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An Investigation of Selected Physical Fitness Activities on Adolescent Boys

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AN INVESTIGATION OF THE EFFECTS OF SELECTED PHYSICAL FITNESS ACTIVITIES ON ADOLESCENT BOYS

by

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This thesis, submitted by Thomas G. Nielson in partial fulfillment of the requirement for the degree of Master of Science in the University of North Dakota, is hereby approved by the Committee under whom the work has been done.

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CHAPTER I

INTRODUCTION

Definition of the Problem

The need for improved physical fitness has been a problem of our society for decades, but has most recently been sharply pointed out by Kraus and Hirschland in 1953.[1] In tests of minimum muscular fitness, American children compared very poorly with European children. Later, other comparisons utilizing the AAHPER Youth Fitness Test also confirmed the findings of Kraus and Hirschland.[2]

In 1955 Dwight D. Eisenhower, President of the United States, turned his attention to this problem of the American youth's physical fitness.[3] He was prompted to do so by his own knowledge as General of

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[1]Hans Kraus and Ruth Hirschland, "Minimum Muscular Fitness Tests in School Children," Research Quarterly, XXV, No. 185 (May, 1954), pp. 178-188.

and

Hans Kraus and Ruth Hirschland, "Muscular Fitness and Health," Journal of the American Association for Health, Physical Education and Recreation, XXIV (December, 1953), pp. 17-19.

[2]Minneapolis Morning Tribune, December 7, 1960, pp. 1 and 8.

and

Howard G. Knuttgen, "Comparison of Fitness of Danish and American School Children," Research Quarterly, XXXII (May, 1961), p. 190.

[3]Robert H. Boyle, "The Report that Shocked the President," Sports Illustrated, III, No. 7 (August 15, 1955).

the Armies, of the inadequate fitness of young men reporting for military service, and the concern he felt over the report of Kraus and Hirschland indicating that American youth were inferior to European youth in physical fitness.

Executive action followed with the establishment of a President's Council on Youth Fitness and a Citizens' Advisory Committee. As a result of this action, through a vast public relations program, the American public was alerted to the dangerously low level of physical fitness of our youth and to the realization that fitness is more essential than ever in today's changing society.

John F. Kennedy succeeded Dwight D. Eisenhower as President of the United States, and even before his inauguration he wrote forcefully in Sports Illustrated of the need for strong programs to improve the physical fitness of our youth. In his statement he emphasized that the physical vigor of our citizens is one of America's most precious resources, that physical fitness is the basis of dynamic and creative intellectual activity, that soft and inactive bodies undermine capacity for thought and for work, and that the age of leisure and abundance can destroy vigor and muscle tone as effortlessly as it can gain time.[4] Within his statement lies a description and definition of this problem.

Purpose of the Study

The purpose of this study was to use, with the knowledge at hand, the methods which the experimenter felt would best produce significant physical fitness increase among summer recreation program

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[4]John F. Kennedy, "The Soft American," Sports Illustrated, XIII, No. 26 (December 26, 1960), pp. 15-17.

participants. The experimenter hoped to find that physical fitness, as measured by the AAHPER Youth Fitness Test, could be significantly increased through a short-time and short-term summer fitness program.

The need for such programs connected with summer recreation programs and activities is necessary because, in these programs, time is available to meet the needs of individuals and specific groups. This is not always the case in school-sponsored physical education classes because of time demands on the pupils and teachers. Many physical educators are also reluctant, and rightly so, to emphasize physical fitness at the expense of teaching skills and activities, and time allotments generally do not allow for both. For these reasons other methods and possibilities of achieving the desired levels of physical fitness should be sought.

Definitions

Many attempts have been made to define physical fitness and yet no one has obtained a definition which is acceptable to all concerned. In searching for an acceptable definition, the experimenter found two which covered the term quite thoroughly from two different viewpoints.

Clifford E. Keeney, Biology Professor at Springfield College, Springfield, Massachusetts, gives a scientific definition when he says:

> Physical fitness is the capacity to do work. It is determined by strength, endurance and coordination. Each of these components in turn is founded upon the underlying biologic bases of age, sex, health status and anatomic and biochemical condition. Furthermore, it is characterized by a high degree of specificity which changes with growth and development. Both the measurement

and practical application of fitness are strongly affected by motivation.[5]

H. Harrison Clarke gives a physical educator's viewpoint when he says:

> The development and maintenance of a sound physique and of soundly functioning organs, to the end that the individual realizes his capacity for physical activity, unhampered by physical drains or by a body lacking in physical strength and vitality.[6]

In this study both of these definitions have been accepted.

It has also been assumed in this study that the various components of physical fitness can be measured by fitness tests as Dr. Paul Hunsicker suggests in his article concerning the "Myths about Fitness".[7] Therefore, the AAHPER Youth Fitness Test was used as a measure of physical fitness.

Limitations

In working with a number of persons in an experimental situation there are a number of individual limitations which arise. By handling the study as a group situation it was hoped that most of these might be eliminated or limited. Therefore, the following limitations were considered as most likely to affect the results or limit the validity of this study:

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[5]Clifford E. Keeney, "Work Capacity," Journal of Health, Physical Education and Recreation, XXXI, No. 6 (September, 1960), p. 30.

[6]H. Harrison Clarke, Application of Measurement to Health and Physical Education (3rd ed.; New York: Prentice Hall, Inc., 1959), p. 16.

[7]Paul Hunsicker, "Myths about Fitness," Journal of Health, Physical Education and Recreation, XXI, No. 2 (February, 1960), pp. 26 and 60.

1. Only a limited number of subjects were available for experimental and control groups.

2. Although attendance was good, all participants in the experimental group did not attend every session.

3. No attempt was made to determine what, if any, particular portion of the fitness program was the major or total contributor to the increases shown.

CHAPTER II

REVIEW OF RELATED LITERATURE

The experimenter was primarily interested in three phases of this study, although it is realized that other factors played a part. Consequently, the review of literature is covered under the headings of motivation, isometrics, and physical fitness.

Motivation

Strong did a study of motivation as related to the performance of 434 sixth-grade children on physical fitness tests,[8] including five items of the AAHPER Youth Fitness Test. He used six motivating situations including:

1. Competition with a classmate of equal ability.
2. Competition with self.
3. Group vs. group.
4. Competition to establish class records.
5. Level of aspiration.
6. Competition with classmate of markedly different ability.

