lack of funds, time, equipment, and personnel lead to restrictions as to the types of tests which can be utilized in the evaluation of physical fitness. A test battery for this purpose must meet the following minimum conditions:

1. It must consist of items which can be used to estimate overall fitness.
2. It must consist of items that can be executed using a minimum of equipment and within limited space.

3. It must be of a type which can be administered by a single instructor using student assistants.
4. It must be of a length which will allow it to be completed within two or three class periods.
5. It must provide valid norms appropriate to the ages and environments of the students likely to be tested.

In 1958 the American Association for Health, Physical Education, and Recreation produced the AAHPER Youth Fitness Test Manual with norms developed in the United States.[7] The battery consists of seven test items - pull-ups, sit-ups, shuttle run, standing broad jump, 50 yard dash, softball throw, and a 600 yard walk-run. Norms were established for ages seven to seventeen. The test seems to meet the requirements listed earlier with the possible exception of the norms which are based on the testing of children in the United States. The appropriateness of these norms for Canadian children might be the subject of another study.

A Canadian version of the AAHPER test was published in 1966. This battery, known as the CAHPER Fitness-Performance Test will be described in Chapter II.

Reliability of Fitness Tests

Clarke states that "the reliability of any test may be defined as

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[7]American Association for Health, Physical Education, and Recreation, AAHPER Youth Fitness Test Manual, (revised edition; Washington: AAHPER, 1967), p. 7.

the degree of consistency with which a measuring device may be applied."[8] Obtaining reliable results is an important aspect of motor fitness testing. Interest in reliability is usually centered on the stability of the subject's performances and this is often estimated by the magnitude of the correlation coefficient between test and retest data.[9] Neilson has suggested several sources of unreliability which may be present in a test of this nature. They are:

1. Variations in the behavior of the examiner produced in some cases by causes inherent in the test and in other cases by causes external to the test. Some authors would classify this under the term scorer reliability - whether or not two or more examiners would record the same results.
2. Continuous variations within the pupils themselves.
3. Constant causes which operate to produce differences in results:
   (a) Improvement due to experience with the first test.
   (b) Improvement due to normal development in the trait being measured.[10]

Clarke contends that test-retest correlations may be high without the test itself being reliable. A case where retest scores are consistently higher than test scores would suggest that this might very well be true.

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[8] H. Harrison Clarke, Application of Measurement, p. 29.

[9] S.R. Brown and A. Field, "Reliability and Errors of Measurement of the AAHPER Youth Fitness Test," (Vancouver: paper prepared for CAHPER Journal publication in August-September, 1967), p. 1.

[10] N.P. Neilson, Statistics, Tests and Measurements in Physical Education (Palo Alto: The National Press, 1960), p. 45.

To detect this condition would require taking into account both the correlation coefficient and the difference between the means.[11] Since the CAHPER test is generally used to distinguish among students rather than having them all reach a specific level, this is unimportant.

Purpose of the Study

The committee who prepared the test manual and established the norms state that they "...agreed that each test item selected was a valid and reliable measure of fitness..."[12] Apparently no analysis of validity or of reliability was performed.

This study was undertaken (1) to attempt to determine the test-retest reliability of the CAHPER test battery as it is set out in the test manual; (2) to attempt to improve administrative procedures in cases where reliability coefficients appeared to be below an acceptable level; and (3) to determine whether or not the order of rotation through the test items on each half of the test affected scores achieved.

Limitations. The results are applicable only to a specific age group of approximately fourteen years. The data were obtained from only one school, a junior secondary school in Victoria, British Columbia. Random selection of subjects was limited by the number of students available in any one age classification.

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[11] H. Harrison Clarke, Application of Measurement, p. 30.

[12] Canadian Association for Health, Physical Education, and Recreation, The CAHPER Fitness-Performance Test Manual (Toronto: Canadian Association for Health, Physical Education, and Recreation, 1966), p. 6.

In the succeeding chapters the CAHPER test will be described, the methods and procedures of the study outlined, the results of analyses of two sets of data discussed, and finally the recommendations set out which originate from these data.

CHAPTER II

THE CAHPER FITNESS-PERFORMANCE TEST

History

As has already been noted, interest in physical fitness and the measurement of the state of the human body has increased in recent years. Although nutrition has improved and more leisure time is available, the increasing automation of our society has reduced, for many, the amount of physical labor previously required. The first co-ordinated effort in Canada, to motivate young people towards fitness, was instituted by the federal government in 1967. As one of the projects undertaken to celebrate Confederation, the Centennial Athletic Awards Programme made crests available for varying levels of fitness of children between the ages of six and eighteen. This scheme was set in motion in part "...to stimulate, encourage, and motivate Canadian youth to strive for excellence and reach higher levels in physical fitness."[13]

The test battery for these awards consisted of three compulsory events and a choice of one optional event. The compulsory items were the standing broad jump, speed sit-ups, and a 300 yard run. The optional skill could be selected from cross-country running, skating, or swimming.

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[13]Centennial Commission, Teacher's Manual: Centennial Athletic Awards Programme (Ottawa: Queen's Printer, 1967), p. 6.

The awards - red, bronze, silver, or gold crests - were based upon the lowest score achieved on any of the four events executed. Training for the program was encouraged and the children could be tested as often as time permitted. No attempt was made to establish Canadian norms as the program was established for use during the Centennial celebrations only. However the seeds were sown for a broader interest in fitness.

Earlier, in 1963, the Canadian Association for Health, Physical Education, and Recreation had requested its research committee to "...design and undertake a project which would establish national norms of physical performance for Canadian children and youth."[14] A research grant request was submitted to and approved by the Fitness and Amateur Sport Directorate of the Department of Health and Welfare. Test items were selected at a conference held in Edmonton in 1964. The testing was started in 1964 and completed in 1965. Random selection of 500 boys and 500 girls in each age group from seven to seventeen from all provinces provided the basis for the norms.[15]

The test manual, although published in 1966, did not reach the schools until 1968. The Centennial Award Scheme, run in 1967, delayed its release.

Test Items

The CAHPER battery consists of six items which are purported to

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[14]Canadian Association for Health, Physical Education, and Recreation, The CAHPER Fitness-Performance Test Manual (Toronto: Canadian Association for Health, Physical Education, and Recreation, 1966), p. 6.

[15]Ibid., p. 7.

measure six different aspects of fitness. The events are:

1. One Minute Speed Sit-Ups to test the muscular strength and endurance of the abdominal muscles.
2. The Standing Broad Jump which measures the explosive strength or power of the legs.
3. The Shuttle Run to determine agility.
4. The Flexed Arm Hang which gives an indication of the muscular endurance of the arm and shoulder muscles.
5. The 50 Yard Run to measure speed.
6. The 300 Yard Run which is indicative of stamina or endurance.[16]

The test is designed to be competitive in nature. Both boys and girls have an opportunity to compete against national norms as well as against each other. The intent of the test is to enable the physical educator to be able to gain a great deal of insight into the fitness of his students without costly equipment.

Use of Results. Although no procedure for estimating overall fitness based on the scores achieved on the six test items is provided, charts can be prepared to give a profile of the results for each participant. From the profile, any areas of apparent weakness can quickly be determined. Figure I illustrates such a profile. In this case it appears that the student is weak in the shoulder girdle and exercises involving this area might be prescribed.

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[16] Ibid., p. 20.

14 YEAR OLD BOYS

Percentile	Speed Sit Up (No.)	Stand Broad Jump (Ft.Ins.)	Shuttle Run (Secs)	Flexed Arm Hang (Secs)	50 Yard Run (Secs)	300 Yard Run (Secs)
100	57	8'7"	9.0	149	6.0	44
95	49	7'2"	10.1	84	6.5	53
90	45	6'11"	10.3	73	6.7	55
85	43	6'8"	10.5	67	6.9	56
80	41	6'6"	10.6	63	7.0	57
75	39	6'4"	10.8	60	7.1	57
70	38	6'2"	10.9	58	7.2	58
65	36	6'1"	10.9	52	7.3	59
60	35	6'0"	11.0	50	7.4	60
55	34	5'10"	11.2	48	7.4	61
50	32	5'9"	11.3	45	7.5	62
45	31	5'8"	11.4	43	7.6	62
40	29	5'7"	11.5	41	7.7	63
35	28	5'5"	11.7	38	7.8	64
30	27	5'4"	11.9	35	7.9	65
25	25	5'2"	12.0	32	8.0	66
20	24	5'1"	12.2	27	8.1	67
15	22	4'11"	12.5	24	8.4	68
10	20	4'8"	13.0	20	8.7	70
5	18	4'4"	13.6	14	9.0	74
0	0	3'10"	15.3	0	11.0	87

FIGURE I

PROFILE OF RESULTS ACHIEVED ON CAHPER TEST[17]

[17]The CAHPER Fitness-Performance Test Manual, p. 38.

Review of Literature

Because of its short time in use, little has been written on the CAHPER test. A search of literature has brought little to light about the test itself. W.G. Lucas made a comparison of regional norms developed by him with the published national norms. He found considerable differences in certain test items at percentiles twenty-five, fifty, and seventy-five. He suggested that one value in using the test is that it can provide a basis upon which to develop a physical fitness program. For those scoring low on national norms, specific remedial programs can be established, while for those who score high an indication of the type of activities which can and should be provided is given. Lucas further stressed that pressure to upgrade percentile levels will result in an increase in overall fitness for our youth.[18]

In another study, Jordan attempted to validate the CAHPER test by correlating it with the Fleishman Basic Fitness Test. In general he found "high" validity substantiated by a multiple correlation coefficient of .790 and a zero-order coefficient of .781.[19]

Related studies. Several authors have described research performed on identical or at least similar test items to those utilized in the

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[18] W.G. Lucas, "CAHPER Fitness Comparisons and Practical Thoughts," Health and Physical Education Council Bulletin of the Alberta Teacher's Association, Vol. VII, No. 3 (Summer, 1968), pp. 15-23.

[19] Charles Jordan, "The CAHPER Fitness-Performance Test As Validated by the Fleishman Basic Fitness Test," (unpublished Master's Thesis, The University of British Columbia, 1966).

CAHPER battery. Although no empirical evidence has been offered for the fourteen year old sample tested in this study, it should be possible to make comparisons.

Fleishman, in a study involving eighteen year olds, found reliability coefficients of .72 for speed sit-ups, .90 for the standing broad jump, .85 in the case of the shuttle run, and .77 when he tested the flexed arm hang. The 50 yard run yielded a coefficient of .86 while the 600 yard walk-run (used in lieu of the 300 yard run) coefficient was found to be .80.[20]

Larson and Yocum, although they do not indicate the bases for their decisions, state that reliability coefficients of .90 and higher should be achieved in the standing broad jump, shuttle run, 50 yard run, and the 300 yard run. They anticipate a "moderately" high coefficient between .80 and .89 for speed sit-ups.[21]

Kane and Meredith, in a study of seven, nine and eleven year olds performing the standing broad jump, found the reliability coefficient to be .83 for boys and .86 for girls when they were tested two days after the initial test. They further found, that for this age range, the children continued to improve until the eighth trial. In their

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[20]Edwin A. Fleishman, The Structure and Measurement of Physical Fitness (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964), p. 59.

[21]Leonard A. Larson and Rachael Dunaven Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education (St. Louis: The C.V. Mosby Company, 1951), p. 163.

program they allowed each of the subjects twelve trials.[22]

No other studies, calculating the reliability coefficients of comparable test items to those used in the CAHPER battery, appear to have been reported in the literature.

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[22]Robert J. Kane and Howard V. Meredity, "Ability in the Standing Broad Jump of Elementary School Children 7, 9, and 11 Years of Age," Research Quarterly, Vol. 23, No. 2 (May, 1952), pp. 201-203.

CHAPTER III

EXPERIMENTAL METHODS AND PROCEDURES

Introduction

The empirical work of this study fell into two main parts. The first involved testing and retesting a group of grade eight boys in accordance with the instructions laid down in the CAHPER Fitness-Performance Test Manual.[23] The results will be described in Chapter IV. The second part entailed a test-retest of another group of students of approximately the same age with a view to improving the reliability coefficients obtained in Part I. This aspect of the study will be delineated in Chapter V.

Subjects

The subjects in the testing project were grade eight boys enrolled in an unrestricted physical education program at a junior secondary school in Victoria, British Columbia.

Selection. The ages, as of May 1, 1970, of all grade eight boys in the school were calculated and those boys selected whose ages ranged from 160 to 174 months. This age provided 104 students and allowed for the use of approximately fifty subjects in each experimental group.

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[23]Canadian Association for Health, Physical Education, and Recreation, The CAHPER Fitness-Performance Test Manual (Toronto: Canadian Association for Health, Physical Education, and Recreation, 1966), pp. 8-19.

