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A STUDY OF THE PHYSICAL FITNESS STATUS  
OF A SELECTED GROUP OF MALE FRESHMEN AND SOPHOMORE  
STUDENTS AT MONTANA STATE UNIVERSITY 1956

by

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B.A. Montana State University, 1952

Presented in partial fulfillment  
of the requirements for the degree of  
Master of Arts

MONTANA STATE UNIVERSITY

1956

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*May 29 1956*  
DATE

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CHAPTER I  
INTRODUCTION TO THE STUDY

The average American youth today appears to be growing soft. Recent publicity about the Kraus-Weber Test given to American and European children has focused attention upon the presumed weakness of American children.<sup>1</sup> More research is needed to confirm this presumption.

Introduction

This study was made to determine the physical fitness of the male freshman and sophomore students in physical education classes at Montana State University.

The study proceeded by administering the Rogers Strength Test to the male students in physical education activity classes at Montana State University during the winter quarter 1956. In analyzing the data in this study, considerations were given to the per cent of students placed in the fitness categories of classification as suggested by Rogers<sup>2</sup> and to the possible influence that physical education may have upon the achieved scores. To determine the degree of influence it was necessary to find the amount of physical education

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<sup>1</sup>U.S. News and World Report, (Dayton, Ohio) March 19, 1954, p. 35.

<sup>2</sup>Leonard A. Larson and Rachael D. Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education. (St. Louis: C.V. Mosby Company, 1951), p. 470.

experience of each testee. Physical education experience was defined and a medium of comparison determined. After this had been accomplished, statistical methods were employed which would show the relationship of this experience to the individual's performance on the test.

Purpose of this study. The purpose of this study was to determine the physical fitness status of a selected group of the male students of Montana State University.

A sub-problem arising in finding the physical fitness status was one of determining the relationship of factors which may influence the individual's achieved status. The factors that were considered were organized physical education and school athletics.

Basic Assumptions. At the time the test was administered there were 1077 male freshman and sophomore students enrolled at Montana State University. Of this number 442 students in required physical education classes completed the test. The difference in the two numbers can partially be contributed to the following: some students are excused from these classes because they are veterans, some are not considered physically capable, and some are not able to participate because of scheduling conflicts. However, this forty-one per cent of the total enrollment was assumed to be a representative sample of all physically fit male freshman and sophomore students at Montana State University during the winter quarter 1956.

This study proceeded on the assumption that the Rogers Strength Test is an adequate measuring device of general body-strength, and that body-strength reflects the basic fitness of the body. "Muscular strength is an important component of physical fitness for normal daily living."<sup>3</sup> In finding the muscular strength of the students the Rogers Strength Test was used. This test provides data for determining a strength index, normal strength index, and physical fitness index. H. Harrison Clarke,<sup>4</sup> states "Inasmuch as body-strength reflects the basic fitness status of the body, the physical fitness index is a measure of that condition."

For this study it was assumed that reported participation in organized physical education classes and school athletics represent planned physical education experience, and that the total planned experience can be indicated by the number of hours of participation.

### Definitions

Physical Fitness. Physical fitness for this study is the status of the individual, measured by the large muscles of the body and is indicated by the physical fitness index.

Muscular Strength. This is the ability of an individual to exert single explosive force against an object.<sup>5</sup> Types of muscular strength include; (1) Static Strength; the

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<sup>3</sup>Ibid. p. 100.

<sup>4</sup>H. Harrison Clarke, Development of the Sub-Strength Individual, (St. Louis; Fred Medart Products Inc. 1951), p. 3.

<sup>5</sup>Larson, op. cit. pp. 78-79



ability of an individual to squeeze, push or pull an instrument or to hold the body in one position over an extended period, and (2) Dynamic Strength; the ability of an individual to lift the body weight or propel it in any direction.<sup>6</sup>

Muscular Endurance. This is considered as the ability to continue successive performances of muscular strength and/or power at a maximum rate of speed over an unlimited time span.<sup>7</sup> Chins and dips were considered items of muscular endurance in this study.