Motivation was found to be a significant factor in increasing scores on the physical fitness tests. The level of aspiration and team

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[8]Clinton H. Strong, "Motivation Related to Performance of Physical Fitness Tests," Research Quarterly, XXXIV, No. 4 (December, 1963), pp. 497-507.

competition situations were the most effective methods. Strong summarizes and adds recommendations based on his study when he states:

> Since the purpose of motivation is to encourage the subject to put forth maximum effort, perhaps the implication to be drawn here is that some of the physical fitness tests used in this are, as well as being tests of physical condition, tests of the potency of the motivational conditions under which the tests are administered.[9]

Nelson, in a study of the effects of ten motivational situations on 250 college men while performing a stressful exercise, concluded that certain motivational situations did affect their performance.[10] The test used was an exercise to the point of exhaustion on an elbow flexion ergograph. He found the most significant results in situations dealing with individual and group competition, verbal encouragements, obtainable goals, and observer being present.

In another study on motivation, Martin tested 80 college women assigned to four equal groups in the jump and reach test.[11] Four motivational conditions were used including:

1. Subjects performing alone with results being withheld.
2. Subjects performing alone but results were given immediately.
3. Subjects performed in a group and results of all performances were withheld.

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[9]Ibid., pp. 503-504.

[10]Jack Kimberly Nelson, "An Analysis of the Effects of Various Motivational Situations to College Men Subjected to a Stressful Phsycial Performance" (unpublished Ed.D. dissertation, University of Oregon, 1962).

[11]Margery May Martin, "A Study to Determine the Effects of Motivational Techniques on Performance of the Jump and Reach Test of College Women" (unpublished Master's dissertation, University of Wisconsin, 1961).

4. Subjects performed in a group and all results were given to the entire group immediately.

In this study the informed subjects in both the individual and group situations had better performances under conditions 2 and 4.

Isometrics

In 1953 Hettinger and Mueller reported studies of various isometric routines,[12] varied as follows: exercise bouts from one to four per day, resistance or loads from thirty-five to eighty per cent of each subject's strength, and duration of contractions from six to forty-five seconds. The optimum exercise routine was found to consist of a simple contraction per day of two-thirds strength, held for six seconds. A weekly strength increase of five per cent for a period of ten weeks was obtained; neither greater frequency, longer duration, nor more proportionate force produced greater muscular strength.

Dennison, Howell, and Morford used two groups of ten subjects, equated on the basis of the Arm Strength Index, in a weight program and an isometric program.[13] The groups met twice a week for eight weeks, and when they were retested, both showed statistically significant improvements in the Arm Strength Index. The difference between the means of the two groups was not statistically significant, though improvement was evident. The investigators stated that considering the time required

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[12]Th. Hettinger and E. A. Mueller, "Muskelleistung and Muskeltraining," Arbeitsphysiologie, XV, No. 2, cited by H. Harrison Clarke, "Development of Volitional Muscle Strength as Related to Fitness," Exercise and Fitness (University of Illinois College of Physical Education, 1960) p. 204.

[13]J. D. Dennison, M. L. Howell, and W. R. Morford, "Effect of Isometric and Isotonic Exercise Programs on Muscular Endurance," Research Quarterly, XXXII, No. 3 (October, 1961), pp. 348-352.

for the isometric exercises (ten minutes per exercise session) and the minimum amount of equipment needed, the results were very encouraging.

In another study on a comparison of static or isometric exercises and dynamic exercises, Berger determined the changes in dynamic strength produced by static training, and, conversely, the changes in static strength produced by dynamic training.[14] He concluded that a static strength test is not as accurate as a dynamic strength test in measuring changes in strength resulting from dynamic muscle training, and a dynamic strength test is not as accurate as a static strength test in measuring changes in strength resulting from static muscle training. Static strength improved significantly more by training statically than dynamically, and dynamic strength improved significantly more by training dynamically than statically. There was no significant relationship found between improvement in static and dynamic strength.

Physical Fitness

Bos compared the performance of children in grades five through twelve to pre-1940 test results from similar groups in California.[15] He found that boys' performances by age in pullups, situps, standing broad jump, and 50-yard dash were essentially similar. Present mean performance for boys based on the Classification Index was inferior in pullups, standing broad jump and the 50-yard dash to earlier performance reported in three studies conducted in California, with the major

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[14]Richard A. Berger, "Comparison of Static and Dynamic Strength Increases," Research Quarterly, XXXIII, No. 3 (October, 1963), pp. 329-333.

[15]Ronald R. Bos, "An Analysis of Youth Fitness Project Data and a Comparison of These Data with Comparable Data Recorded to 1940" (unpublished Ph.D. dissertation, University of Michigan, 1961).

discrepancies at the elementary and junior high level rather than the senior high level.

In comparing the fitness of Danish and American school children, Knuttgen gave the AAHPER Youth Fitness Test to 319 male and 134 female Danish school children.[16] He discovered in comparing the results in terms of age and the Neilson-Cozens Classification Index that seventy per cent of the boys and eighty-six per cent of the girls exceeded the various American mean scores. The Danish boys scored higher than the American boys in six of the seven events, and the percentages which scored above the American means ranged from fifty-nine to ninety-six per cent. The only item in which the Americans scored better was the softball throw.

Another study, comparing 10,000 British boys and girls with the million American boys and girls used to establish the AAHPER Youth Fitness Test norms, was done by Pohndorf and Campbell.[17] The investigators found that in tests of leg power and endurance the British girls scored higher than the American boys in the age groups 10--11 and 10--13 respectively.

In the seven items tested, the British girls outscored the American girls in all seven and at every test age, except in the arm strength for 12 year-olds. On the average the British girls led the American girls on all items and ages by 23 per cent. For all tests and all ages the British boys finished 14 per cent higher than the American

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[16]Knuttgen, Research Quarterly, pp. 190-196.

[17]Minneapolis Morning Tribune, p. 1.

average, and it would have been 20 per cent except for the American superiority in the softball throw. It was felt that American boys were involved in throwing activities to a greater extent than the British boys.

Hall and Cain reported that sixty Illinois counties have conducted 4-H fitness testing programs each summer for twenty years with fewer than ten per cent of those retested showing improvement.[18] Of twenty-eight counties compared using a t test, twnety-three made gains but only eight were significant at the .01 level.

In one county, three groups were given different programs consisting of: (1) verbal encouragement, (2) a stepped-up conditioning program, and (3) some conditioning and a "diet table". The differences between the first and second test scores were not significant for group 1, but were highly significant for groups 2 and 3.

The evidence presented points to a deficiency in the physical fitness of American youth. The American Association of Health, Physical Education and Recreation notes that:

> The physical fitness of a nation definitely is not displayed in the showing of its Olympic team, nor by its economic or literate stature, but by what its individuals actually can do. United States youth certainly does not display good physical fitness when looked at by this criteria.[19]

It may also be, as suggested in the study by Bos, that this deficiency in physical fitness is increasing as time passes.

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[18]D. M. Hall and Rolene LaHayne Cain, "Improvements Resulting from a Fitness Program," Research Quarterly, XXXV, No. 1 (March, 1964), p. 80.

[19]Minneapolis Morning Tribune, p. 1.