Using a table of random numbers, the boys were assigned to Group I and to Group II. Each group was then randomly broken into three subgroups - A, B, and C. In order to make use of more testers these three subgroups were further partitioned into two sections each - A1, A2, B1, B2, C1, C2.

Orientation. Physical education periods were used to explain and demonstrate the various test items. The reasons for running the program were outlined to the students and the procedures for carrying out the testing, discussed. Students were assigned to their sections on the first day of testing.

Facilities

Both studies used the same facilities. Indoor portions of the test were performed in the gymnasium and the two running events (50 and 300 yard runs) were conducted around orange markers on a paved area next to the school grounds. The paved area was used to avoid problems which might have arisen due to damp weather had the grass field been utilized.

The test manual suggests the use of mats in testing the performance of the standing broad jump. However, as the mats tend to move under the jumper's thrust, it was found extremely difficult to hold them in one spot. It was decided, instead, to perform this item on the floor with distances marked every two inches with two foot long pieces of tape. As the tester had only to record jumps to the nearest inch, scoring was simplified. The manual proposes laying a cloth measuring tape along

the path of the jump with the examiner attempting to record the point of impact by the rear heel.

Regulation chinning bars were used to test the flexed arm hang. The shuttle run was tested on the gymnasium floor and the speed sit-ups were performed on mats.

Weather

The tests were conducted during the months of April and May when the weather conditions were good. No rain was encountered and it was cool and windy for only one of the periods outside. It is believed that results were not adversely affected to any extent by weather conditions.

Time

All tests were carried out after school as it was not possible to arrange for students, testers, and assistants during school hours. Tests were started at three-thirty in the afternoon and were usually completed within forty-five minutes. By starting at the same time each day the element of fatigue was controlled as closely as possible. Additionally, due to the time of day, there were few distractions from bystanders as most of the other students had left the school.

To reduce the possible effects of fitness changes due to activity between tests, Part 1 of the test battery was given on days one and three and Part 2 on days two and four. The schedule was so arranged as to complete the testing within one school week with no interruption by weekends.

Testers and Assistants

The teachers, six in number, were staff members from the school. Five were teachers who either were or had been actively engaged in teaching physical education. The sixth was an interested staff member who agreed to assist in the project. All were given an orientation as to the requirements of the research including demonstrations of the events. In addition, each of them was provided with a set of written instructions (Appendices 2 and 3).

Each tester was responsible for the same two events for both test and retest. That is, if an individual supervised sit-ups in Part 1 and the 50 yard run in Part 2, he tested the same two events on the retest. Furthermore, due to the subsectioning of the groups, it was arranged each time to have the same testers test the same students in the same order.

The assistants consisted of grade nine and ten students, all of whom had been exposed to the test items. They were selected by members of the Physical Education Department of the school and were assigned to testers as recorders. They remained with the same examiner for the duration of the testing.

Tabulation of Results

Score sheets (Appendix 4) with a student's name recorded on them were placed in the appropriate subgroup sections and stapled into booklets. Results from these individual score sheets were transposed to master sheets (Appendix 5) in order to make coding for computer programming less tedious.

Analysis of Data

The basic analyses which were performed were as follows:

1. A product-moment correlation coefficient was calculated on the test and retest scores in order to determine the test-retest reliability of each of the test items. The effect, if any, of varying the administration technique in Part II would be evident if different coefficients were obtained. Scott suggests that this tool is the one most often used in physical education tests.[24]

2. In order to determine the variation that might be expected in scores of individuals if they were tested and retested repeatedly, a second index of reliability -- the standard error of measurement -- was computed.

3. A t-test for the significance of the difference between correlated means was used to test for significant differences in performance over two trials due to practice effect. This test is applicable where two sets of scores for a single group are correlated.[25]

4. A one-way analysis of variance was computed to determine the extent to which treatment effect by varying the order of rotation through the test items had an effect on performance. The one-way classification is appropriate in as much as there is only one treatment variable -- rotation order.

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[24]Gladys M. Scott (ed.), Research Methods in Health, Physical Education, and Recreation (second edition; Washington: American Association for Health, Physical Education, and Recreation, 1959), p. 193.

[25]George A. Ferguson, Statistical Analysis in Psychology and Education (second edition; New York: McGraw-Hill Book Company, 1966), p. 171.

CHAPTER IV

PART I

I. THE PROBLEM

Part I was conducted with three purposes in mind. These were:

1. To determine the test-retest reliability of each of the test items administered in accordance with the CAHPER manual.

2. To determine the extent of "practice effect" over two trials. A statistically significant increase in the mean of the second test would tend to indicate that some learning had taken place as a result of the first test.

3. To determine whether the order of rotation through the three test items in each part of the test had any effect on the results for any of those items.

II. ADMINISTRATION

Subjects

Out of the original fifty students selected for assignment to Part I, only thirty-seven completed the testing program. The remaining thirteen students either did not appear at all or failed to appear often enough to be tested and retested on each of the items. The mean age of the thirty-seven subjects was found to be 166.6 months with a standard deviation of 4.6 months.

The students had previously been informed of the requirements of the test items and the purpose of being tested twice.

Testers and Assistants

Two testers and two assistants were assigned to each of the three items being tested each day. Subgroup sections, designated A1, A2, B1, B2, C1, C2, had been established so as to enable the students to be scored by the same tester each time. Subjects were called in the order in which their names appeared on the score sheets. The numbers in each of the subgroup sections were:

A1 - 6	B1 - 7	C1 - 6
A2 - 6	B2 - 6	C2 - 6

Testing Schedule

Part 1, consisting of speed sit-ups, standing broad jump, and the shuttle run, were tested on days one and three. Part 2, made up of the flexed arm hang, 50 yard run, and 300 yard run, were performed on days two and four.

Rotation Order

In order to ascertain the effects, if any, of different rotation orders through the various test items, the groups, A, B, and C, started and finished at different stations. For example, Group A started Section 1 of the test with speed sit-ups, Group B with the standing broad jump, and Group C with the shuttle run. Group A completed this half of the test with the shuttle run, Group B with sit-ups, and Group C at the standing broad jump area. Table I presents the order in which each of the test items was taken by the three groups.

Procedures and Scoring

A complete description of the instructions and scoring methods laid down by the test manual will be found in Appendix 1.

III. STATISTICAL ANALYSES AND INTERPRETATION

Acceptable Conditions

There appears to be fairly general agreement as to acceptable levels of reliability for physical education tests. Mathews states that reliability coefficients above .90 are excellent. He also suggests that items such as those included in the CAHPER test battery should provide highly consistent results. Coefficients between .80 and .89 are considered by him as being fair, while coefficients in the range of .70 to .79 are rated as fair to poor.[26]

Meyers and Blesh agree with Mathews and add that coefficients between .80 and .89 are considered satisfactory for individual measurement and .70 to .79 is suitable for group evaluation.[27] Scott makes the statement that "the generally accepted standard of test reliability is .85 for individual use, and .75 when test results are used to evaluate group achievement."[28] Bovard and Cozens quote values comparable to

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[26]Donald K. Mathews, Measurement in Physical Education (Philadelphia: W.B. Saunders Company, 1968), p. 26.

[27]Carlton R. Meyers and T. Erwin Blesh, Measurement in Physical Education (New York: The Ronald Press Company, 1962), p. 63.

[28]Gladys M. Scott (ed.), Research Methods in Health, Physical Education, and Recreation (second edition; Washington, American Association for Health, Physical Education, and Recreation, 1959), p. 244.

TABLE I

ROTATION ORDER OF GROUPS

THROUGH TEST ITEMS

Order	Speed Sit Ups	Standing Broad Jump	Shuttle Run	Flexed Arm Hang	50 Yard Run	300 Yard Run
1	A	B	C	A	B	C
2	C	A	B	C	A	B
3	B	C	A	B	C	A

those of Meyers and Blesh.[29]

In as much as the CAHPER test is generally used for individual measurement rather than for group evaluation, a reliability coefficient for one of the test items, of .80 or higher is considered here to be adequate. Standard errors of measurement were calculated to provide an indication of the amount of error which can be expected in an individual's observed scores. These values will provide another index of reliability for each of the test items.

Correlation and t-Test Results

The results of computations of the product-moment coefficients of correlation between the test and retest for the six items, standard errors of measurement, and the t-tests for the significance of the differences between correlated means have been summarized in Table II. Included as well are means and standard deviations for each test and retest.

Interpretation of Results

1. Speed Sit-Ups. An r of .863 would be considered as an acceptable level of reliability. The standard error of measurement (SE_M) of approximately 4 shows that, at the 95% level of confidence, an individual's true score would fall within a range of ±8 of his observed score.

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[29] John F. Bovard and Frederick W. Cozens, Tests and Measurements in Physical Education (Philadelphia: W.B. Saunders Company, 1938), p. 333.

There was a small but non-significant decrease between the means of the test and retest. This may have been due to stiffness occurring because the tests were run only forty-eight hours apart. A more likely reason would involve the difficulty of maintaining motivation. This aspect will be dealt with more fully in the following chapter.

Brown and Field, in a study completed at the University of British Columbia, stated that "many UBC students were either unwilling or unable to do a reasonably large number of sit-ups despite preliminary encouragement to do so." They found a SE_M of 6.93 which they considered as being quite large. They concluded that the level of subject stability, for this item, was "not very good."[30]

Fleishman's test of eighteen year olds yielded a coefficient of only .72. His test was of shorter duration - thirty seconds rather than sixty.[31] Larson and Yocum suggest that the reliability will be at a "moderate" level (.80 - .89) for this skill.[32]

2. Standing Broad Jump. A correlation value of .832 would be slightly below the .85 level suggested by Scott but within the limits of .80 and higher set forth by other authors quoted and accepted for

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[30] Stanley R. Brown and A. Field, "Reliability and Errors of Measurement of the AAHPER Youth Fitness Test," CAHPER Journal, Vol. 33, No. 6 (August-September, 1967), p. 19.

[31] Edwin A. Fleishman, The Structure and Measurement of Physical Fitness (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964), p. 59.

[32] Leonard A. Larson and Rachael Dunaven Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education (St. Louis: The C.V. Mosby Company, 1951), p. 163.

TABLE II

RESULTS OF CORRELATIONS AND t-TESTS

Test Item		$\bar{X}$	s	r	t	SE_M
Sit-Ups	Test	46.432	11.180	.863	.521	4.14
	Retest	45.865	12.956			
Standing Broad Jump	Test	71.946	8.017	.832	3.191*	3.29
	Retest	69.270	9.031			
Shuttle Run	Test	11.357	.935	.706	.389	.507
	Retest	11.400	.736			
Flexed Arm Hang	Test	45.541	21.775	.751	1.236	10.86
	Retest	43.162	24.201			
50 Yard Run	Test	8.035	.437	.678	1.036	.248
	Retest	8.116	.639			
300 Yard Run	Test	62.162	7.073	.419	1.602	5.39
	Retest	65.892	15.364			

n = 37 Age $\bar{X}$ = 166.6 Age s = 4.6

Critical t-values (two-tail) $nt_{(30,.05)} = 2.042$

$t_{(40,.05)} = 2.021$

*Significant at the .05 level.

use in this study. The SE_M was found to 3.29 inches, which is close to that of 3.35 found by Brown and Field. Brown and Field felt that although this value was better than that computed for sit-ups it was still inadequate.[33]

A statistically significant decrease in the means from test to retest was found. Lack of motivation seems to be the most logical explanation for the difference.

Fleishman, in his research, found a relatively high coefficient of .90.[34] Larson and Yocum consider that this event should produce a value of .90.[35]

3. Shuttle Run. Using the procedure given in the test manual, produced a reliability coefficient of .706 which is not of sufficient magnitude to warrant its use as a tool for individual measurement. Fleishman found a correlation value of .85[36] while Larson and Yocum suggested that it should be "high" (.90 or higher).[37]

The SE_M of .507 again appears large as this would allow for a true score range of ±1 second from the observed scores. Brown and Field's

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[33]Brown and Field, loc. cit.

[34]Fleishman, loc. cit.

[35]Larson and Yocum, loc. cit.

[36]Fleishman, loc. cit.

[37]Larson and Yocum, loc. cit.

SE_M of .24 seconds was considered by them as indicating subject instability.[38]

Although the mean time for retest was slightly lower there was not a significant difference in means.

4. Flexed Arm Hang. Again, in so far as this sample was concerned, this item would not appear to be sufficiently reliable for use with individuals (r = .751). Fleishman's sample gave much the same results with an r of .77.[39] It must be noted, however, that with Fleishman's sample the method of holding the bar, was slightly different from the prescribed method in the CAHPER test used in this study. Thus it may not be possible to compare the two groups. No other results from comparable tests were found in the literature.