Strength Index. The gross score obtained from the seven test items which comprise the Rogers Strength Test.<sup>8</sup>

Physical Fitness Index. The score derived from dividing the achieved strength index by a norm for the individual's sex, weight, and age.<sup>9</sup>

Physical Education Experiences. For purposes of this study it is defined as organized physical education and school athletics.

Critical Ratio. The term refers to the obtained difference of two means divided by the standard error of their difference.

Confidence-Interval for the True Mean. Since the true-mean itself is unknown, the confidence-interval used was mean plus or minus three standard error of the mean, which is said

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<sup>6</sup>Ibid.

<sup>7</sup>Ibid.

<sup>8</sup>H. Harrison Clarke, The Application of Measurement to Health and Physical Education, (New York: Prentice-Hall, 1945), p. 137.

<sup>9</sup>Ibid. p. 138.

to define the limits of the 99.97% confidence-interval.<sup>10</sup>

Level of Significance. In this study the .05 level and above were considered as significant. The .05 level means that ninety-five times out of 100 times, the difference between two means is an actual difference and not due to chance.

Coefficient of Correlation. This refers to that ratio which expresses the extent to which changes in one variable are dependent upon changes in a second variable.<sup>11</sup>

Limitations of the Study.

This study was limited to the male students participating in the freshman and sophomore physical education activity classes at Montana State University during the winter quarter 1956. All students had been examined physically and were assumed to be capable of participating in physical education.

The study was limited to the use of the Rogers Strength Test as the means of determining physical fitness. From the scores achieved on this test the following information about each individual was obtained: the strength index, the normal strength index, and the physical fitness index.

This writer realized that factors other than participation in physical education classes contribute to the total planned physical education experience: however, they were

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<sup>10</sup>Henry E. Garrett, Statistics in Psychology and Education, (New York: Longmans, Green and Company, 1953), p. 188. <sup>11</sup>Ibid. p. 126.

omitted from this study as they were too numerous and the information too difficult to obtain in the time available for this study. In addition, it was acknowledged that factors other than physical education experience contribute to physical fitness, but were omitted as either too extensive or difficult to measure.

The level of significance applied to this study was in accordance with Henry E. Garrett,<sup>12</sup> who states, "differences between means being 'statistically different', or not due to chance as at least at the .05 level which is indicated by a critical ratio of 1.96."

#### Need for the Study.

At the present limited attention is given to classification of the male students for enrollment in physical education activity classes at Montana State University. Nor is there sufficient data on the individual's physical fitness status to provide a guide in the selection of benefiting activities by the individual student.

"A knowledge of physical fitness of boys and girls is the logical starting point for conducting effective physical education programs,"<sup>13</sup>

Extensive studies of sub-strength individuals during the past quarter-century have shown unmistakably the basic relationship of adequate strength to organic functions: to stamina for long continued activity, to proper mental attitudes, to good social relationships; in fact

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<sup>12</sup>Ibid. p. 216.

<sup>13</sup>H. Harrison Clarke, The Application of Measurement Physical Education, (New York: Prentice-Hall,

to almost every desirable phase of mental health, physical fitness, and social efficiency.<sup>14</sup>

The initial paragraph of this study with regard to the recent publicity of the presumed weakness of American children substantiates a need for this study. Further facts of unfitness as cited by Larson and Yocum,<sup>15</sup> with regards to men of military age, illustrates an additional need. These facts are as follows:

The documented statistics reveal that at least 40% of the twenty-two million men of military age were unfit for military duty. . . . Specific research demonstrates that selected men were lacking in the physical qualities necessary for the conduct of a moderate work load over a short period of time.

An attempt was made in this study to provide information which should be of value as a guide for the students, and the staff of the physical education department at Montana State University. An endeavor was made to provide information as to the general strength and fitness of the selected students and to provide data which could be of benefit to those concerned with physical education of all ages.

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<sup>14</sup>H. Harrison Clarke, Development of the Sub-Strength Individual, (St. Louis: Fred Medart Products Inc., 1951), p. 2.

<sup>15</sup>Larson, op. cit. p. 22.