The experimenter believes that using the right approach, American youth can equal the physical fitness of the youth of any country. To do this the programs for increasing fitness must be made available, American youth must be shown the values and importance of fitness, and youth must be challenged to seek the achievement of this goal.

CHAPTER III

METHOD OF PROCEDURE

Description and Administration of the Test Battery

The test items were taken from the AAHPER Youth Fitness Test Manual which had its initial beginnings in 1957 at a meeting of selected members of the AAHPER Research Council. At this meeting the items themselves were chosen and an advisory committee was appointed to secure national norms for the test.

The Youth Fitness Test Battery consisted of seven items[20] of which the first four were given indoors and the last three outdoors. In all cases where the subject, for some obvious or proclaimed reason, did not do his best, he was given an extra opportunity. The experimenter attempted at all times to get the subject's best performance on each test. All persons who were tested were somewhat familiar with the test from school testing experience.

The following are the test items and brief descriptions of each:

1. Pullup

The subject, using an overhand grip, palms facing forward, attempted to get his chin above the bar as many times as possible without kicking or swinging his legs.

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[20]American Association for Health, Physical Education and Recreation, AAHPER Youth Fitness Test Manual, A Youth Fitness Project for the National Physical Fitness Test Program (Washington, D.C.: AAHPER, 1961).

2. Situp

These were done with straight legs and alternating the touching of elbow to knee. No more than 78 situps were to be done to conserve time and because this was an excellent score for this age group.[21]

3. Shuttle Run

Two chalk erasers were set thirty feet away from the subject and on the command, "Go", he returned both to the starting line individually, laying the first one down on the starting line and sprinting by the line with the second. The time was measured to one-tenth of a second.

4. Standing Broad Jump

The subject stood with both toes behind the starting line, feet apart, and then swung his arms, crouched, and jumped as far as possible. Three trials were allowed and the longest was recorded to the nearest inch.

5. 50-yard Dash

The subjects ran 50-yards on a cinder track as fast as possible and each was timed to one-tenth of a second.

6. Softball Throw for Distance

The subject threw three softballs from behind the starting line, with no more than a six-foot approach, using an overhand throw. The distance was recorded for the best throw to the nearest foot.

7. 600-yard Run-Walk

The distance was laid out on a quarter mile cinder track and each subject, running in a small group of not more than eight, attempted to travel the distance as fast as he could.

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[21]President's Council on Youth Fitness, Youth Physical Fitness Suggested Elements of a School-Centered Program (U.S. Government Printing Office: Washington, D.C., 1961), p. 47.

The selection of this test was based on the ease of administration and the assumption that the items were valid measures of physical fitness because the test had been used extensively and had been recommended by AAHPER for nation-wide use.

Each of 54 volunteers for a physical fitness testing program was tested using the AAHPER Youth Fitness Tests, and 49 were again retested at the end of four weeks. The tests were both administered from 9:00 till approximately 10:30 A.M. on very similar summer mornings. The seven items in the test were administered in the same order in each case and recorded by the same person or persons. The order of administration on both pre- and post-tests for the seven items included was: first and second, standing broad jump or shuttle run; third, situps; fourth, pullups; fifth, 50-yard dash; sixth, 600-yard run-walk; and seventh, softball throw. It was found by the experimenter, through previous experience in administering and taking the test, that this order seemed to be best in insuring the subject's achieving a maximum performance in the standing broad jump and shuttle run.

Selection of Participants

The study began with 54 summer baseball program participants, basically 11 to 13 year-olds, who volunteered to take part in a physical fitness testing program. The 54 volunteers were broken down into an experimental group containing 23 members and a control group of 31 members, all of whom were given the AAHPER Youth Fitness Test.

The experimental group was formed from those volunteers who would be available for the length of the experimental program and who had easiest means of transportation to the area used. It was felt by

the experimenter that they would be less likely to drop out because of difficulties in attending, and peer pressure among those in this locality might keep attendance up.

These groups were reduced to 20 members per group for the statistical computations. Two members from the experimental group and three members from the control group failed to complete the program and testing. Also one additional member was dropped from the experimental group because of illness prior to the post-testing period which greatly affected his scores. Then eight members were dropped from the control group in order that the chronological mean age of each group would be 150 weeks or 12.5 years, and to achieve the most nearly exact means on the pre-test scores of each test item for each group. In this manner it was felt that more nearly equal samples of the same population were obtained.[22]

Description of the Physical Fitness Program

The physical fitness program in which the experimental group took part consisted of twenty meetings of 30 to 40 minutes, over a period of four weeks. The mean number of periods attended for each subject was eighteen. Each period consisted of two sets of partner isometric or static contractions taking fifteen minutes and fifteen to twenty-five minutes of running, jumping, or chinning.

The period of partner isometric contractions consisted of eight movements, four with the arms and four with the legs, while the partner provided the immovable force. The arm movements were performed

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[22]Benton J. Underwood, et al, Elementary Statistics (New York: Appleton-Century-Crofts, Inc., 1954), pp. 172-173.

with partners facing toward each other and the subject's arms straight and raised in a forward direction from his sides to form a 45° angle with his body. The partner then grasped the subject's wrists and held them in this same position for each of the four movements. These included movements in an upward, downward, together and apart direction.

In the four leg movements a position with subject lying on his back and his partner standing with his feet close together and between the ankles of the subject, was assumed. The subject, keeping his legs straight, raised his feet to a position forming an approximate 45° angle with the ground. His partner then held his ankles while the subject attempted to perform the same movements described previously for the arms. In the leg movements the subject was told that he must keep his buttocks on the ground and also attempt to keep his back flat on the ground during all movements.

The subjects were told to hold maximum strength isometric contractions for six seconds for the first two weeks and eight seconds thereafter. This was done to insure at least a two-thirds strength movement for six seconds as is suggested as optimum by Hettinger and Mueller.[23]

Isometrics were used as a means of conditioning and strength building in this study because of limited time and equipment, and the evidence of significant gains in short periods of time.

During the other portion of the practice sessions, fourteen periods of running were held. Proper form in sprinting was discussed, demonstrated, and practiced. Runs of 440 yards were made against time

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[23]Hettinger and Mueller, Arbeitsphysiologie, p. 111.

and proper methods of changing directions in the shuttle run were suggested and practiced. Chinning was practiced three times, and the standing broad jump was worked on three times. In the standing broad jump the arm swing, upward explosion from the crouch, and reach with the legs before landing were discussed, demonstrated, and practiced.

Realizing the importance of motivation as described in the review of related literature, motivational factors were included to encourage the participants' best efforts. Many of the motivational situations described are natural to this age group and therefore arise without stimulation. The situations were, however, pointed out and emphasized to the experimental group. In the control group the motivational situations were only allowed to occur naturally among the members, if they occurred at all, and other than the instruction on the pre-test to, "Do your best", and post-test to, "Try and improve on your last score", no motivation as such was attempted.