The SE_M of 10.86 reflects the low reliability coefficient found for this item. It is far too large, allowing, at the 95% level of confidence, for a range of ±21.29 seconds about the observed score.

The trend of a decrease in mean from test to retest continued although the t-test failed to indicate a significant difference. The variance for both tests was extremely high. The variation in body build and strength is very pronounced at this age and since no consideration is given to these factors, a large variance might be expected in a test of this nature.

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[38] Brown and Field, loc. cit.

[39] Fleishman, loc. cit.

5. 50 Yard Run. A low reliability coefficient of .678 resulted for this item suggesting that under the procedures by which it was given it would be of little value for either individual or group use. Fleishman, on the other hand, found fairly consistent results with an r of .86.[40] Larson and Yocum propose a value of .90 or higher.[41]

With a SE_M of .248 seconds the true scores would be within a range of half a second above and below the individuals' observed scores. Brown and Field's study of university students provided a standard error of measurement of .19 and he felt that this was too high.[42]

No significant difference was found in the means although the times were slower on the second portion of the test.

6. 300 Yard Run. Sample results here produced the lowest reliability coefficient of any item. Larson and Yocum predict a coefficient of .90[43] but it is not known whether it was for a straight 300 yard run or a shuttle run as in this test. A similar, but longer test involving a 600 yard walk-run yielded an r of .80 for Fleishman.[44]

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[40]Fleishman, loc. cit.

[41]Larson and Yocum, loc. cit.

[42]Brown and Field, loc. cit.

[43]Larson and Yocum, loc. cit.

[44]Fleishman, loc. cit.

The standard error of measurement of 5.39 seconds is very similar to that of 5.66 found by Brown and Field for their 600 yard walk-run.[45]

Predictive Indices

Clarke suggested the use of a predictive index which can be derived from the reliability coefficient.[46] The resulting value gives the percentage better than chance of predicting performance. The formula for this index is:

$$P.I. = 1 - \sqrt{1 - r^2}$$

Table III was prepared to produce the applicable indices for each of the six items.

As r increases, the possibility of predicting performance increases. For example, when r = .80, P.I. = .40 or 40% better than chance. For r = .90 the P.I. jumps to .564 or 56.4% better than chance. As expected, a perfect correlation would result in a 100% better than chance in prediction.

In the results obtained, the only items which might be predicted with any degree of assurance would be sit-ups and the standing broad jump.

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[45]Brown and Field, loc. cit.

[46]H. Harrison Clarke, Application of Measurements to Health and Physical Education (fourth edition; Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1967), p. 422.

TABLE III

PREDICTIVE INDICES

Test Item	r	P.I. (%)
Speed Sit-Ups	.863	49.4
Standing Broad Jump	.832	44.5
Shuttle Run	.706	29.2
Flexed Arm Hang	.751	34.0
50 Yard Run	.678	26.5
300 Yard Run	.419	9.2

Analysis of Variance

A one-way analysis of variance for groups of 12, 13, and 12 subjects provided the results recorded in Table IV. In no instance, either test or retest, does the F-statistic become significant and in only one case (the retest of flexed arm hang) does it even approach significance. The means do not differ sufficiently and on this basis it would seem safe to assume that it makes no difference in which order the three items in each part of the test are performed.

Homogeneity of Variance. An assumption, in the use of analysis of variance, is that the variances of each treatment group are homogeneous, that is, that they are drawn from the same population.[47] One method of determining significant differences in variance is Bartlett's test for homogeneity. A chi square distribution, with degrees of freedom equal to the number of treatment groups less one, results. This particular test is of value where the numbers in the groups vary.[48] Table V reproduces the chi square values computed for each item and for both test and retest.

The first score results of items sit-ups, shuttle run, and 300 yard run, and the second scores for the 300 yard run proved to be statistically heterogeneous. Winer has stated that "moderate" departures of homogeneity do not seriously affect the sampling distribution. A small positive bias

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[47] W. James Popham, Educational Statistics (New York: Harper and Row, 1967), p. 181.

[48] B.J. Winer, Statistical Principles in Experimental Design (Toronto: McGraw-Hill Book Company, 1962), p. 95.

TABLE IV

ONE-WAY ANOVA FOR TEST ITEMS

Test Item		Source	SS	MS	df	F	$F_{(.05)}$
Speed Sit-Ups	1	Groups	220.5000	110.25	2	.85	19.46
		Error	4404.6250	129.55	34		
	2	Groups	566.6250	283.31	2	1.71	3.28
		Error	5643.7500	165.99	34		
Standing Broad Jump	1	Groups	100.3750	50.19	2	.75	19.46
		Error	2283.5625	67.16	34		
	2	Groups	90.6875	45.34	2	.53	19.46
		Error	2926.6250	86.08	34		
Shuttle Run	1	Groups	1.0742188	.54	2	.58	19.46
		Error	31.2460940	.92	34		
	2	Groups	2.1992188	1.10	2	2.10	3.28
		Error	17.8085940	.52	34		

TABLE IV (continued)

Test Item		Source	SS	MS	df	F	$F_{(.05)}$
Flexed Arm Hang	1	Groups	299.9375	149.97	2	.30	19.46
		Error	17243.3130	507.16	34		
	2	Groups	2892.7500	1446.38	2	2.62	3.28
		Error	18778.3130	552.30	34		
50 Yard Rund	1	Groups	.20166016	.10	2	.50	19.46
		Error	6.84814450	.20	34		
	2	Groups	.85790160	.43	2	1.02	3.28
		Error	14.25341800	.42	34		
300 Yard Run	1	Groups	181.0000	90.50	2	1.84	3.28
		Error	1670.0625	49.12	34		
	2	Groups	302.6250	151.31	2	.61	19.46
		Error	8431.0000	247.97	34		

results since relatively more significant results are obtained than the exact sampling warrants. He further states "...F tests are robust with respect to departures from homogeneity of variance."[49]

With small samples, the appearance of one extreme score will increase the variance to a large degree. This was true in the case of the 300 yard run retest. If one extreme time had been disregarded, the variance for the group would have decreased from 426.09 to approximately 26.96. In one other group the presence of an extreme score had a similar effect.

IV. CONCLUSIONS

Reliability

The results obtained from this sample of grade eight boys have shown that only two items -- sit-ups and standing broad jump -- produced test-retest correlations within a range considered acceptable for individual evaluation. The 50 and 300 yard run reliability coefficients would not be suitable for group use under the conditions in which the items were performed.

The standard error of measurement calculations show large measurement errors. Subject stability appears lacking and perhaps more practice in the events is necessary before acceptable reliability can be expected.

Practice Effect

Only in the standing broad jump was there a significant difference

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[49] Ibid., p. 93.

TABLE V

HOMOGENEITY OF VARIANCE

Item	Test	Retest	$\chi^2_{(2,.05)}$
Speed Sit-Ups	6.4521*	4.4362	
Standing Broad Jump	.2615	1.8718	
Shuttle Run	8.4681*	3.8712	5.991
Flexed Arm Hang	2.2801	.0649	
50 Yard Run	.2889	3.9854	
300 Yard Run	8.0140*	20.9020*	

*Significant heterogeneity at the .05 level.

between means of test and retest. In this case, as with all other items, the mean of the first scores was better than that of the second scores. In other words, the subjects did not do as well, on the average, in the second test as they had done on the first.

As previously mentioned it is possible that part of the reason for poorer scores might have been due to stiffness because of the short time interval between the tests. A more likely cause may be the difficulty of instilling and maintaining motivation. This reason is the basis for one of the hypotheses tested in Part II.

Treatment Effect

There were no observed differences in scores attributable to the various rotation orders in each half of the test. It appears that it is not necessary to follow a particular order in the administration of the test items so that three groups could be tested at the same time without impairing the test. This could be of importance in a school situation where the teacher has only student help in his testing program.

CHAPTER V

PART II

I. THE PROBLEM

Because the reliability coefficients resulting from the testing of Group 1 were generally lower than those required for use in individual measurement, a second study was instituted in which attempts were made to raise the reliability of the test items.

Several writers have reported variations in the administrative procedures for items identical to some of those used in the CAHPER battery. Marmis proposed that two trials are sufficient for the standing broad jump, three for the shuttle run, and two for the 50 yard run.[50] Klesius, in a test of 150 grade ten students, suggested the use of three trials each for the same test items.[51] In a report on a study involving high school girls, ages fourteen to seventeen, Eckert used means of three trials for the 50 yard run and the standing broad jump.[52] Kane and Meredith, in their research with seven, nine, and eleven year olds, found that at least eight trials were necessary in the standing broad

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[50]Gary Marmis and others, "Reliability of Multi-Trial Items of the AAHPER Youth Fitness Test," Research Quarterly, Vol. 40, No. 1 (March, 1969), p. 245.

[51]Stephen E. Klesius, "Reliability of the AAHPER Youth Fitness Test Items and Relative Efficiency of the Performance Measures," Research Quarterly, Vol. 39, No. 3 (October, 1968), p. 809.

[52]Helen M. Eckert, "Performance of High School Girls in Running, Jumping, and Throwing," CAHPER Journal, Vol. 34, No. 3 (February-March, 1968), p. 26.

jump before consistent scores appeared.[53] Neilson contended that one method of improving test item reliability was to average results.[54] Klesius also made use of mean scores.[55] Fleishman, on the other hand, used best scores in computing reliabilities.[56]

In view of the above, several innovations were included in the second testing program. They were:

1. An attempt to increase interest and thus motivation.

2. An increase in the number of trials allowed for the standing broad jump, shuttle run, and the 50 yard run. It was considered impractical to expect subjects to perform more than once in the other three test items due to the fatigue induced.

3. To use mean and best scores in an attempt to discover which yielded the larger correlation coefficient.

II. ADMINISTRATION

Pilot Studies

In an effort to determine the effects of using an increased number of trials in certain test items and also the value of using means rather than best scores, three pilot groups were set up. Two were composed

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[53]Robert J. Kane and Howard V. Meredity, "Ability in the Standing Broad Jump of Elementary School Children 7, 9, and 11 Years of Age," Research Quarterly, Vol. 23, No. 2 (May, 1952), pp. 201.

[54]N.P. Neilson, Statistics, Tests, and Measurements in Physical Education (Palo Alto: The National Press, 1960), p. 45.

[55]Klesius, op. cit., p. 811.

[56]Edwin A. Fleishman, The Structure and Measurement of Physical Fitness (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964), p. 59.

of four grade eight students each while the third consisted of four grade nine boys. These subjects were volunteers from physical education classes.

Each of the three groups performed the test twice with one trial each for sit-ups, flexed arm hang, and the 300 yard run, five trials for the standing broad jump, four for the shuttle run, and three for the 50 yard sprint. These seemed to be the numbers of trials beyond which scores started to decrease rapidly.

The only apparently significant results were that the increased number of trials appeared to provide more adequate reliability. The difference between the use of "best" scores and mean scores was not discernible. This may have been due to the composition and size of the groups which created a competitive situation and hence raised the motivational level of the subjects.

Subjects of Group 2

Fifty grade eight boys were originally assigned to Group 2. Of these fifty, forty-three appeared each evening and completed all of the testing. The mean age of this second group was 165.4 months with a standard deviation of 3.3 months. The mean age was thus 1.2 months younger than those in Group 1.

As in the first study, groups and subgroups were selected for ease in supervising.

Testers and Assistants

The same testers and assistants that were used in Part I agreed

to assist in the second part of the study. They again worked in pairs with two sets at each station. Each tester examined the same items with which he had worked previously.

The only change from the earlier work was the use of eight students to do the holding and counting for all participants at the speed sit-up station. In Part 1 the students worked in pairs, one holding and counting while his partner performed the item. When one student finished, the members of the pair exchanged places.

Testing Schedule and Rotation Order

The first half of the test was again run on days one and three with the second portion being tested on days two and four. Testing started at 3:30 p.m.

Table VI presents the rotation order of the groups through each test item.

Motivation

In all cases in Part I, the student's mean scores on the retest were lower than on the original test. Observation of their efforts led to the hypothesis that motivation was inadequate. The only incentive that had been offered was a verbal request that each student do his best. It must be said, however, that in a few cases competitive rivalry did arise -- particularly in the flexed arm hang.

This age group (junior secondary) seems to be one in which motivation is difficult to achieve and maintain. This appears to be particularly true in the case of testing in physical education. Brown, in his study

TABLE VI

ROTATION ORDER OF GROUPS

THROUGH TEST ITEMS

PART II

Order	Speed Sit-Ups	Standing Broad Jump	Shuttle Run	Flexed Arm Hang	50 Yard Run	300 Yard Run
1	A	B	C	A	B	C
2	C	A	B	C	A	B
3	B	C	A	B	C	A

at the University of British Columbia, found "...indifference apparent."[57] Carl E. Willgoose and others stated that "as in all testing, pupil orientation and motivation is important."[58] In this study the lack of motivation was undoubtedly intensified to some degree by the fact that the program was conducted during out-of-school hours rather than in class periods.