CHAPTER II  
REVIEW OF THE LITERATURE

Muscular strength and endurance are defined as, the ability to exert single explosive force against an object, and to continue successive performances at a maximum rate over an unlimited time span. Since strength underlies most of our daily activities, strength testing becomes important to the people concerned with the developing of this strength if they are to effectively accomplish their work. Strength testing is not a modern technique. Cureton cites evidence of strength testing as early as 1702,<sup>1</sup> by De la Hire and Amontons.

To assure a better understanding of this study a review of the literature concerning the Rogers Strength Test is presented.

While still a medical student at Yale, Dr. Dudley A. Sargent introduced a procedure for testing strength. He advanced the procedure in more detail about 1880 while at Harvard.<sup>2</sup> It was Sargent's test that Dr. Frederick Rand Rogers, in 1925, revised by standardizing testing procedure

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<sup>1</sup>T.K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C.V. Mosby Company, 1947), p. 358.

<sup>2</sup>John F. Bovard, Fredrick W. Cozens, and E. Patricia Hagman, Tests and Measurement in Physical Education, (Philadelphia: W.B. Saunders Company, 1950), p. 21.

and developing norm tables for their interpretations.<sup>3</sup>

In selecting the individual elements composing the Physical Fitness Index Battery, Rogers tried to include only tests that would measure most of the large muscles of the body. Most of the large muscles not tested are antagonistic to those tested and must have strength about equal thereto. Rogers' composite of seven items is a reduction from the ten tests given by Sargent.<sup>4</sup>

The seven test items comprising the Rogers Strength Test are: pull-ups(chins); push-ups(dips); leg lift; back lift; right hand grip; left hand grip; and lung capacity.

Clarke cites the contributions made by Rogers which have been considered significant.<sup>5</sup> Some of which are: the construction of norm tables for all combinations of sex, age, and weight for every two pounds; producing evidence that strength reflects organic conditions so accurately that repeated strength test scores indicate changing health with great accuracy; discovery that strength depends twice as heavily upon weight as upon age and providing proof that the strength test measures general athletic ability.

Continued improvements of the Rogers Strength Test have been made. Clarke cites the following studies which show some of these improvements.<sup>6</sup> Development of special

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<sup>3</sup>Frederick Rand Rogers, Physical Capacity Tests in the Administration of Physical Education, (New York: Bureau of Publications, Teachers College Columbia University, 1926).

<sup>4</sup>H. Harrison Clarke, The Application of Measurement to Health and Physical Education, (New York: Prentice-Hall, 1945), p. 137.

<sup>5</sup>Ibid.

<sup>6</sup>Harrison Clarke, Development of the Sub-Strength (St. Louis: Fred Medart Products Inc., 1951),

arm-strength tests for girls and data for the first norms for girls by Chauncey R. Mann, Troy, New York in 1927; Improvement in testing apparatus and techniques between 1927 and 1929 by Everett T. Grout, Schenectady, New York; Development of the 'belt technique' for the leg lift test, devised in 1938 at Boston University by Gordon Hathaway assisted by Professor Edgar W. Everts; Construction of norms for the revised tests by Seymour Maskel, William Lynch, Robert E. Laveague and Rachel Kelly at Boston University.

Validity of the test was increased by Chamberlain and Smiley.<sup>7</sup> They selected at random a group of students at Cornell University, who were carefully examined by a group of physicians and given estimates as to their status of health by these physicians. These estimates were compared with the physical fitness indices of the group. The resulting correlation was a highly satisfactory  $.60 \pm .05$ . Further evidence of the test's validity has been shown in numerous case studies. Some of these to be considered as typical are reported by Millard L. Rogers.<sup>8</sup>

Case No. 1. -- W.S. was a freshman tested on the morning of registration day. His test score was 74. (This is considered a low fitness index.) The same afternoon he was admitted to the university hospital suffering from a serious nervous disorder.

Case No. 2. -- R.H. was first tested on

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<sup>7</sup>C.G. Chamberlain and D.F. Smiley, "Functional Health and the Physical Fitness Index," Research Quarterly, March 1931, Vol. II, No. 1, p. 93.

<sup>8</sup>Millard L. Rogers, "The Case Study Method," Journal of Health and Physical Education, March 1945, Vol. 16, No. 3, p. 119.

registration day, receiving a score of 97. Retested several days later, his PFI had dropped 7 points to 90. Three days later he was sent to the city hospital. Doctor's diagnosis -- spinal meningitis. (This is an example of changing fitness status.)