An attempt was made to motivate the experimental group in the following manners, all of which have contributed to significant increases in performance as related by Strong, Kimberly, and Martin as was discussed in the review of related literature.

1. Verbal Encouragement

The experimenter gave verbal encouragement in the form of, "try to do better", and also praise both in practice and testing. No criticism was used.

2. Individual Competition

Members of the group were always present when others were practicing, and competition between natural groupings within the experimental group developed and were encouraged.

3. Group Competition

The familiarity between individuals in the experimental and control groups led to the encouragement of the experimental group to do well, so that they might score higher than the control group.

4. Obtainable Goals

Certain goals were established for each person to work toward, such as the excellent or next highest category suggested in the Youth Physical Fitness booklet.[24]

5. Informing Subjects of Results

The subjects were always kept informed of their results immediately after their performance.

6. Subject Competing with Himself

It was suggested in practice and testing that the subject attempt to do better than last time. His last score was periodically checked to keep him aware of it.

Statistical Procedure

The statistical procedure used in this study included the matched sample and random sample t test. In using these two procedures, the matched sample t test was computed by the direct difference method as seen in Appendix A, and the random sample t test was computed on an electronic computer, the figures for which are shown in Appendix B.

The direct difference method for the matched sample t test was used in determining significance within each group on the pre- and post-test means. This is possible when the matched scores are those of the

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[24]President's Council on Youth Fitness, Youth Physical Fitness Suggested Elements of a School-Centered Program.

same person taken under the same conditions.[25]

The random sample t test was used in determining any significant original difference between the pre-test means of the experimental and control groups. Also the differences between pre- and post-test means for each of the seven test items for the experimental group were compared to the same mean differences in the control group. This was to determine any significant increases or decreases due to test and retest situation[26] in the case of the control group or the experimental program, plus the test and retest situation in the case of the experimental group.

The null hypothesis was used on all comparisons, and it asserts that there is no true difference between two population means, and that the difference found between sample means is, therefore, accidental and unimportant.[27] Rejecting the null hypothesis is then the same as saying that there is a significant difference between sample means, and, conversely, in saying the results are not significant, the null hypothesis is then accepted.

The significance was reported only at the .05 and the .01 levels of confidence. These were determined using the t table found in Garrett and Woodworth's Statistics in Psychology and Education.[28] The degrees

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[25]Underwood, et al, p. 168.

[26]M. Gladys Scott (ed.), Research Methods in Health, Physical Education, and Recreation (Washington, D.C.: AAHPER, 1959), p. 186.

[27]Henry E. Garrett and R. S. Woodworth, Statistics in Psychology and Education (5th ed.; New York: Longmans, Green and Co., 1958), p. 213.

[28]Ibid., p. 449.

of freedom for the matched sample t test were determined by the formula df = N-1, where N equals the number of pairs of subjects.[29] The degrees of freedom for the random sample t test were determined by the formula df = N_1-1+N_2-1; or df = N_1+N_2-2.[30] In this formula, N_1 and N_2 equal the number of subjects in group 1 and 2 respectively.

The results gained using the preceding statistical procedure are shown in tables 1, 2, and 3. From these results conclusions were drawn and recommendations made for the application of the findings.

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[29]Underwood, et al, pp. 170-171.

[30]Ibid., p. 131.

CHAPTER IV

ANALYSIS OF DATA

Test Results

The matched sample t test was computed, using the direct difference method, to determine the significance of the improvements within each group. The degrees of freedom were found to be 19 (N-1 where N equals 20). Upon entering the t table with 19 degrees of freedom, it was determined that a t value of 2.093 was necessary for a confidence level of .05 and 2.861 for .01.

At these levels of confidence the control group improved significantly in the shuttle run at the .05 level and at the .01 level in the pullups. The experimental group reached the .05 and .01 levels of significance in six of the seven items, missing only in the softball throw. In the five following items the experimental group was significant at the .01 level of confidence: situps, pullups, shuttle run, 50-yard dash, and 600-yard run-walk. The group was significant at the .05 level of confidence in the standing broad jump. Comparisons within the experimental and control groups for the matched sample t test are shown in Table 1.

The random sample t test was used to determine whether or not there was a significant statistical difference between the groups originally. This was done by comparing the mean scores of the two groups on each test item.

TABLE 1

MATCHED SAMPLE t TEST OF PRE- AND POST-TEST MEAN DIFFERENCES WITHIN GROUPS

Test Item	Experimental Group		Control Group	
	t Value[a]	Significance[b]	t Value[a]	Significance[b]
Situps	4.640	.01 level	1.634	not. signif.
Pullups	3.012	.01 level	2.885	.01 level
Standing Brd. Jump	2.769	.05 level	-0.228	not signif.
Shuttle Run	-3.926	.01 level	-2.098	.05 level
50-yd. Dash	-3.702	.01 level	-0.476	not signif.
Softball Throw	1.442	not signif.	-0.268	not signif.
600-yd. Run-Walk	-2.951	.01 level	-0.666	not signif.

[a]Negative sign shows better times in running events or poorer performance in other events, between pre- and post-test means. Conversely, a positive sign shows the opposite in each case.

[b]Significance at the .05 level equals 2.093 and at the .01 level equals 2.861.

Degrees of freedom for the random sample t test were determined as 38 (N_1+N_2-2 where N_1 equals 20 and N_2 equals 20). Using 38 degrees of freedom, a t value of 2.025 was necessary for a confidence level of .05 and 2.715 for .01. Using this procedure, no significant differences were found between groups at the beginning of the study. As a result, the null hypothesis was accepted for the original pre-test means between the two groups.

Following the administration of post-test, item mean differences between pre- and post-tests were computed for each group. Each difference was then compared between groups using the random sample t test. Thirty-eight degrees of freedom and t values of 2.025 and 2.715 for the .05 and .01 levels of confidence were again used.

TABLE 2

RANDOM SAMPLE t TEST OF PRE-TEST MEANS BETWEEN GROUPS

Test Item	t Value[a]	Significance[b]
Situps	-0.531	not significant
Pullups	1.149	not significant
Standing Brd. Jump	1.042	not significant
Shuttle Run	0.025	not significant
50-yard Dash	0.028	not significant
Softball Throw	-0.562	not significant
600-yard Run-Walk	0.671	not significant

[a]Negative signs indicate that the control group means were originally greater and, conversely, positive signs indicate the experimental means were originally greater.

[b]Significance at the .05 level equals 2.025 and at the .01 level equals 2.715.

The experimental group was found to have made reportable significant improvement on four of the seven items. Significant improvements were found at the .05 level for situps, standing broad jump, and the shuttle run, when compared to control group mean differences. The 50-yard dash mean improvement of the experimental group was found to be significant beyond the .01 level. In the three nonsignificant items, the experimental group also had larger differences between pre- and post-test means than those of the control group, but they were not significant at either level. The above scores may be seen in Table 3.