In Part II, several procedures were tried in an effort to instill and maintain motivation throughout the test and retest.

1. Each student was promised a profile (Appendix 6) of his results. In fact Group 1 students were also given profiles although the reports had not been promised to them.

2. Participants were provided with hand-outs containing percentile norms along with the names and scores of the top three subjects in each test item from Part I (Appendix 7).

3. Wall charts, containing identical information to the hand-outs, were displayed around the gymnasium.

4. After the test had been run once, a chart depicting all results, was posted in the gymnasium.

5. Testers were requested to verbally encourage each participant.

6. In the shuttle run, flexed arm hang, 50 and 300 yard runs, two students performed at the same time providing competition.

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[57]Stanley R. Brown, "AAHPER Youth Fitness Test Results of University of British Columbia Students," CAHPER Journal, Vol. 33, No. 3 (February-March, 1967), p. 19.

[58]Carl E. Willgoose, Nathaniel Askew and Mildred P. Askew, "Reliability of the 600 Yard Run-Walk Test at the Junior High School Level," Research Quarterly, Vol. 32, No. 2 (May, 1961), p. 264.

Number of Trials

Speed sit-ups, flexed arm hang, and the 300 yard run were left at one trial each. The case for the 300 yard run was supported by Willgoose when he pointed out that "...rapid respiration and great fatigue set in."[59] Similar effects would be found in the other two events.

Part II was run using five trials for the standing broad jump (not including two practice trials), four trials for the shuttle run, and three attempts at the 50 yard run.

Scoring

It was decided to attempt to determine which of two schemes provided the highest test-retest coefficients of correlation. The two methods used were, best scores attained on a series of trials and average scores on a series of trials.

III. STATISTICAL ANALYSES AND INTERPRETATION

Tools of Analyses

The data were treated to the same statistical analyses as in Part I. That is:

1. Product-moment correlations for test-retest reliabilities were found. A coefficient of .80 or higher was considered of sufficient magnitude to be satisfactory for individual measurement.

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[59] Carl E. Willgoose, Evaluation in Health Education and Physical Education (New York: McGraw-Hill Book Company, 1961), p. 158.

2. Standard errors of measurement were calculated to indicate the size of the reduction of measurement errors by the changes which had been introduced.

3. t-tests for significant differences between correlated means were conducted to determine the presence or absence of "practice effect."

4. A one-way analysis of variance was carried out to determine whether the rotation order through items affects scores. Included were tests for homogeneity of variance.

Product-Moment Correlations, t-tests, and SE_M

Tables VII and VIII present the means and standard deviations of the raw scores, the reliability of the test items, t-ratios, and the standard errors of measurement, Where more than one trial was allowed, the calculations are recorded for both the best score from several trials and also for the mean score for several trials (although not necessarily the same number). A complete summary of all computations not given in the tables will be found in Appendix 8.

Results

1. Speed Sit-Ups. There was a rather sharp decrease in the reliability coefficient for this item when it is compared with the results from Part I. From a relatively high value of .863 for Group 1 it dropped to .725 for Group 2, A possible explanation for the drop in test-retest correlation is that, as the scores in Group 1 were reported by boys working in pairs, greater similarity between first and second trials was reported than was actually the case. Using one group of students, not involved in the test, to do all of the holding and

TABLE VII

RESULTS OF CORRELATIONS AND t-TESTS

USING BEST SCORE

Test Item	No. of Trials	Test $\bar{X}$	Retest $\bar{X}$	Test s	Retest s	r	t	SE_M
Speed Sit-Ups	1	42.395	43.512	7.919	8.131	.725	1.214	4.15
Standing Broad Jump	4	68.860	70.140	7.319	7.908	.843	1.928	2.90
Shuttle Run	4	11.128	11.023	.670	.670	.777	1.517	.306
Flexed Arm Hang	1	45.977	48.721	16.586	17.980	.859	1.919	6.23
50 Yard Run	3	7.758	7.667	.528	.567	.756	1.528	.261
300 Yard Run	1	60.465	62.047	4.332	4.946	.821	3.611*	1.83

n = 43 Age $\bar{X}$ = 165.4 Age s = 3.3

Critical t values $t_{(40,.05)} = 2.021$

$t_{(60,.05)} = 2.000$

*Significant at the .05 level.

TABLE VIII

RESULTS OF CORRELATIONS AND t-TESTS

USING MEAN SCORE

Test Item	No. of Trials	Test $\bar{X}$	Retest $\bar{X}$	Test s	Retest s	r	t	SE_M
Standing Broad Jump	5	66.112	67.335	7.556	8.197	.856	1.859	2.87
Shuttle Run	4	11.514	11.438	.679	.762	.781	1.021	.318
50 Yard Run	3	7.932	7.850	.538	.557	.756	1.451	.265

n = 43 Age $\bar{X}$ = 165.4 Age s = 3.3

Critical t values $t_{(40,.05)} = 2.021$

$t_{(60,.05)} = 2.000$

counting, possibly gave more valid scores.

The SE_M of 4.15 was virtually identical to that derived in Part I. This is explained by the fact that although there was a decrease in the reliability coefficient there was also a decrease in the variance from 121.824 for Part I to 62.71 for Part II. As indicated in Chapter IV this SE_M value is rather large.

Thus it would seem that this item is insufficiently reliable for individual measurement. Brown and Field came to the same conclusion in their study at the University of British Columbia.[60]

The t-test did not indicate a significant difference in means between test and retest.

2. Standing Broad Jump. The correlation coefficient between test and retest scores for Group 2 increased slightly over the .832 value calculated for Group 1. Using the best of four trials an r of .843 was achieved while using the mean of five trials increased its value to .856.

The standard error of measurement decreased from 3.29 in Part I to 2.90 in the case of the best of four trials and to 2.87 for the mean of five trials.

There was no significant difference in the means for either of the two methods used in the calculations.

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[60] S.R. Brown and A. Field, "Reliability and Errors of Measurement of the AAHPER Youth Fitness Test," CAHPER Journal, Vol. 33, No. 6 (August-September, 1967), p. 18.

On the basis of the results achieved in this portion of the study, the standing broad jump could be considered as sufficiently reliable for individual measurement for the age group sampled.

3. Shuttle Run. Analysis of Group 1's test-retest scores provided a reliability coefficient of .706 while the scores of the subjects of Group II produced a value of .777, when using the best of four trials, and .781 when analyzing the mean of four trials. The SE_M was substantially reduced from .507 in the first part to .306 for "best" score and .318 for mean score.

The changes in administrative procedure for this item failed to result in a coefficient large enough for use in distinguishing among individuals.

4. Flexed Arm Hang. A decided increase in reliability was found for this event. Part I provided a coefficient of .751 while Part II, testing two people on the bar at one time, increased the reliability to .859. The SE_M was nearly halved (from 10.86 to 6.23).

The mean time increased from 45.98 seconds on the test to 48.72 seconds on the retest but this difference was not found to be significant at the .05 level.

Under the conditions of Part II, the flexed arm hang could be considered acceptable for individual measurement.

5. 50 Yard Run. The running of two subjects at a time and the using of either the best of three trials or the mean of three trials served to increase the product-moment correlation coefficient from .678

in the case of Group 1 to .756 for the second group. The SE_M for Group 2 was slightly larger than the .248 recorded in Part I. The best of three trials provided a standard error of .261 while the mean of three trials SE_M was found to be .265. There was an increase in variance in both instances over that found in Part I. Mean times showed a decrease on retest but the difference was not found to be significant.

On the basis of the results obtained, this item would not be reliable enough for differentiation among individuals.

6. 300 Yard Run. The change in both the reliability coefficient and the standard error of measurement was greater for this event than for any other. From a coefficient of .419 in Part I the reliability rose to .821 for the second group. The SE_M decreased from 5.39 for Group 1 to 1.83 for Group 2.

It would appear that the competition provided by a second runner served to increase motivation, although this was not true in the case of the 50 yard run. Perhaps the shorter distance does not as easily lend itself to an increase in effort due to competition.

There was a significant increase in the mean time for the retest which may have been accounted for by the cooler, windy day on which it was run. In Chapter II it was suggested that this was not expected to affect scores to any degree but it would appear that it may have done so.

Predictive Indices

Table IX indicates the percentage better than chance of predicting

TABLE IX

PREDICTIVE INDICES

PART II

Test Item	r	Group II P.I. (%)	Group I P.I. (%)
Speed Sit-Ups	.725	31.1	49.4
Standing Broad Jump	.856	48.3	44.5
Shuttle Run	.781	37.5	29.2
Flexed Arm Hang	.859	48.8	34.0
50 Yard Run	.756	34.5	26.5
300 Yard Run	.821	42.9	9.2

performance based upon the highest coefficients found. Included in the table, for comparison purposes, are the indices tabulated in Part I.

All items, with the exception of sit-ups, show an increase in predictability. This is due to the increase in the size of the correlation coefficients. In this study the standing broad jump has the best index of any item under the conditions in which they were performed.

Analysis of Variance

The results of one-way analysis of variance for each item are tabulated in Tables X and XI. The numbers in Groups A, B, and C were 13, 14, and 16, respectively. Analyses were completed for test and retest as well as for the two sets of scores used in the correlations (best scores of several trials and mean scores of several trials).

In no case did a significant F ratio occur although the critical value, at the .05 level, was approached in the 300 yard run. Here then, as in the first part of the study, it is found that the rotation order followed had no effect on the scores achieved.

Homogeneity of Variance. Bartlett's test of homogeneity, as described in Chapter IV, was used with the results of Group 2. The resulting chi squares are set forth in Table XII and only one item, the retest of flexed arm hang, exceeds the critical value. Again, the appearance of one extremely high score has greatly increased the variance in one group. It is doubtful, however, whether this apparent heterogeneity of the group had any great effect except to produce a more significant

TABLE X

ONE-WAY ANOVA FOR TEST ITEMS

USING BEST SCORE

Test Item	No. of Trials		Source	SS	MS	df	F	$F_{(.05)}$
Speed Sit-Ups	1	1	Groups	31.2500	15.63	2	.23	19.47
			Error	2665.0625	66.63	40		
	2		Groups	21.6875	10.84	2	.15	19.47
			Error	2821.0625	70.53	40		
Standing Broad Jump	1	4	Groups	88.7500	44.44	2	.80	19.47
			Error	2214.3125	55.36	40		
	2		Groups	116.2500	58.13	2	.90	19.47
			Error	2572.9375	64.32	40	.	
Shuttle Run	1	4	Groups	1.1796875	.59	2	1.30	3.23
			Error	18.0937500	.45	40		
	2		Groups	1.2226563	.61	2	1.35	3.23
			Error	18.0625000	.45	40		

TABLE X (continued)

Test Item	No. of Trials	Source	SS	MS	df	F	$F_{(.05)}$
Flexed Arm Hang	1	Groups	22.6875	11.34	2	.04	19.47
		Error	11806.3130	295.16	40		
	2	Groups	760.6875	380.34	2	1.16	3.23
		Error	13140.0000	328.50	40		
50 Yard Run	1	Groups	.20288086	.10	2	.34	19.47
		Error	11.78491200	.29	40		
	2	Groups	.74511719	.37	2	1.14	3.23
		Error	13.0710450	.33	40		
300 Yard Run	1	Groups	83.5625	41.78	2	2.31	3.23
		Error	723.1875	18.08	40		
	2	Groups	113.8750	56.94	2	2.43	3.23
		Error	938.0625	23.45	40		

TABLE XI

ONE-WAY ANOVA FOR TEST ITEMS

USING MEAN SCORE

Test Item	No. of Trials		Source	SS	MS	df	F	$F_{(.05)}$
Standing Broad Jump	1	5	Groups	82.6875	41.34	2	.70	19.47
			Error	2372.9375	59.32	40		
	2		Groups	139.8125	69.91	2	1.02	3.23
			Error	2749.9375	68.75	40		
Shuttle Run	1	4	Groups	.01015625	.46	2	.96	19.47
			Error	18.88281300	.47	40		
	2		Groups	2.20703130	1.10	2	1.94	3.23
			Error	22.74609400	.57	40		
50 Yard Run	1	3	Groups	.19458008	.10	2	.32	19.47
			Error	12.22314500	.31	40		
	2		Groups	.49804680	.25	2	.75	19.47
			Error	13.29614300	.33	40		

TABLE XII

HOMOGENEITY OF VARIANCE

PART II

Test Item	Trials	Test	Retest	$\chi^2_{(2,.05)}$
Speed Sit-Ups	1	1.5409	.3689	
Standing Broad Jump	Best of 4	.0567	1.9147	
	$\bar{X}$ of 5	.5364	.5035	
Shuttle Run	Best of 4	.0593	.0694	
	$\bar{X}$ of 4	.3430	.7153	5.991
Flexed Arm Hang	1	4.8124	7.0326*	
50 Yard Run	Best of 3	.1840	.5122	
	$\bar{X}$ of 3	.0946	.5816	
300 Yard Run	1	.3541	.2257	

*Significant heterogeneity at the .05 level.