Rogers Strength Test has been employed in a variety of ways some of which are indicated by the studies of Hines<sup>9</sup> and Grimsley.<sup>10</sup> Hines confirmed Rogers' conclusion that sub-strength individuals do not have the energy for long-continued and effective mental effort in his study of interpreting the individual's physical fitness in light of his I.Q. Grimsley on the other hand used the test to improve the selection of men for heavy work.

H. Harrison Clarke, who completed a record form for systematic follow-up studies of the strength test,<sup>11</sup> started a measurement project in March, 1939 in central New York State. The purpose of this project was to try out, in actual school situations, procedures for meeting the physical fitness objective in physical education. The project proceeded by using the Strength Test and the physical fitness index to determine fitness of the individuals in the schools participating in the project. The procedure followed was to continue the regular program, after testing, for the school, while

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<sup>9</sup>Thomas R. Hines, "A New Emphasis on Health," Journal of Health and Physical Education, January 1939.

<sup>10</sup>The value of Physical Fitness tests in Employee Selection, cited by H. Harrison Clarke, Development of the Sub-Strength Individual, (St. Louis: Fred Medart Products Inc. 1951), p. 15.

<sup>11</sup>H. Harrison Clarke, The Application of Measurement to Health and Physical Education, (New York: Prentice-Hall, 1945), p. 326.



selecting those boys with low physical fitness indices for special follow-up work and retesting at the end of the year. This also provided motivation for the students in the physical education program. Significant among the results were the following:<sup>12</sup>

1. The median Physical Fitness Index score for the nine schools included in the 1941-1942 tabulation, was 112, an increase of 15 points over scores recorded for the year preceding the inauguration of the project.

2. All nine of the schools had a median score above 100 in 1942. In 1938 - 1939 only two of the six schools then reporting had a median Physical Fitness Index above 100.

3. One school, the median score reached 112. Following a year's change in program and dropping of testing the median Physical Fitness Index decreased eight points to 104.

4. Average increases of 12 to 15 Physical Fitness Index points per year were typical.

In determining that the strength index predicts general athletic ability, Rogers<sup>13</sup> used "making the school team" as a criterion of athletic ability. Clarke in citing this study also relates the work of Granger,<sup>14</sup> Dealing with the strength indices of athletes and non-athletes. Significant data of these studies include the following:

Rogers; (a) Not more than five boys in 100, including the football men themselves, reached the median strength index for the football lettermen.

(b) Ten football players achieved strength indices higher than 371 of the 390 boys including themselves.

(c) No single score was recorded above the median score achieved by the five 'best athletes' or school team captains by any boy not a member of some major sports team.

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<sup>12</sup>Ibid. p. 319.  
227.  
228.

Granger; (a) The average strength index for the athletes was lower than in the study by Rogers, as Granger's included tennis men, a group whose average strength index was 270 points below any other of his athletic squads.

(b) The difference between the lettermen and the mass of pupils was  $337 \pm 23.09$ .

(c) It was found that 85.5 or 90 per cent of the lettermen had strength indices greater than the average of the mass.

The author found no studies other than Clarke's follow-up study which gave consideration to the total physical education program of a school and its effect upon the achieved physical fitness indices.

The following excerpts about the Rogers Strength Test from the book Measurement and Evaluation<sup>15</sup> provide additional data about the test being an adequate measuring device, and also summarizes what has been reported.

Physical Fitness Index: Validity based on correlations of .65 with medical judgments and case studies.

Strength Index: Correlates about .85 with athletic index composed of track and field skill events.

Reliability: Corrected self-correlations of the various test items range from .96 - .99 and for the entire battery about .94.

Objectivity: High.

Reported in this chapter were some of the numerous improvements and applications of the Rogers Strength Test. Evidence was presented that a 'measurement project' improved the level of achieved physical fitness in those schools participating. Also reported were the studies of Rogers and

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<sup>15</sup>American Association for Health, Physical Education, and Recreation, Measurement and Evaluation, (Washington, D.C.: National Education Association, 1950), p. 131.