TABLE 3

RANDOM SAMPLE t TEST OF PRE- AND POST-TEST MEAN DIFFERENCES BETWEEN GROUPS

Test Item	t Value[a]	Significance[b]
Situps	2.638	.05 level
Pullups	0.592	not significant
Standing Brd. Jump	2.069	.05 level
Shuttle Run	-2.328	.05 level
50-yard Dash	-2.912	.01 level
Softball Throw	1.170	not significant
600-yard Run-Walk	-1.179	not significant

[a]Negative signs indicate better times in running events and in all cases the experimental group had larger differences between pre- and post-test scores than did the control group.

[b]Significance at the .05 level equals 2.025 and at the .01 level equals 2.715.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

In this study forty boys from a summer baseball recreation program volunteered to participate in a physical fitness testing program. The volunteers were then pre-tested, using the AAHPER Youth Fitness Test, and divided into experimental and control groups. The experimental group then participated in a physical conditioning program consisting of twenty meetings, designed to improve fitness through short periods of static and dynamic exercise accompanied by varying motivational situations. Following the conditioning program both groups were post-tested, again using the AAHPER Youth Fitness Test.

The study found significant increases and mean trends established in the experimental group of twenty 11 to 13 year-olds, who participated in the thirty to forty minute physical conditioning program for four weeks. In comparing improvements within each group, the experimental group had significant mean score improvements at the .05 level of confidence in the standing broad jump, and at the .01 level of confidence in the situps, pullups, shuttle run, 50-yard dash, and 600-yard run-walk. The control group had mean improvements within the group significant at the .05 level of confidence in the shuttle run and at the .01 level of confidence for pullups.

In comparing pre-test mean scores, no significant difference was found between groups. Based on post-test results a comparison between groups indicated that the experimental group improvements were significant at the .05 level in situps, standing broad jump, and shuttle run, and at the .01 level in the 50-yard dash. In the items in which the difference was not significant, pullups, softball throw, and 600-yard run-walk, the experimental group had greater mean difference improvements between the pre- and post-test than did the control group.

Conclusion

It would seem by the evidence compiled herein, that there was a certain amount of merit to the belief that physical fitness can be increased in a program of short duration. Care must be taken in accepting the results because of the limited sample, and the necessity of adjusting the sample groups so that they might be termed samples of the same population. On the other hand, the samples were proved not significantly different originally, and significant gains were shown for the experimental group as compared to the control group through valid statistical measures.

The experimenter also believed even more strongly at the close of this study that there was not only an increased, but an ever increasing, need for improved physical fitness on all levels. If these problems can not be solved in the school program, then other ways of handling the situation should be developed. Rudyard Kipling stated it well many years ago when he wrote:

> Nations have passed away and left no traces
> And history gives the naked cause of it---
> One single, simple reason in all cases,
> They fell because their people were not fit.

Nothing on earth--no Arts, no Gifts, nor Graces---
No Fame, no Wealth--outweighs the want of it.
This is the law which every law embraces---
Be fit--be fit! In mind and body be fit!

This is the lesson at all Times and Places---
One changeless Truth on all things changing writ
For boys and girls, men, women, nations, races,
Be fit---be fit! And one again---Be fit![31]

Yet while working toward this goal it must be remembered that physical fitness is a means to ends, such as health, enjoyable participation, working capacity, and general all-around more enjoyable living, and not an end in itself. The other factors involved in these end results should not suffer at the expense of physical fitness, as necessary as it may be.

Recommendations

The experimenter believes that further study should be made to determine the role which each phase of this study - isometrics, practice and coaching in events, and motivation - actually had in the final results. It would also be recommended that the number of meetings be increased from twenty to thirty and then to forty to determine the optimum period of time for such a program. Finally it is recommended that similar studies be done on different age and ability levels to determine the effects on wider levels of our population.

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[31] Journal of Health, Physical Education and Recreation, XXXI, No. 6 (September, 1960), p. 30, citing Rudyard Kipling.

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Matched Sample t Test of Pre- and Post-Test

Differences Within Groups

$$M_D = \frac{\Sigma D}{N}$$

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - M_D^2}$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$t = \frac{M_D}{\sigma_{M_D}}$$

D = difference between pre- and post-test scores
N = number of subjects
M_D = mean difference
σ_D = standard error of the difference
σ_{M_D} = standard error of the mean difference

SITUPS
Experimental Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	78	78	0	0
2	78	78	0	0
3	78	78	0	0
4	78	78	0	0
5	78	78	0	0
6	78	78	0	0
7	78	78	0	0
8	68	78	10	100
9	67	78	11	121
10	50	60	10	100
11	50	78	28	784
12	46	76	20	400
13	45	65	20	400
14	41	60	19	361
15	40	53	13	169
16	36	78	42	1764
17	30	40	10	100
18	26	52	26	676
19	22	54	32	1024
20	2	21	19	361
N=20	M_1=53.45	M_2=66.95	$\Sigma D(+)$ 260 $\Sigma D(-)$ 0 260	ΣD^2 = 6360

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{318.00 - 169}$$

$$= \sqrt{149}$$

$$\sigma_D = 12.207$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{12.207}{19}$$

$$= \frac{12.207}{4.359}$$

$$\sigma_{M_D} = 2.800$$

$$M_D = \frac{260}{20} = 13.00$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{13.00}{2.80}$$

$$t = 4.64$$

SITUPS
Control Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	78	78	0	0
2	78	78	0	0
3	78	78	0	0
4	78	78	0	0
5	78	78	0	0
6	78	78	0	0
7	78	78	0	0
8	67	42	-25	625
9	63	78	15	225
10	63	78	15	225
11	54	57	3	9
12	53	60	7	49
13	52	59	7	49
14	50	78	28	784
15	48	52	4	16
16	41	51	10	100
17	32	36	4	16
18	30	31	1	1
19	23	25	2	4
20	20	21	1	1
N=20	M_1=57.1	M_2=60.70	$\Sigma D(+)$ 97 $\Sigma D(-)$ -25 72	ΣD^2 = 2104

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{105.200 - 12.961}$$

$$= \sqrt{92.239}$$

$$\sigma_D = 9.60$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{9.60}{4.359}$$

$$\sigma_{M_D} = 2.202$$

$$M_D = \frac{72}{20} = 3.60$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{3.60}{2.202}$$

$$t = 1.63487$$

PULLUPS
Experimental Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	12	13	1	1
2	11	12	1	1
3	11	13	2	4
4	10	11	1	1
5	7	7	0	0
6	6	7	1	1
7	5	10	5	25
8	5	3	-2	4
9	5	6	1	1
10	5	6	1	1
11	4	5	1	1
12	4	6	2	4
13	2	4	2	4
14	1	1	0	0
15	1	1	0	0
16	1	0	-1	1
17	1	4	3	9
18	1	1	0	0
19	0	0	0	0
20	0	2	2	4
N=20	M_1=4.60	M_2=5.60	$\Sigma D(+)$ 23 $\Sigma D(-)$ - 3 20	ΣD^2 = 62