F ratio than was warranted. It may be noted from Table IX that the F ratio for retest was markedly different than that computed for the first test of the same item. There was undoubtedly less difference than appears but since the critical value for F was not approached, this discrepancy may be ignored.

CHAPTER VI

CONCLUSIONS

With the interest in physical fitness accelerating over the past few years it was natural that it should become one of the major objectives of physical education programs in the public schools. Limitations imposed by equipment costs, time, facilities, and lack of trained personnel, necessitated the development of a relatively simple test of the state of fitness for purposes of student evaluation. The CAHPER Fitness-Performance Test has been constructed and is being used. It has an advantage over many other similar tests in that norms for Canadian children have been established.

The purpose of this study of the CAHPER Fitness-Performance Test has been three-fold:

1. To determine the test-retest reliability of each of the six items which comprise the test battery.

2. To attempt to increase unacceptable reliability coefficients obtained in Part I of the study by varying the administrative technique prescribed in the manual.

3. To determine whether or not the rotation order through the events of each half of the test had any significant effect upon the results achieved.

The subjects used in the study were grade eight boys with a mean age of 166 months. Data from thirty-seven students were used in Part I and from forty-three students in the analyses of Part II.

Acceptable Reliability Coefficients

For the purposes of this study a coefficient of .80 and higher has been deemed to be suitable for individual measurement. This seems to be in keeping with the level suggested by writers in this area.

Reliability

In as much as the CAHPER Fitness-Performance Test battery is generally used as a method of individual assessment, the coefficients realized from analysis of test-retest scores in Part I produced values too low to be acceptable in all but two items (speed sit-ups and standing broad jump). The innovations introduced in Part II of the study served to increase the correlation coefficients of all items with the exception of sit-ups. There were still only three items -- standing broad jump, flexed arm hang, and the 300 yard run -- which were sufficiently reliable for use in individual measurement.

It is difficult to assess the reason for the decided drop in the reliability of speed sit-ups in the second part of the study. The only plausible reason seems to be that the data in Part I may have been inaccurate in as much as the students, working in pairs, counted and reported each other's movements, whereas, in Part II, a team of eight boys did all the holding and counting. The .725 coefficient realized by the second group may be closer to the true value for this item. Brown, dealing with university students, stated that he found it difficult to obtain reliable results, in this event, from untrained groups.[61] Klesius also found

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[61]Stanley R. Brown, "AAHPER Youth Fitness Test Results of University of British Columbia Students," CAHPER Journal, Vol. 33, No. 3 (February-March, 1967), p. 18.

difficulty in recording acceptable results although the reliability he obtained was not stated.[62]

While the reliability coefficients appear to be disappointingly low, nevertheless it should be noted that the subjects tested were as homogeneous as circumstances permitted. Had the test been performed with a more heterogeneous group the values achieved would inevitably have been higher. Extreme scores would have had less effect on calculations of coefficients for the latter group. It is unfortunate that no literature could be found citing results of other research for the same age group tested in this study.

On the basis of the sample tested then, the three items which were found to be sufficiently reliable to evaluate individuals would require that there be competition and constant attention (by the tester) to other methods of motivation. Additionally, increased numbers of trials, over those prescribed in the test instructions, for these three events, must be allowed to ensure reliability. In the case of the standing broad jump the mean score of trials would be used in place of "best" score.

Practice Effect

The t-tests for the differences between correlated means produced no significant t's and thus it can be assumed that there was no practice effect. The subjects did not do better on the retest due to having learned procedures from the first test.

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[62]Stephen E. Klesius, "Reliability of the AAHPER Youth Fitness Test Items and Relative Efficiency of the Performance Measures," Research Quarterly, Vol. 39, No. 3 (October, 1968), p. 811.

Order of Items

In each half of the test no significant differences were found which could be attributed to the order of rotation through the three test items and thus a class might be divided into three sections, each being tested on a different item at the same time. This would conserve time and is in keeping with the procedure proposed by the manual.

Concluding Remarks

In conclusion it would seem that further testing with other age groups might provide work for other researchers. Perhaps by foregoing the advantages of random selection of students in favor of using physical education groups in class periods in school time might produce better motivation and consequently more acceptable levels of reliability. This, of course, may exclude certain other of the control measures such as time of day, time between test and retest and also the use of staff members as testers, that were made use of in this study. However, the conditions might be much more normal for the subjects themselves and much closer to those in which the CAHPER test might ultimately be used in a school system.

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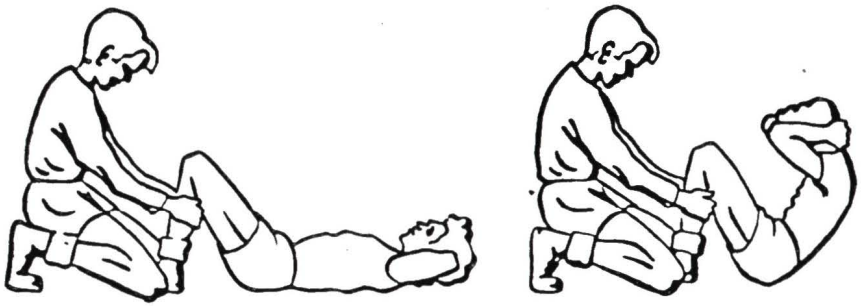
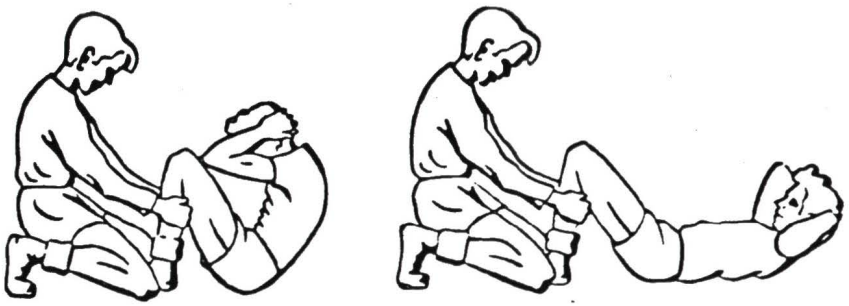
APPENDICES

APPENDIX 1

CAHPER MANUAL TEST INSTRUCTIONS

THE ONE MINUTE SPEED SIT-UP





Equipment Gym mat and stop-watch or timer.

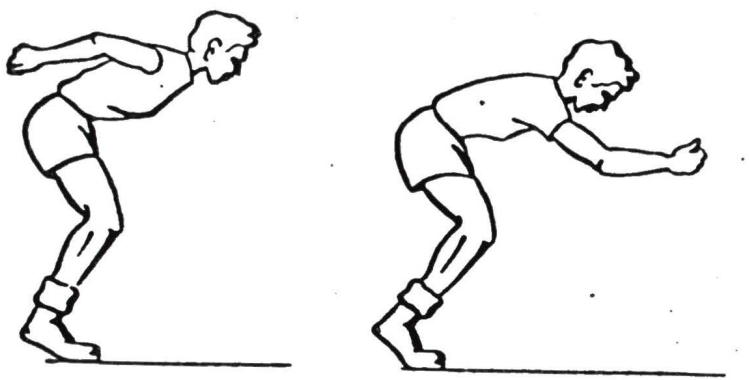
Start The subject assumes a back-lying position on the mat, fingers interlaced behind his head. The knees are bent and the feet are *held* flat on the floor by a partner.

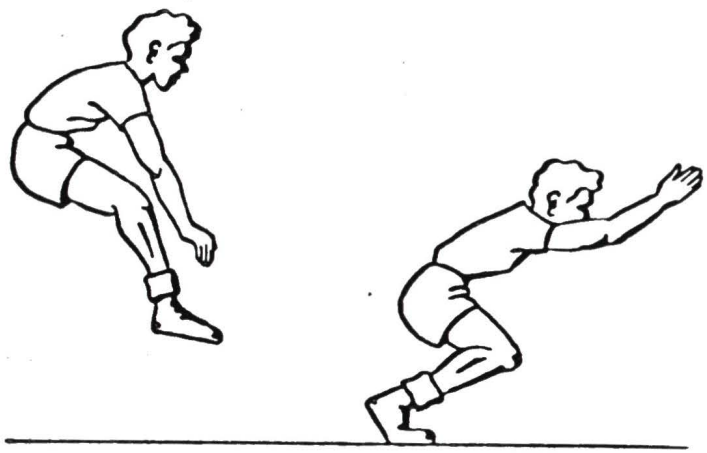
Performance The subject sits up and touches both elbows to his knees. Then he returns to the starting position.

Scoring The movement sit-up and return is counted as one execution. The total score is the number of complete executions performed in 60 seconds. Count when the elbows touch the knees. Allow one trial.

Controls The partner kneels straddling the performer's feet. He places his hands on the calves of the subject's legs just below the back of the knee to prevent the subject from sliding and to maintain the starting position of the legs throughout the test. Only the shoulders have to touch the floor. The sit-ups do not need to be performed continuously.

THE STANDING BROAD JUMP





Equipment A 10 foot tumbling mat is recommended and a cloth tape measure.

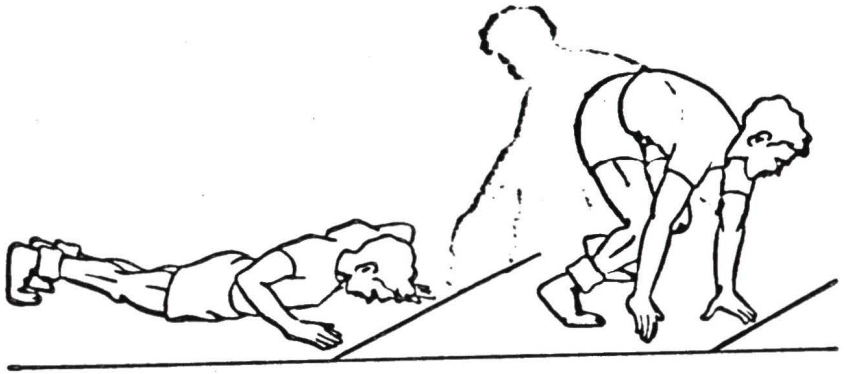
Start The subject assumes a position with the feet slightly apart and the toes behind the take-off line.

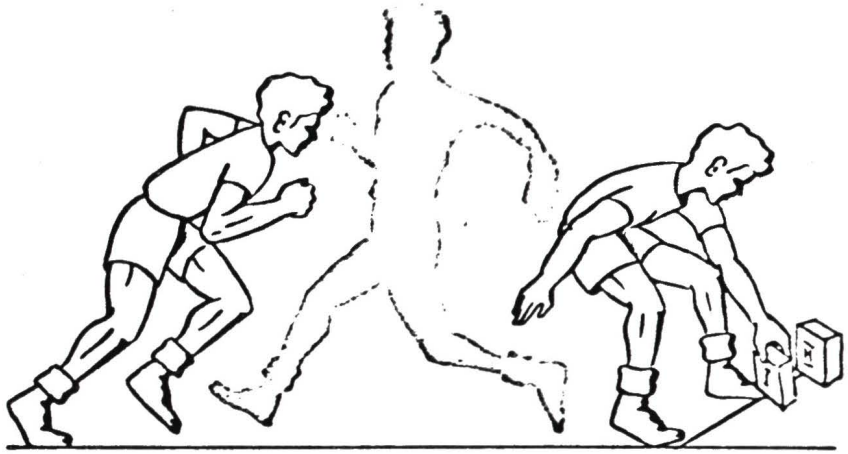
Performance The hips, knees and ankles should be bent enough so that the subject can vigorously push with his legs, and swing his arms to jump as far forward as possible.

Scoring Measurement is in terms of inches to the nearest inch from the take-off line to the heel of the foot nearest the take-off line.

Controls The suggested take-off angle should be between 30 and 45 degrees. Two valid trials are allowed, the better trial recorded. If any part of the body touches behind the heels, the jump will be considered invalid. Two or three practice trials will be allowed.

THE SHUTTLE RUN





Equipment Two wooden blocks (2" x 3" x 3") and a stop-watch calibrated to one-tenth of a second.