Grangers, who used the same criteria for concluding that the strength index predicts general athletic ability.

CHAPTER III  
PROCEDURES OF THE STUDY

This study was primarily concerned with the determining of the physical fitness of a selected group of students at Montana State University. The instrument used to accomplish this was the Rogers Strength Test which seemed to be an adequate measuring device in that it met most of the statistical and administrative criteria of a good test. Those statistical criteria are; validity, reliability, objectivity, accuracy, norms and scoring. The administrative criteria being; economy of time, expense, equipment, and effort; comprehensiveness; non-coachableness; simplicity and provisions for instructions.

An information sheet was prepared which provided for recording of test scores and for recording the amount of time spent in physical education by the students.<sup>1</sup>

Only one set of instruments for each test item was available, and it was found necessary to give the test in the gymnasium which would be used simultaneously by the regularly scheduled classes.

A trial test was organized and administered to determine, the best testing station arrangement, the maximum

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<sup>1</sup>See Appendix A.

number of students which could be tested during a single class period, the best area in relation to the activity classes that were being held concurrently, and as a training session for testors. At this time the instructions for each test item were given to the testors.

Each activity class in the required physical education program was scheduled to be tested during one of their regularly scheduled class periods. This interfered with a minimum of one period of class work for the students tested. Because the classes were of different sizes it was necessary to schedule more than one class for some of the testing sessions. Scheduling was made to limit the number of testees to not more than forty students per one hour session. This was the maximum number that could be effectively tested as determined by the trial test. These forty or less students were organized into seven groups, each with a group leader, selected from the students in the class being tested in charge of each group.

To assure uniformity of directions the author met with the class instructor prior to the day of testing. Information sheets and the directions for their completion were distributed to instructors of physical education classes who supervised the filling out of the forms. At this time the testees were assigned to one of the seven groups and group leaders were appointed for each group. The testees were oriented as to the purpose of the test and procedure to be followed during

the testing session. They were told to maintain group unity unless directed otherwise and that the groups would rotate from station to station as the station testers directed under control of the group leader.

The testing stations were arranged to allow the greatest number of students to be tested in the time allotted and so there would be a rest of at least five minutes between the pull-ups (chins) and push-ups (dips) stations. All test items were conducted at separate stations, with the exception of the back and leg lifts which were combined because of the availability of only one back and leg dynamometer. Each testing station was provided with a set of instructions on the administration of the item of the test at that station. These instructions were available to both the testor and testee.<sup>2</sup> The scoring of the test was done by the testors and recorded by the group leaders under the supervision of the testor at each station.

Persons participating as testors were physical education department staff members, graduate students, and senior physical education majors, who were familiar with the Rogers Strength Test. Testing sessions were held every hour there was a scheduled activity class. The entire testing program required a total of nine days, this included make-up sessions for absentees. The complete test was administered to a total 442 students.

The strength index is found by adding the arm strength score with the total score of the other items. The arm

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<sup>2</sup>See appendix A.

strength score is found by using the following formula; the weight in pounds, divided by ten plus the height in inches minus sixty, times the total of chins and dips. Procedures used in determining the normal strength index and physical fitness index are those shown by Larson and Yocum.<sup>3</sup> By dividing the obtained strength index by the normal index assigned for the individual according to his age and weight each physical fitness index was calculated. When the physical fitness indices were calculated, Rogers' classifications of "A", "B", "C", and "D" were determined for each achieved physical fitness index. The per cent of students falling into each classification was determined.

The next step was to determine the mean physical fitness index, and the standard error of the mean for the tested group. This data provided statistical information for the evaluation of the central tendency of the group. The mean and standard error of the mean were determined by using the statistical methods outlined by Garrett<sup>4</sup> for measures of central tendency.

The next step in the study was to calculate the amount of time spent in planned physical education experiences of each student. This was accomplished by determining from the data on the information sheets, the time in hours spent in

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<sup>3</sup>Leonard A. Larson and Rachael D. Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education, (St. Louis: C.V. Mosby Company, 1951), p. 470.