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{3.10 - 1}$$

$$= \sqrt{2.10}$$

$$\sigma_D = 1.449$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{1.449}{4.359}$$

$$\sigma_{M_D} = .332$$

$$M_D = \frac{20}{20} = 1$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{1}{.332}$$

$$t = 3.012$$

PULLUPS
Control Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	12	10	-2	4
2	10	11	1	1
3	10	12	2	4
4	5	5	0	0
5	4	6	2	4
6	4	5	1	1
7	3	3	0	0
8	3	4	1	1
9	3	4	1	1
10	2	4	2	4
11	2	4	2	4
12	2	5	3	9
13	2	1	-1	1
14	1	2	1	1
15	1	1	0	0
16	1	1	0	0
17	0	0	0	0
18	0	1	1	1
19	0	1	1	1
20	0	0	0	0
N=20	M_1=3.25	M_2=4.00	$\Sigma D(+)$ 18 $\Sigma D(-)$ - 3 15	ΣD^2 = 37

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{1.85 - .5625}$$

$$= \sqrt{1.2875}$$

$$\sigma_D = 1.135$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{1.135}{4.359}$$

$$\sigma_{M_D} = .260$$

$$M_D = \frac{15}{20} = .750$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{7.50}{2.60}$$

$$t = 2.88461$$

STANDING BROAD JUMP
Experimental Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	77	76	- 1	1
2	74	73	- 1	1
3	73	80	7	49
4	73	74	1	1
5	73	74	1	1
6	72	76	4	16
7	72	71	- 1	1
8	72	71	- 1	1
9	70	76	6	36
10	70	74	4	16
11	70	70	0	0
12	70	70	0	0
13	69	71	2	4
14	68	70	2	4
15	68	68	0	0
16	67	65	- 2	4
17	66	67	1	1
18	62	70	8	64
19	62	65	3	9
20	62	64	2	4
N=20	M_1=69.50	M_2=71.25	$\Sigma D(+)$ 41 $\Sigma D(-)$ - 6 35	ΣD^2 = 213

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{10.65 - 3.06}$$

$$= \sqrt{7.59}$$

$$\sigma_D = 2.755$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{2.755}{4.359}$$

$$\sigma_{M_D} = .632$$

$$M_D = \frac{35}{20} = 1.75$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{1.75}{.632}$$

$$t = 2.76898$$

STANDING BROAD JUMP
Control Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	82	82	0	0
2	79	82	3	9
3	77	77	0	0
4	73	73	0	0
5	72	71	-1	1
6	72	72	0	0
7	72	72	0	0
8	70	71	1	1
9	69	69	0	0
10	67	67	0	0
11	67	62	-5	25
12	66	63	-3	9
13	66	67	1	1
14	66	63	-3	9
15	63	66	3	9
16	62	64	2	4
17	59	59	0	0
18	58	50	-8	64
19	57	63	6	36
20	53	54	1	1

N=20 M_1=67.50 M_2=67.35 $\Sigma D(+)$ 17 $\Sigma D(-)$ -20 -3 ΣD^2 = 169

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{8.450 - .225}$$

$$= \sqrt{8.225}$$

$$\sigma_D = 2.868$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{2.868}{4.359}$$

$$\sigma_{M_D} = .6579$$

$$M_D = \frac{-3}{20} = -.150$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{-.150}{.6579}$$

$$t = -.22796$$

SHUTTLE RUN
Experimental Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	9.7	9.7	0	0
2	10.0	9.7	-.3	.09
3	10.1	10.0	-.1	.01
4	10.2	10.0	-.2	.04
5	10.3	9.5	-.8	.64
6	10.3	10.2	-.1	.01
7	10.3	10.7	.4	.16
8	10.3	10.4	.1	.01
9	10.4	9.6	-.8	.64
10	10.4	10.4	0	0
11	10.5	10.1	-.4	.16
12	10.6	9.8	-.8	.64
13	10.6	9.8	-.8	.64
14	10.8	10.6	-.2	.04
15	10.9	10.4	-.5	.25
16	11.0	10.5	-.5	.25
17	11.2	10.8	-.4	.16
18	11.2	10.4	-.8	.64
19	11.6	10.3	-1.3	1.69
20	12.0	10.0	-2.0	4.00
N=20	M_1=10.62	M_2=10.145	$\Sigma D(+)$ .5 $\Sigma D(-)$ 10.0 -9.5	ΣD^2=10.07

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{.5035 - .2256}$$

$$= \sqrt{.2779}$$

$$\sigma_D = .527$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{.527}{4.359}$$

$$\sigma_{M_D} = .121$$

$$M_D = \frac{-9.5}{20} = -.475$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{-.475}{.121}$$

$$t = -3.92561$$

SHUTTLE RUN
Control Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	9.7	10.0	.3	.09
2	9.8	10.0	.2	.04
3	9.8	9.8	.0	0
4	10.0	10.3	.3	.09
5	10.2	10.2	.0	0
6	10.2	10.1	- .1	.01
7	10.3	9.8	- .5	.25
8	10.3	10.3	.0	0
9	10.4	10.2	- .2	.04
10	10.4	10.3	- .1	.01
11	10.4	10.0	- .4	.16
12	10.5	10.6	.1	.01
13	10.7	11.0	.3	.09
14	10.7	10.7	.0	0
15	10.8	10.7	- .1	.01
16	11.0	10.5	- .5	.25
17	11.7	12.5	.8	.64
18	11.7	11.2	- .5	.25
19	11.8	11.0	- .8	.64
20	11.9	10.8	-1.1	1.21
N=20	M_1=10.61	M_2=10.50	$\Sigma D(+)$ 2.0 $\Sigma D(-)$ -4.3 -2.3	ΣD^2 = 3.79

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{.1895 - .1323}$$

$$= \sqrt{.0572}$$

$$\sigma_D = .2392$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{.239}{4.359}$$

$$\sigma_{M_D} = .0548$$

$$M_D = \frac{-2.3}{20} = -.115$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{-.115}{.0548}$$

$$t = 2.09854$$

50 YARD DASH
Experimental Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	7.1	7.4	.3	.09
2	7.3	7.3	0	0
3	7.5	7.4	- .1	.01
4	7.5	7.3	- .2	.04
5	7.5	7.6	.1	.01
6	7.5	7.3	- .2	.04
7	7.6	7.2	- .4	.16
8	7.7	7.9	.2	.04
9	7.7	7.5	- .2	.04
10	8.0	7.8	- .2	.04
11	8.0	8.0	0	0
12	8.0	7.6	- .4	.16
13	8.0	7.8	- .2	.04
14	8.3	7.8	- .5	.25
15	8.3	7.5	- .8	.64
16	8.5	7.5	-1.0	1.00
17	8.5	7.8	- .7	.49
18	8.7	7.5	-1.2	1.44
19	8.8	8.0	- .8	.64
20	9.2	7.8	-1.4	1.96
N=20	M_1=7.985	M_2=7.60	$\Sigma D(+)$ .6 $\Sigma D(-)$ -8.3 -7.7	ΣD^2 = 7.09