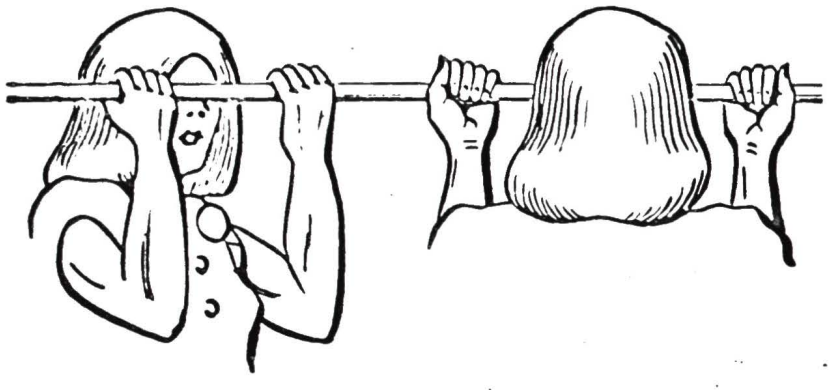
Start The subject lies face down, hands at the sides of the chest and the forehead on the starting line.

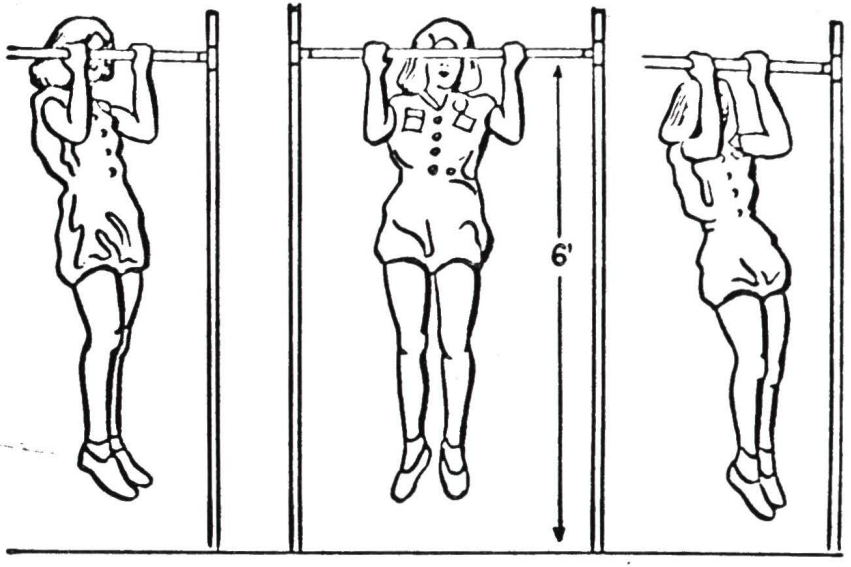
Performance On the signal, the subject jumps to his feet and runs 30 feet to the line. He picks up one block of wood, returns to the starting line, and *places* the block behind this line. He returns to the initial line, picks up the second block of wood, and runs back across the finish line.

Scoring Measurement is in terms of seconds to the nearest tenth of a second from the starting signal until the subject's chest crosses the finish line.

Controls The test should be taken in gym shoes or bare-foot. A 'ready' warning signal is given prior to the starting signal. Two trials with sufficient rest between are allowed and the better trial is recorded.

THE FLEXED ARM HANG





Equipment A doorway gym bar or horizontal bar placed 6 feet from the floor; a bench and a timer or stop-watch.

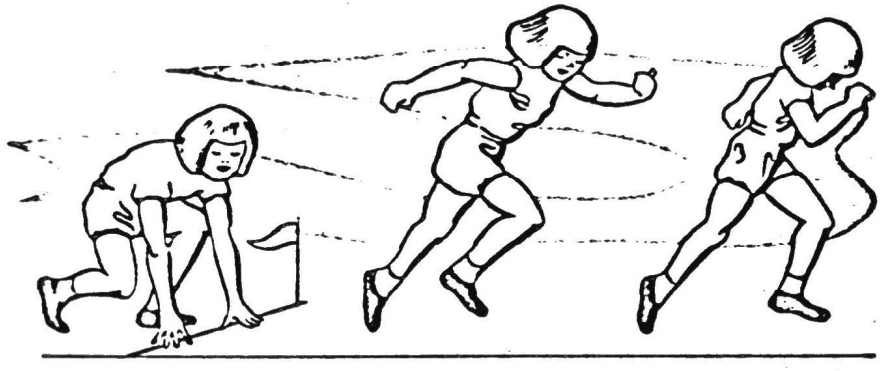
Start The subject takes a reverse grasp on the bar (palms toward face). He is assisted to the position on the bar so that his eyes are at the level of the bar. The arms are fully bent.

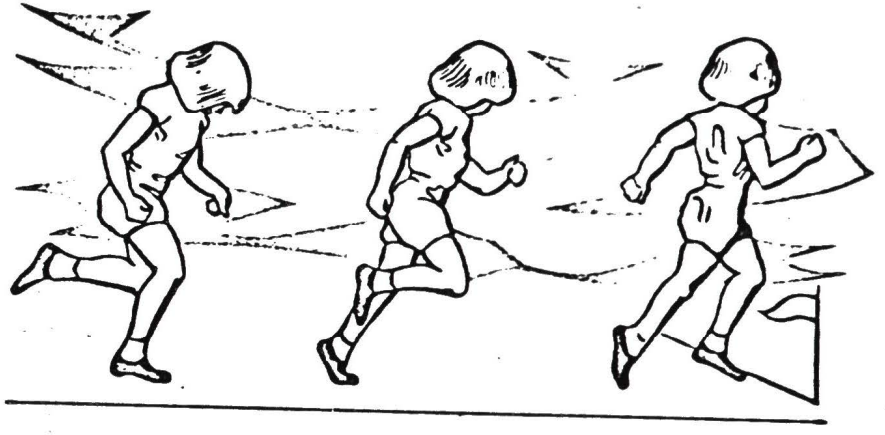
Performance The subject holds himself in this hanging position as long as he is able.

Scoring The total period of time that the subject can maintain the exact position is determined to the nearest second.

Controls The subject must keep the eyes at the level of the bar. When the subject's head drops below the bar, the test is terminated. One trial is allowed. The tester counts the seconds out loud.

THE 50 YARD RUN





Equipment A 50 yard straightaway with markers or stakes placed at the start and the finish line; a stop-watch calibrated to one-tenth of a second and a starting flag.

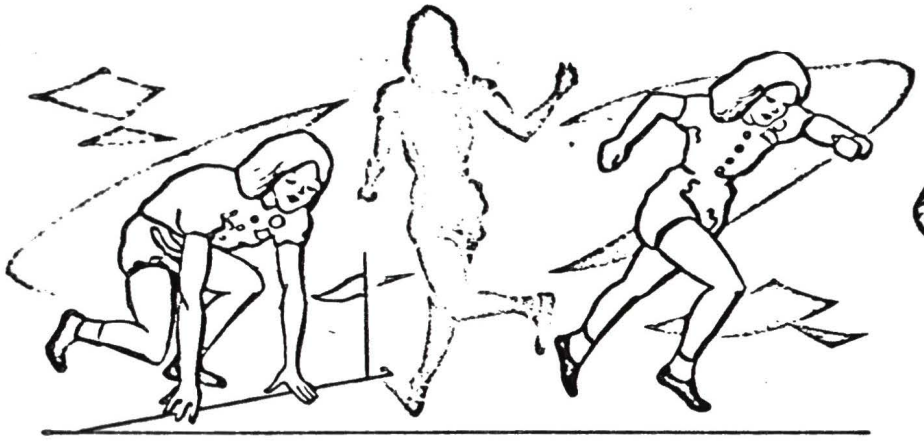
Start A racing crouch start or a standing position may be assumed.

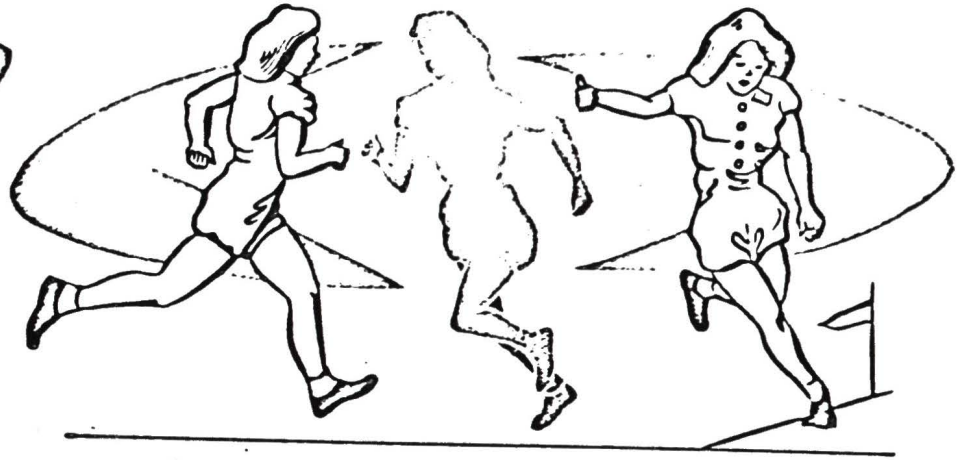
Performance On the starting signal 'ready', 'go', the starter drops the flag and the runner sprints the 50 yard distance as fast as he can.

Scoring The elapsed time from the starting signal to the passage of the runner's chest across the finish line is scored to the nearest tenth of a second.

Controls The test is taken in gym shoes. Only one runner is tested at a time on a course, but one tester may time two runners on adjacent courses with a split timer or two stop-watches.

THE 300 YARD RUN





Equipment A 50 yard straightaway with markers or stakes placed at the start and the finish line, a stopwatch and a starting flag.

Start A racing crouch start or a standing position may be assumed.

Performance On the starting signal the subject runs straight up and around the stake marker and back over the 50 yard straightaway. The circuit is run 3 times to make up the 300 yards.

Scoring The elapsed time from the starting signal to the passage of the runner's chest across the finish line is scored to the nearest second.

Controls The test is taken in gym shoes. Only one runner is tested a time on a course, but one tester may time two runners on adjacent courses with a split timer or two stop watches.

APPENDIX 2

INSTRUCTIONS TO TESTERS

Part 1

CAHPER Fitness-Performance Test

Purposes of Project

1. To determine the reliability of the test. To accomplish this a group of approximately 50 grade 8 students will be tested and then retested to determine whether or not they are ranked roughly in the same order each time.
2. To attempt to increase reliability by varying the administrative procedure. Increasing number of trials, averaging results rather than taking the best, and attempting to increase motivation are some methods which may be used. These will be determined by working with small groups of 4 or 5 students. Once the new procedure has been decided upon, a second group of 50 different students will be tested using this form.
3. To determine how much (if any) effect the order of rotation through the parts of the test has on results.

Instructions

1. Tests will be run after school between 3:30 and 4:30. Four days will be required to complete the test and retest for one group. Half of the test is completed each day.
2. The test consists of six items - speed sit-ups, standing broad jump, flexed arm hang, shuttle run, 50 yard run, and 300 yard run.

Day 1 - Speed sit-ups, standing broad jump, and shuttle run.

Day 2 - Flexed arm hang, 50 yard run, and 300 yard run.

Day 3 - Repeat day 1.

Day 4 - Repeat day 2.

3. Students will be placed in sub-groups and must proceed through the test items in the same rotation order on the retest as they did on the initial test. Where two testers are at a station the students will be tested by the same person each time. These smaller groups will also be set up ahead of time.
4. Each group remains at its station until instructed to move.
5. Students will be selected to record results at each station.
6. Details of each test item and places where they will be tested follow.
7. It is requested that little verbal encouragement be given to the subjects of the first test group. All will have been introduced to the test items beforehand.

Station - Speed Sit-Ups.

Staff - Tester A.

Instructions

Subject assumes a back-lying position on the mat, fingers interlaced behind his head. The knees are bent and the feet are held flat on the floor by a partner.

The subject sits up and touches both albows to his knees. He then returns to the starting position. This constitutes a count of one. The total score is the number of executions performed in 60 seconds.

The partner kneels straddling the performer's feet. He places his hands on the calves of the subject's legs just below the back of the knee to prevent the subject from sliding and to maintain the starting position of the legs throughout the test. Only the shoulders have to touch the mat.

Station - Standing Broad Jump.

Staff - Testers B and C.

Instructions

The subject assumes a position with the feet slightly apart and the toes behind the take-off line. The hips, knees, and ankles should be bent enough so that the subject can vigorously push with his legs, swing his arms forward, and jump as far forward as possible.

Two valid trials are allowed, both being recorded. Up to three practice trials will be allowed. Measurement is in inches from the take-off line to the heel of the foot nearest the take-off line. If any part of the body touches behind the heels, the jump will be considered invalid.

Station - Shuttle Run.

Staff - Testers D and E.