<sup>4</sup>Henry E. Garrett, Statistics in Psychology and Education, (New York: Longmans, Green and Company, 1953), pp. 52-54.

physical education classes, and in school athletics. The amount of time was calculated from the reported number of meeting periods per week of physical education classes and/or athletics, the number of years participating, and the number of minutes of each class period. To facilitate these calculations a table was prepared for the various combinations which appeared on the information sheets. The total number of hours was the sum of the time spent in physical education classes and/or time spent in athletics. Tables for computing the total time in physical education can be found in the appendix.<sup>5</sup>

After the physical education experiences had been calculated a critical ratio technique was employed to reveal the relationship of the physical fitness index to the amount of planned physical education experience. In order to use the critical ratio technique it was first necessary to divide physical education experience into groups. Two groups were formed; those falling above the mean physical education experience and those falling below the mean physical education experience. To insure that the mean used was significant, the confidence-interval of the mean plus and minus three standard errors of the mean was applied. This interval was used to represent the mean and cases within the interval were not considered. The critical ratio was found by using the method outlined by Garrett,<sup>6</sup> and the significance of the difference noted in relationship to the levels of

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<sup>5</sup>See appendix A.

<sup>6</sup>Garrett, op. cit., p. 356.



significance defined in chapter 1.

The final analysis of the data sought to determine if participation in athletics tended to raise or lower the achieved physical fitness index and/or strength index. The same criteria for athletes and non-athletes used by Rogers and Granger,<sup>7</sup> that being, letter-winners and non-letter-winners, was employed. A coefficient of correlation and critical ratios were calculated to show the relationship.

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<sup>7</sup>H. Harrison Clarke, The Application of Measurement to Health and Physical Education, (New York: Prentice-Hall 1945), p. 228.

CHAPTER IV  
ANALYSIS OF THE DATA

In analyzing the data, the author used approved statistical methods in finding the various critical ratios, coefficient of correlations, means, standard error of the means, and standard deviations. The procedure used in administration and scoring of the Rogers Strength Test were those as prescribed by Rogers and outlined by Larson and Yocum.<sup>1</sup>

Central Tendency of Physical Fitness Scores.

After the tests had been scored and the physical fitness indices for each individual calculated, the scores were grouped according to the classifications established by Rogers. Thus a picture of the total sample's fitness was observed by noting the per cent of students falling into each of the classifications. Table I provides this information.

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<sup>1</sup>Leonard A. Larson and Rachel D. Yocum, Measurement and Evaluation in Physical, Health, and Recreation Education, (St. Louis: C.V. Mosby Company, 1951), pp. 470-474.

TABLE I

PER CENT OF STUDENTS IN EACH  
PHYSICAL FITNESS CLASSIFICATION

CLASSIFICATIONS (with physical fitness index limits)	NUMBER OF STUDENTS	PER CENT OF TOTAL SAMPLE
A-- 115 and above	14	3.17
B-- 100 to 114	22	16.29
C-- 85 to 99	150	33.94
D-- 84 and below	206	46.60

Note: This table reads as follows: There are 14 students who are classified "A", or had a score of 115 or better, this number is 3.17 per cent of the total sample.

The physical fitness index was determined by dividing the achieved strength index by the normal strength index of the individual, the resultant per cent represented the physical fitness index of the subject. A person who achieves a strength index of 2660, and who has a normal strength index of 2660 will have a resultant physical fitness index of 100. This index is considered the normal index. Table I reveals that nearly eighty-one per cent of the students tested were below this normal index. It will also be noted that the largest number of students fell into the "D" group which is the lowest classification. This number is highly significant in that it represents nearly half of the total sample. This information would seem to indicate that for the most part the students tested are physically inferior to the considered normal index.

Since the reliability of statistics is largely dependent upon the number of cases considered, the author feels that

the sample tested, which is forty-one per cent of the total number of male freshmen and sophomores enrolled at Montana State University during the time of testing, is a sufficient number.

A description of the achieved physical fitness indices is shown by the mean physical fitness index, standard deviation, and standard error of the mean. The mean of this data is 86.99 with the standard error of the mean .71, and the standard deviation 14.96. This shows that the central tendency of those tested is in the "C" classification even when the limits of the mean (84.86 -- 89.12) are considered. This is, however, the lower portion of the "C" classification.