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{.3545 - .1482}$$

$$= \sqrt{.2063}$$

$$\sigma_D = .454$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{.454}{4.359}$$

$$\sigma_{M_D} = .104$$

$$M_D = \frac{-7.7}{20} = -.385$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{-.385}{.104}$$

$$t = 3.70192$$

50 YARD DASH
Control Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	7.2	7.3	.1	.01
2	7.3	7.4	.1	.01
3	7.3	7.5	.2	.04
4	7.4	7.6	.2	.04
5	7.5	7.4	-.1	.01
6	7.6	7.6	0	0
7	7.6	7.3	-.3	.09
8	7.8	7.8	0	0
9	7.8	7.8	0	0
10	7.9	8.0	.1	.01
11	7.9	7.5	-.4	.16
12	8.0	8.2	.2	.04
13	8.1	7.8	-.3	.09
14	8.1	8.2	.1	.01
15	8.3	8.1	-.2	.04
16	8.4	8.5	.1	.01
17	8.6	9.3	.7	.49
18	8.7	8.1	-.6	.36
19	9.0	8.8	v.2	.04
20	9.1	8.8	-.3	.09
N=20	M_1=7.98	M_2=7.95	$\Sigma D(+)$ 1.8 $\Sigma D(-)$ -2.4 -.6	ΣD^2 = 1.54

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{.0770 - .0009}$$

$$= \sqrt{.0761}$$

$$\sigma_D = .276$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{.276}{4.359}$$

$$\sigma_{M_D} = .0633$$

$$M_D = \frac{-.6}{20} = -.030$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{-.030}{.063}$$

$$t = -.47619$$

SOFTBALL THROW
Experimental Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	170	180	10	100
2	170	170	0	0
3	169	150	-19	361
4	142	143	1	1
5	141	136	- 5	25
6	139	157	18	324
7	136	130	- 6	36
8	135	132	- 3	9
9	134	147	13	169
10	133	127	- 6	36
11	129	125	- 4	16
12	127	127	0	0
13	125	130	5	25
14	120	124	4	16
15	118	112	- 6	36
16	117	118	1	1
17	110	116	6	36
18	101	109	8	64
19	94	124	30	900
20	92	124	32	1024

N=20 M_1=130.10 M_2=134.05 $\Sigma D(+)$ 128 $\Sigma D(-)$ -49 79 ΣD^2 = 3179

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{158.95 - 15.60}$$

$$= \sqrt{143.35}$$

$$\sigma_D = 11.958$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{11.958}{4.359}$$

$$\sigma_{M_D} = 2.7433$$

$$M_D = \frac{79}{20} = 3.95$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{3.95}{2.74}$$

$$t = 1.4416$$

SOFTBALL THROW
Control Group

Subject	Tests		Difference	(Difference)^2
	#1	#2		
# 1	188	173	-15	225
2	160	162	2	4
3	154	143	-11	121
4	149	136	-13	169
5	146	145	- 1	1
6	142	153	11	121
7	140	133	- 7	49
8	137	126	-11	121
9	131	172	41	1681
10	131	120	-11	121
11	131	133	2	4
12	129	131	2	4
13	127	111	-16	256
14	127	142	15	225
15	123	123	0	0
16	122	132	10	100
17	119	106	-13	169
18	110	108	- 2	4
19	106	110	4	16
20	105	102	- 3	9
N=20	M_1=133.85	M_2=133.05	$\Sigma D(+)$ 87 $\Sigma D(-)$ -103 - 16	ΣD^2 = 3400

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{170.00 - .64}$$

$$= \sqrt{169.36}$$

$$\sigma_D = 13.014$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{13.014}{4.359}$$

$$\sigma_{M_D} = 2.985$$

$$M_D = \frac{-16}{20} = -.80$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{-.80}{2.985}$$

$$t = -.26800$$

600 YARD RUN-WALK
Experimental Group

Subject	Tests		Difference	(Difference)^2
	#1	#2		
# 1	122	119	- 3	9
2	124	146	22	484
3	124	124	0	0
4	127	126	- 1	1
5	128	124	- 4	16
6	128	125	- 3	9
7	131	126	- 5	25
8	133	124	- 9	81
9	133	149	16	256
10	134	126	- 8	64
11	134	136	2	4
12	136	118	-18	324
13	137	124	-13	169
14	140	128	-12	144
15	140	121	-19	361
16	141	139	- 2	4
17	149	150	1	1
18	149	126	-23	529
19	151	141	-10	100
20	153	138	-15	225

N=20 M_1=135.70 M_2=130.50 $\Sigma D(+)$ 41, $\Sigma D(-)$ -145, -104 ΣD^2 = 2806

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{140.30 - 27.04}$$

$$= \sqrt{113.26}$$

$$\sigma_D = 10.642$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{10.642}{4.359}$$

$$\sigma_{M_D} = 2.4414$$

$$M_D = \frac{-104}{20} = 5.20$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{-5.20}{2.44}$$

$$t = 2.1311$$

600 YARD RUN-WALK
Control Group

Subject	Tests #1	Tests #2	Difference	(Difference)^2
# 1	115	123	8	64
2	115	115	0	0
3	117	123	6	36
4	118	118	0	0
5	120	131	11	121
6	121	131	10	100
7	121	124	3	9
8	122	127	5	25
9	124	122	- 2	4
10	125	125	0	0
11	127	124	- 3	9
12	132	125	- 7	49
13	132	121	-11	121
14	132	124	- 8	64
15	134	130	- 4	16
16	138	126	-12	144
17	154	145	- 9	81
18	167	157	-10	100
19	169	147	-22	484
20	170	187	17	289
N=20	M_1=132.65	M_2=131.25	$\Sigma D(+)$ 60 $\Sigma D(-)$ -88 -28	ΣD^2 = 1716

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{85.50 - 1.96}$$

$$= \sqrt{83.84}$$

$$\sigma_D = 9.156$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}}$$

$$= \frac{9.156}{4.359}$$

$$\sigma_{M_D} = 2.100$$

$$M_D = \frac{-28}{20} = -1.400$$

$$t = \frac{M_D}{\sigma_{M_D}} = \frac{-1.400}{2.100}$$

$$t = -.6666$$

Random Sample t Test of Pre-Test
Means Between Groups*

$$M_1 = \frac{\Sigma X}{N} \qquad M_2 = \frac{\Sigma X}{N}$$

$$\sigma_1 = \sqrt{\frac{\Sigma X^2}{N} - M_1^2} \qquad \sigma_2 = \sqrt{\frac{\Sigma X^2}{N} - M_2^2}$$

$$\sigma_{M_1} = \frac{\sigma_1}{\sqrt{N-1}} \qquad \sigma_{M_2} = \frac{\sigma_1}{\sqrt{N-1}}$$

$$\sigma_D = \sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2}$$

$$t = \frac{M_1 - M_2}{\sigma_D}$$

M_1 = experimental group mean
M_2 = control group mean
X = score
N = number of subjects
σ = standard deviation
σ_M = standard error of the mean
σ_D = standard error of the difference

* Results recorded were computed electronically.