Instructions

The subject lies face down, hands at the sides of the chest, and the forehead on the starting line. On the signal, the subject jumps to his feet and runs 30 feet to the line. He picks up one block of wood, returns to the starting line, and places the block behind this line. He returns

to the line, picks up the second block of wood and runs back across the starting line.

Measurement is in terms of seconds to the nearest tenth of a second from the starting signal until the subject's chest crosses the finish line. Two trials with rest between are allowed with both times being recorded.

Station - Flexed Arm Hang.

Staff - Testers A and C.

Instructions

The subject takes a reverse grasp on the bar (palms toward the face). He is assisted to a position on the bar so that his eyes are at the level of the bar. The arms are fully bent and the subject holds himself in this hanging position as long as he is able.

The subject must keep the eyes at the level of the bar. When his head drops below the bar the test is terminated. One trial is allowed. The tester counts the seconds out loud.

The total period of time that the subject can maintain the exact position is determined to the nearest second.

Station - 50 Yard Run.

Staff - Testers E and F.

Instructions

A racing crouch start or a standing position may be assumed. On a starting signal, the runner sprints the 50 yard distance as fast as he can. Time is taken to the nearest tenth of a second. One trial is allowed.

Station - 300 Yard Run.

Staff - Testers B and D.

Instructions

A racing crouch start or a standing position may be assumed. On a starting signal the subject runs straight up and around the 50 yard marker and back to the starting point. The circuit is run 3 times to make up the 300 yards. Time on one trial is recorded to the nearest second.

APPENDIX 3

INSTRUCTIONS TO TESTERS

Part 2

A second group of 50 students has been selected to be tested and retested by the CAHPER test. Some modifications have been made in an attempt to improve the test.

1. Increase in number of recorded trials for:
   a. Shuttle Run 4 trials
   b. Standing Broad Jump 5 trials
   c. 50 Yard Run 3 trials
2. For the Speed Sit-Up item a team of 6 students will do all of the holding and counting.
3. In the 300 Yard Run the performers are to go to the markers, stop, and return rather than going around them.
4. In an effort to increase motivation:
   a. Placards will be displayed which will show some of the Canadian norms as well as the top three performers in each event on the first test.
   b. In the Flexed Arm Hang two performers will be on the bar at one time with the timer counting off the seconds so that the recorder can get the time each finishes.
   c. In the 50 and 300 Yard Runs and the Shuttle Run two students will run at the same time with a timer for each. One timer will act as starter.

d. In all cases it is requested that verbal encouragement be given to each performer.

The tests will be run in four days, immediately after school, as was the case in Experiment 1. The schedule will be as follows:

Day 1	Speed Sit-Ups	Tester A
	Standing Broad Jump	Testers B and C
	Shuttle Run	Testers D and E
Day 2	Flexed Arm Hang	Testers A and C
	50 Yard Run	Testers E and F
	300 Yard Run	Testers B and D
Day 3	Repeat of Day 1	
Day 4	Repeat of Day 2	

As before the groups will rotate through the same tester each time.

APPENDIX 4

SCORE SHEET

Name _____ Group _____

Sub-group _____

Speed Sit Ups	Standing Broad Jump					Shuttle Run			

Flexed Arm Hang	50 Yard Run				300 Yard Run

APPENDIX 5

MASTER SCORE SHEET

Code No.	Name	Age	Div.	Speed Sit Ups	Standing Broad Jump					Shuttle Run				Flexed Arm Hang	50 Yard Run			300 Yard Run
					1	2	3	4	5	1	2	3	4		1	2	3	

APPENDIX 6

PROFILE OF PHYSICAL FITNESS

_____ JUNIOR SECONDARY SCHOOL

Physical Fitness Performance Record

June 19__

Name _____ Grade _____ Division _____

To Parents:

This report of student fitness performance is based upon results achieved on the Canadian Association for Health, Physical Education, and Recreation Fitness-Performance Test. The test consists of six items as follows:

1. One Minute Speed Sit-Ups to test muscular strength and endurance of the abdominal muscles.
2. Standing Broad Jump to measure explosive strength or power of the legs.
3. Shuttle Run to determine agility.
4. Flexed Arm Hang to ascertain muscular endurance of arm and shoulder muscles.
5. 50 Yard Run to measure speed.
6. 300 Yard Run to indicate stamina or endurance.

Each test result is recorded and the resulting profile can be seen on the opposite side of this report. The 50th percentile indicates, on a Canada wide basis, the point below which 50% of the students in the age group would be expected to score. A glance at the chart will enable you to note any observed areas of weakness.

_____

(Instructor)

13 YEAR OLD BOYS

Percentile	Speed Sit Ups (No.)	Stand Broad Jump (Ft.In.)	Shuttle Run (Sec)	Flexed Arm Hang (Sec)	50 Yard Run (Sec)	300 Yard Run (Sec)
100	56	7'8"	9.7	111	6.0	51
95	48	6'6"	10.3	75	6.9	56
90	45	6'3"	10.7	68	7.1	58
85	43	6'1"	10.9	65	7.3	59
80	41	6'0"	11.0	61	7.4	60
75	39	5'10"	11.1	57	7.5	61
70	38	5'9"	11.2	53	7.6	62
65	37	5'8"	11.4	50	7.7	63
60	35	5'6"	11.5	46	7.8	64
55	34	5'5"	11.6	43	7.9	64
50	33	5'3"	11.8	40	8.0	65
45	31	5'2"	11.9	36	8.1	65
40	30	5'1"	12.1	33	8.2	66
35	29	4'11"	12.3	30	8.3	67
30	26	4'10"	12.4	27	8.4	67
25	25	4'9"	12.5	23	8.5	69
20	23	4'7"	12.9	19	8.7	70
15	22	4'5"	13.0	17	8.8	71
10	19	4'3"	13.5	12	9.1	73
5	15	4'0"	13.9	9	9.5	77
0	0	2'8"	17.6	0	11.0	104

APPENDIX 7

INFORMATION SHEET FOR PARTICIPANTS

Part 2

Canadian Norms

SIT-UPS			STANDING BROAD JUMP			SHUTTLE RUN		
Percentile	13	14	Percentile	13	14	Percentile	13	14
100	56	57	100	7'8"	8'7"	100	9.7	9.0
75	39	39	75	5'10"	6'4"	75	11.1	10.8
50	33	32	50	5'3"	5'10"	50	11.8	11.3
25	25	25	25	4'9"	5'2"	25	12.5	12.0

FLEXED ARM HANG			50 YARD RUN			300 YARD RUN		
100	111	149	100	6.0	6.0	100	51	44
75	57	60	75	7.5	7.1	75	61	57
50	40	45	50	8.0	7.5	50	65	62
25	23	32	25	8.5	8.0	25	69	66

Scoring

1. Sit-ups - number completed in one minute.
2. Shuttle run - seconds.
3. Standing Broad jump - feet and inches.
4. Flexed arm hang - seconds.
5. 50 yard run - seconds.
6. 300 yard run - seconds.

RESULTS OF FIRST TESTS

SIT-UPS

Position	Name	Division	Score	Percentile
1	_____	14	70	100
2	_____	16	69	100
2	_____	18	69	100

STANDING BROAD JUMP

1	_____	16	7'2"	95-100
2	_____	14	7'1"	90-95
3	_____	14	7'0"	90-95
	_____	15	7'0"	95-100
	_____	18	7'0"	90-95

SHUTTLE RUN

1	_____	18	9.8	95-100
2	_____	14	10.0	95-100
3	_____	14	10.4	85-90

FLEXED ARM HANG

1	_____	14	111	95-100
2	_____	18	91	95-100
3	_____	16	88	95-100

50 YARD RUN

1	_____	16	7.0	80
2	_____	18	7.1	75
3	_____	14	7.2	85-90

300 YARD RUN

1	_____	18	51	95-100
2	_____	16	52	95-100
3	_____	14	53	95-100

APPENDIX 8

ADDITIONAL CORRELATIONS AND t-TESTS

Part 2

STANDING BROAD JUMP DATA	TEST $\bar{X}$	RETEST $\bar{X}$	TEST s	RETEST s	r	t
Trial 1	66.047	67.233	7.609	8.531	.718	1.256
2	65.860	67.163	7.891	8.403	.743	1.441
3	66.465	67.326	7.650	8.251	.740	.967
4	66.023	68.209	8.318	8.338	.834	2.952*
5	66.163	66.744	8.760	9.364	.809	.668
Best of 2	67.767	68.535	7.566	8.213	.731	.855
3	68.209	69.535	7.306	7.998	.787	1.704
5	69.512	70.302	7.617	8.357	.839	1.117
$\bar{X}$ of 2	65.953	67.198	7.442	8.297	.759	1.459
3	66.124	67.240	7.397	8.070	.789	1.427
4	66.099	67.483	7.444	8.034	.836	2.007
SHUTTLE RUN						
Trial 1	11.674	11.442	.873	.859	.506	1.750
2	11.439	11.430	.756	.845	.579	.082
3	11.500	11.412	.805	.942	.548	.683
4	11.442	11.467	.691	.866	.658	.250
Best of 2	11.302	11.181	.766	.738	.721	1.392
3	11.198	11.067	.739	.678	.767	1.732
$\bar{X}$ of 2	11.557	11.436	.743	.760	.704	1.354
3	11.538	11.428	.714	.770	.757	1.373
50 YARD RUN						
Trial 1	7.926	7.912	.596	.598	.778	.227
2	7.893	7.798	.523	.611	.613	1.224
3	7.977	7.840	.588	.590	.700	1.950
Best of 2	7.807	7.709	.553	.557	.747	1.604
$\bar{X}$ of 2	7.909	7.855	.542	.575	.747	1.451

APPENDIX 9

RAW DATA - Part 1

Code No.	Age (Mths)	Speed Sit Ups		Standing Broad Jump		Shuttle Run		Flexed Arm Hang		50 Yard Run		300 Yard Run	
		1	2	1	2	1	2	1	2	1	2	1	2
01	170	63	70	80	85	10.4	11.1	94	111	8.0	7.7	58	58
02	164	50	46	69	66	10.7	10.9	30	30	8.5	7.8	59	59
03	164	61	53	80	77	10.5	10.0	46	66	7.8	7.2	53	54
04	164	56	58	71	73	12.0	11.1	51	66	8.1	7.9	64	67
05	171	44	48	84	84	11.2	11.3	60	63	7.9	7.9	59	62
06	162	53	53	66	67	11.2	11.6	49	34	8.1	8.5	59	61
07	171	53	50	63	60	11.8	11.5	53	53	8.4	8.2	61	65
08	168	41	48	55	53	11.7	11.5	21	12	8.3	8.4	65	72
09	163	49	50	84	81	10.6	11.3	70	77	7.6	7.6	59	60
10	161	46	44	70	73	11.0	11.1	41	46	7.7	7.9	59	59
11	171	45	44	74	72	11.2	11.5	31	24	8.1	7.6	61	57
12	173	65	69	83	80	10.6	10.6	88	32	7.5	7.0	52	55
13	164	53	50	86	84	10.6	11.1	56	37	7.7	7.7	59	62
14	162	50	45	71	67	11.1	11.1	51	66	7.7	7.9	62	67
15	163	48	40	69	61	11.3	12.1	36	17	8.3	8.4	60	62
16	166	42	67	76	72	11.4	11.8	64	60	8.3	7.8	68	65
17	164	23	21	68	58	12.0	13.6	49	30	8.9	8.4	63	62

Code No.	Age (Mths)	Speed Sit Ups		Standing Broad Jump		Shuttle Run		Flexed Arm Hang		50 Yard Run		300 Yard Run	
		1	2	1	2	1	2	1	2	1	2	1	2
18	167	41	43	65	65	11.7	11.3	60	71	8.1	9.5	70	133
19	161	50	51	76	70	10.6	10.9	39	30	7.9	7.7	57	58
20	160	59	61	78	72	11.6	11.9	65	60	7.2	7.6	59	57
21	168	45	45	70	63	11.1	11.8	45	31	8.3	8.3	61	118
22	168	34	35	74	73	11.0	11.2	30	16	8.0	7.9	63	65
23	175	43	40	74	72	11.3	11.4	27	26	8.0	8.1	61	62
24	175	51	53	84	72	9.8	9.9	17	22	7.1	7.2	51	51
25	162	69	54	79	80	11.2	10.7	88	91	8.1	8.0	59	63
26	165	56	63	73	74	10.7	11.0	56	25	7.5	7.8	57	57
27	160	45	31	72	63	11.6	11.5	31	41	8.8	8.0	65	67
28	173	20	15	60	55	12.9	12.9	18	21	8.2	8.6	67	67
29	161	49	49	60	68	12.0	12.0	26	32	8.6	9.4	72	71
30	163	46	49	71	75	11.9	12.1	59	76	8.0	8.4	63	61
31	167	27	30	55	58	15.7	13.1	13	7	8.4	9.1	73	72
32	174	46	41	80	74	11.4	11.3	60	31	7.5	7.9	61	63
33	171	44	42	74	65	11.0	11.2	60	38	7.8	8.0	63	60
34	174	46	46	68	69	10.8	10.5	38	63	7.4	7.3	57	58
35	172	40	37	62	62	11.6	11.8	10	21	8.9	9.7	92	75
36	164	18	10	62	44	12.1	10.7	9	10	8.6	9.4	71	74
37	165	47	46	76	76	10.9	11.4	81	61	8.0	8.5	57	59

APPENDIX 10

RAW TEST DATA - Part 2

Code No.	Age (Mths)	Speed Sit Ups	Standing Broad Jump					Shuttle Run				Flexed Arm Hang	50 Yard Run			300 Yard Run
			1	2	3	4	5	1	2	3	4		1	2	3	
38	163	41	49	53	46	47	50	12.9	12.8	12.5	13.5	44	9.3	9.3	9.1	73
39	166	55	72	73	75	75	72	10.5	10.8	10.4	11.2	52	6.8	6.8	6.8	55
40	162	45	77	75	76	71	73	10.9	11.3	11.5	11.9	60	7.6	8.0	7.8	60
41	164	43	75	79	79	78	80	11.4	11.4	11.6	11.5	47	7.7	7.8	7.6	60
42	169	46	80	79	78	72	70	10.6	11.5	11.4	10.9	43	7.8	7.9	7.7	60
43	164	45	63	60	63	64	59	13.3	11.7	11.9	12.1	30	8.3	8.2	8.3	62
44	169	46	53	59	59	61	63	11.6	11.2	11.1	11.0	50	8.4	8.2	8.1	65
45	164	38	66	62	62	63	61	11.6	11.6	11.4	11.3	41	8.0	7.8	7.7	60
46	161	37	66	62	61	60	63	10.6	10.8	11.0	11.2	40	7.4	7.3	7.4	59
47	166	38	59	60	64	63	58	11.9	12.3	11.8	12.2	15	7.9	7.8	8.0	69
48	171	56	63	60	66	64	63	11.5	11.2	11.3	11.4	60	8.5	7.9	8.0	61
49	164	35	60	56	59	55	56	13.7	13.3	13.3	12.5	36	8.5	8.3	8.0	65
50	167	42	65	64	65	65	68	12.1	12.3	12.6	11.5	69	8.5	8.4	8.0	64
51	167	42	74	69	73	73	74	11.4	10.8	10.6	10.7	42	7.9	8.0	8.2	56
52	164	32	72	69	69	69	74	12.1	12.5	11.8	11.4	59	7.6	7.7	8.0	60
53	162	46	65	69	68	61	61	11.3	11.1	11.4	11.6	55	8.2	8.0	8.2	61
54	169	45	63	70	70	59	75	11.3	12.0	11.1	11.0	38	7.8	7.9	7.5	61

Code No.	Age (Mths)	Speed Sit Ups	Standing Broad Jump					Shuttle Run				Flexed Arm Hang	50 Yard Run			300 Yard Run
			1	2	3	4	5	1	2	3	4		1	2	3	
55	163	48	73	78	76	76	79	10.2	11.3	11.2	10.9	51	7.8	8.0	7.9	58
56	165	41	75	75	74	74	73	10.9	11.2	10.6	11.0	33	7.2	7.6	7.3	57
57	162	41	67	62	67	66	65	12.3	12.2	11.8	11.9	26	8.6	8.8	8.9	65
58	156	34	73	74	72	76	80	10.8	10.8	10.5	10.6	37	6.5	6.6	7.0	55
59	161	34	63	55	62	51	53	13.5	11.7	11.7	11.6	42	7.7	7.9	8.0	60
60	168	56	62	72	67	66	69	11.3	10.6	11.8	10.5	47	7.7	7.9	7.5	58
61	170	42	51	50	54	57	56	11.6	11.5	12.3	12.0	26	8.5	8.2	8.1	65
62	167	43	54	59	58	62	59	13.1	11.9	12.9	11.8	64	8.4	8.5	9.0	69
63	166	54	84	76	83	85	80	10.8	9.3	10.1	10.0	60	6.7	7.1	7.0	56
64	166	23	68	72	68	69	69	11.8	11.0	11.0	11.0	60	7.9	8.0	7.8	58
65	169	54	75	73	77	76	78	10.7	11.0	10.9	10.6	47	7.8	7.8	7.9	58
66	160	42	70	78	64	78	70	11.0	10.5	10.1	10.3	52	7.7	7.5	7.6	55
67	167	42	67	65	65	65	57	11.3	11.7	11.4	11.3	50	7.4	7.5	7.7	54
68	160	48	66	69	68	66	76	10.8	10.8	10.8	11.0	52	7.6	7.4	8.0	54
69	167	34	75	76	76	83	83	10.7	10.6	10.5	10.5	38	7.4	6.9	7.1	61
70	168	48	71	65	71	69	66	11.0	10.9	13.3	10.7	50	8.3	8.0	8.1	62
71	170	35	67	62	64	63	63	12.0	11.8	11.2	11.4	95	8.1	8.4	8.0	59
72	171	40	53	51	51	53	53	13.0	12.1	12.4	12.7	21	8.0	8.1	8.2	63
73	165	48	63	57	56	60	57	12.5	12.0	12.4	11.7	30	9.1	9.1	9.2	67

Code No.	Age (Mths)	Speed Sit Ups	Standing Broad Jump					Shuttle Run				Flexed Arm Hang	50 Yard Run			300 Yard Run
			1	2	3	4	5	1	2	3	4		1	2	3	
74	163	36	60	59	62	65	59	12.2	11.5	11.7	12.0	31	6.9	7.3	7.2	55
75	161	53	63	68	68	72	74	11.9	11.2	12.0	11.8	84	7.9	7.9	7.9	59
76	169	55	61	59	64	60	62	11.2	10.9	10.9	11.7	60	7.8	7.8	8.0	58
77	166	43	66	71	71	65	70	12.5	10.3	10.1	12.0	66	8.2	8.0	8.1	55
78	168	35	64	64	64	66	64	11.9	12.1	12.2	11.9	35	9.0	7.8	9.2	66
79	165	21	61	60	60	52	52	12.9	13.0	12.2	12.5	13	8.5	8.2	8.9	61
80	166	41	66	63	63	64	58	11.4	11.4	11.8	11.7	26	7.9	7.8	9.0	61

RAW RETEST DATA - Part 2

Code No.	Age (Mths)	Speed Sit Ups	Standing Broad Jump					Shuttle Run				Flexed Arm Hang	50 Yard Run			300 Yard Run
			1	2	3	4	5	1	2	3	4		1	2	3	
38	163	42	45	49	48	46	44	12.9	13.2	13.4	13.9	52	8.6	8.8	8.6	73
39	166	57	77	73	74	76	74	10.3	10.6	10.4	10.6	63	6.9	6.9	7.0	56
40	162	50	77	77	73	78	76	11.7	12.1	11.0	11.1	60	8.4	8.0	8.3	60
41	164	43	79	77	77	79	80	13.8	10.9	11.1	11.9	54	7.6	7.4	7.4	62
42	169	54	86	80	74	81	74	10.9	10.9	11.5	11.8	52	8.5	7.2	7.4	59
43	164	41	66	65	69	62	64	11.5	11.5	11.7	11.6	41	8.2	8.4	8.2	65
44	169	46	65	63	63	64	52	13.0	13.0	11.4	11.3	61	8.3	8.2	8.2	68
45	164	43	67	65	68	66	62	11.7	11.3	11.6	11.2	50	7.5	7.1	7.4	62
46	161	52	70	73	67	73	74	10.7	10.4	10.4	10.6	60	7.3	7.1	7.1	64
47	166	39	62	62	61	60	64	11.5	11.3	13.2	11.4	24	7.7	7.8	7.7	70
48	171	48	68	63	60	61	66	12.1	11.1	11.2	11.4	62	8.4	8.1	8.6	60
49	164	21	65	62	59	63	62	12.0	12.4	12.7	13.1	50	8.0	7.9	8.0	67
50	167	43	70	70	72	72	71	11.8	12.7	13.1	11.4	71	8.5	8.3	8.5	71
51	167	37	79	79	77	75	75	10.5	10.4	10.0	10.2	41	7.3	7.7	7.4	61
52	164	35	79	79	81	79	76	11.9	11.3	11.5	11.0	56	7.2	7.5	7.4	52
53	162	45	63	67	63	67	63	10.4	11.4	12.0	11.7	50	8.2	8.0	7.8	62
54	169	47	60	64	69	63	65	11.9	10.5	11.4	11.0	41	7.8	7.2	7.6	57
55	163	50	80	82	81	79	81	11.3	11.4	11.7	12.3	51	8.0	7.6	7.6	59

Code No.	Age (Mths)	Speed Sit Ups	Standing Broad Jump					Shuttle Run				Flexed Arm Hang	50 Yard Run			300 Yard Run
			1	2	3	4	5	1	2	3	4		1	2	3	
56	165	45	71	72	76	77	74	10.9	11.0	11.5	11.3	34	7.4	7.4	7.0	61
57	162	45	64	64	62	65	65	12.1	11.6	11.9	11.9	21	8.9	8.0	8.5	69
58	156	33	77	76	81	81	82	10.3	10.2	10.2	10.4	46	6.9	7.3	7.5	60
59	161	48	50	50	54	57	54	12.1	11.9	11.9	11.7	31	7.5	7.6	7.6	60
60	168	53	64	69	74	70	70	11.1	10.9	10.6	10.3	45	8.7	7.8	8.0	59
61	170	40	63	66	60	64	61	11.5	11.5	11.4	11.4	19	7.6	7.6	7.9	67
62	167	49	63	63	61	61	58	12.2	11.6	11.7	11.9	76	8.7	9.1	8.9	65
63	166	46	75	78	79	82	79	10.0	9.8	9.9	9.7	55	6.8	6.6	7.2	55
64	166	26	70	64	67	65	67	11.2	11.0	11.0	10.9	40	7.5	7.5	7.6	58
65	169	54	72	76	73	77	75	10.9	10.3	10.5	11.1	61	7.9	8.0	7.5	57
66	160	43	70	72	74	78	78	10.5	11.1	10.5	10.9	50	7.8	7.9	8.0	59
67	167	54	69	63	69	70	69	11.2	10.9	10.5	10.9	52	7.3	7.4	7.3	56
68	160	44	66	67	67	60	68	10.5	11.5	10.6	12.1	65	7.1	6.9	6.9	56
69	167	38	77	79	76	77	82	10.8	10.9	10.4	10.6	28	8.2	8.8	8.2	67
70	168	39	72	68	61	74	66	11.2	12.2	11.6	12.7	46	8.0	7.8	7.8	67
71	170	37	51	47	58	56	48	13.3	12.4	14.4	12.7	115	7.9	7.7	8.2	62
72	171	31	63	63	66	63	58	12.7	12.6	12.0	13.4	27	7.9	7.7	8.2	63
73	165	45	57	52	52	54	53	11.6	13.8	11.7	12.1	40	9.3	9.5	9.3	71
74	163	43	68	67	68	66	70	10.9	11.1	11.3	11.2	35	7.1	6.9	7.0	58

Code No.	Age (Mths)	Speed Sit Ups	Standing Broad Jump					Shuttle Run				Flexed Arm Hang	50 Yard Run			300 Yard Run
			1	2	3	4	5	1	2	3	4		1	2	3	
75	161	54	70	67	73	70	74	10.3	10.8	10.6	10.9	70	8.2	8.0	8.0	59
76	169	61	65	63	65	67	61	11.0	10.6	10.6	10.6	71	7.5	7.5	7.3	57
77	166	38	63	68	66	64	61	10.6	11.8	11.4	11.3	46	8.0	7.6	7.2	57
78	168	39	60	68	68	67	58	11.5	11.6	11.1	11.5	40	8.7	8.2	8.0	67
79	165	30	55	60	52	59	54	12.2	12.2	12.6	12.9	13	8.9	8.7	9.0	66
80	166	43	58	56	57	65	62	11.5	11.8	11.5	11.2	30	8.0	8.6	8.8	64

APPENDIX 11

COMPOSITION OF GROUPS

Part 1

A	B	C
01	02	05
04	03	09
06	08	14
07	11	15
10	12	17
13	21	19
16	24	20
18	25	22
29	26	23
30	27	31
34	28	32
35	36	33
	37	

Part 2

A	B	C
38	51	65
39	52	66
40	53	67
41	54	68
42	55	69
43	56	70
44	57	71
45	58	72
46	59	73
47	60	74
48	61	75
49	62	76
50	63	77
	64	78
		79
		80

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