Situps

$M_1 = 53.45$ $M_2 = 57.10$

$\sigma_1 = 23.333$ $\sigma_2 = 19.965$

$\sigma_{M_1} = 5.217$ $\sigma_{M_2} = 4.464$

$\sigma_D = 6.866$

$M_1 - M_2 = -3.65$

$t = 1.149$

Pullups

$M_1 = 4.60$ $M_2 = 3.25$

$\sigma_1 = 3.898$ $\sigma_2 = 3.522$

$\sigma_{M_1} = .871$ $\sigma_{M_2} = .787$

$\sigma_D = 1.174$

$M_1 - M_2 = 1.35$

$t = 1.149$

Standing Broad Jump

$M_1 = 69.50$ $\quad$ $M_2 = 67.50$

$\sigma_1 = 4.135$ $\quad$ $\sigma_2 = 7.514$

$\sigma_{M_1} = .924$ $\quad$ $\sigma_{M_2} = 1.680$

$\sigma_D = 1.918$

$M_1 - M_2 = 2.00$

$t = 1.042$

Shuttle Run

$M_1 = 10.62$ $\quad$ $M_2 = 10.61$

$\sigma_1 = .561$ $\quad$ $\sigma_2 = .682$

$\sigma_{M_1} = .125$ $\quad$ $\sigma_{M_2} = .152$

$\sigma_D = .197$

$M_1 - M_2 = .00$

$t = .025$

50-Yard Dash

$M_1 = 7.98$ $\quad$ $M_2 = 7.98$

$\sigma_1 = .556$ $\quad$ $\sigma_2 = .560$

$\sigma_{M_1} = .124$ $\quad$ $\sigma_{M_2} = .125$

$\sigma_D = .176$

$M_1 - M_2 = .00$

$t = .028$

Softball Throw

$M_1 = 130.10$ $\quad$ $M_2 = 133.85$

$\sigma_1 = 22.456$ $\quad$ $\sigma_2 = 19.615$

$\sigma_{M_1} = 5.021$ $\quad$ $\sigma_{M_2} = 4.386$

$\sigma_D = 6.667$

$M_1 - M_2 = -3.75$

$t = -0.562$

600-Yard Run-Walk

$M_1 = 135.70$ $M_2 = 132.65$

$\sigma_1 = 9.325$ $\sigma_2 = 18.030$

$\sigma_{M_1} = 2.085$ $\sigma_{M_2} = 4.031$

$\sigma_D = 4.538$

$M_1 - M_2 = 3.05$

$t = .671$

Random Sample t Test of Pre- and Post-Test Differences Between Groups*

$$M_1 = \frac{\Sigma X}{N} \qquad M_2 = \frac{\Sigma X}{N}$$

$$\sigma_1 = \sqrt{\frac{\Sigma X^2}{N} - M_1^2} \qquad \sigma_2 = \sqrt{\frac{\Sigma X^2}{N} - M_2^2}$$

$$\sigma_{M_1} = \frac{\sigma_1}{\sqrt{N-1}} \qquad \sigma_{M_2} = \frac{\sigma_2}{\sqrt{N-1}}$$

$$\sigma_D = \sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2}$$

$$t = \frac{M_1 - M_2}{D}$$

M_1 = experimental group mean
M_2 = control group mean
X = score
N = number of subjects
σ = standard deviation
σ_M = standard error of the mean
σ_D = standard error of the difference

*Results recorded were computed electronically.

Situps

$M_1 = 13.00$ $\quad$ $M_2 = 3.60$

$\sigma_1 = 12.523$ $\quad$ $\sigma_2 = 9.853$

$\sigma_{M_1} = 2.800$ $\quad$ $\sigma_{M_2} = 2.203$

$$\sigma_D = 3.563$$

$$M_1 - M_2 = 9.40$$

$$t = 2.638$$

Pullups

$M_1 = 1.00$ $\quad$ $M_2 = .75$

$\sigma_1 = 1.486$ $\quad$ $\sigma_2 = 1.164$

$\sigma_{M_1} = .332$ $\quad$ $\sigma_{M_2} = .260$

$$\sigma_D = .422$$

$$M_1 - M_2 = .25$$

$$t = .592$$

Standing Broad Jump

$M_1 = 1.75$ $M_2 = -0.15$

$\sigma_1 = 2.826$ $\sigma_2 = 2.978$

$\sigma_{M_1} = .631$ $\sigma_{M_2} = .665$

$\sigma_D = .918$

$M_1 - M_2 = 1.90$

$t = 2.069$

Shuttle Run

$M_1 = -.48$ $M_2 = -.12$

$\sigma_1 = .540$ $\sigma_2 = .430$

$\sigma_{M_1} = .120$ $\sigma_{M_2} = .096$

$\sigma_D = .154$

$M_1 - M_2 = -.36$

$t = -2.328$

50-yard Dash

$M_1 = -.39$ $\quad M_2 = -.03$

$\sigma_1 = .465$ $\quad \sigma_2 = .283$

$\sigma_{M_1} = .104$ $\quad \sigma_{M_2} = .063$

$\sigma_D = .121$

$M_1 - M_2 = -0.35$

$t = -2.912$

Softball Throw

$M_1 = 3.95$ $\quad M_2 = -.80$

$\sigma_1 = 12.283$ $\quad \sigma_2 = 13.351$

$\sigma_{M_1} = 2.746$ $\quad \sigma_{M_2} = 2.985$

$\sigma_D = 4.056$

$M_1 - M_2 = 4.75$

$t = 1.170$

600-Yard Run-Walk

$M_1 = -5.20$ $\quad$ $M_2 = -1.40$

$\sigma_1 = 10.918$ $\quad$ $\sigma_2 = 9.394$

$\sigma_{M_1} = 2.441$ $\quad$ $\sigma_{M_2} = 2.100$

$$\sigma_D = 3.220$$

$$M_1 - M_2 = -3.80$$

$$t = -1.179$$