#### Physical Education Experience.

To carry the study beyond one which showed merely physical fitness status the author sought to relate physical education experience to achieved physical fitness. As explained under "procedures," information concerning physical education experiences obtained from information sheets was organized for use in determining the relationship. The critical ratio technique was used to determine the level of significance that time in planned physical education experience played in developing physical fitness. To use the critical ratio technique it was necessary to divide physical education experience into groups for comparison. Since the total "planned physical education experience" was indicated by the total number of hours of participation for each student, two

groups were formed; those whose total hours fell above the mean number of hours for the total group and those below the mean number of hours for the total group. To insure that the true mean was used, the confidence-interval  $\pm 3$  standard error of the mean was utilized. The mean number of hours for the whole group was 677.55, and the standard error of the mean 22.52. The confidence-interval calculated produced the limits of the mean to be used. These were 609.96 and 745.14. This interval, now considered the mean, is shown in Table II.

TABLE II  
HOURS OF PHYSICAL  
EDUCATION EXPERIENCE

RANGE	MEAN	SD	SD <sub>M</sub>	CONFIDENCE-INTERVAL
0 - 2424	677.55	473.7	22.52	609.96 - 745.14

The mean physical fitness index was computed for the above average physical education experience group and the below average physical education group. The critical ratio was calculated by dividing the difference of the two obtained physical fitness index means by the standard error of the differences. The data used in this treatment is shown in Table III.

TABLE III

DATA FOR THE CRITICAL RATIO ANALYSIS  
OF PHYSICAL FITNESS INDEX AND PHYSICAL  
EDUCATION EXPERIENCE

	GROUP I Above average physical education experience.	GROUP II Below average physical education experience.
MEAN	84.88	82.15
SD	16.80	13.02
SD <sub>M</sub>	1.27	.85

The resultant ratio of 1.79 was significant at .08 level indicating that under similar conditions approximately eight times out of 100 the difference between the two means would be due to chance. Since this ratio is below 1.96 which indicates the .05 level of significance, it is considered not significant. From these findings it appears that the total amount of time spent in planned physical education has a low relationship or significance to the physical fitness index.

#### Athletic Participation

As reported from related literature in chapter 2 of this study, the achieved strength index of the Rogers Strength Test correlated about .85 with general athletic ability. Using the same criteria for distinguishing between athletes and non-athletes as Rogers and Granger,<sup>2</sup> the author calculated a bi-serial correlation to indicate the influence of athletics

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<sup>2</sup>H. Harrison Clarke, The Application of Measurement to Health and Physical Education, (New York: Prentice-Hall 1945), p. 227.

upon the achieved physical fitness indices. Using the information of letter-winners and non-letter-winners, reported on the information sheets, the following statistical data was produced for study.

TABLE IV  
STATISTICAL DATA USED FOR THE  
BI-SERIAL CORRELATION BETWEEN THE  
LETTER-WINNERS AND NON-LETTER-WINNERS

STATISTICAL TERMS	LETTER-WINNERS (athletes)	TOTAL NON-LETTER- SAMPLE WINNERS (non-athletes)	
MEAN PHYSICAL FITNESS INDEX	88.58	86.99	85.21
STANDARD DEVIATION	16.14	14.96	13.33
STANDARD ERROR OF THE MEAN	1.06	.71	.92
PROPORTION OF TOTAL SAMPLE	.5294		.4706
HEIGHT OF ORDINATE AXIS SEPARATING PROPORTIONS		.398	

The resultant correlation of .14 indicates some degree of positive relationship between participation in athletics and the achieved physical fitness index. However, this relationship is slight.

Another picture of the relationship between these two groups is found by employing the critical ratio technique. Considering the difference between the mean physical fitness index of the two groups and dividing the difference by the standard error of the difference a ratio of 2.40 is computed.

This ratio is significantly high as it is better than 1.96 which represents the .05 level of significance, but does not reach the .01 level of significance. Since it is better than the .05 level this degree of relationship indicates that those individuals who earn letters in athletics will, better than 95 times out of 100, achieve higher physical fitness indices than those who do not win letters.

The predictability of the Strength Index for general athletic ability has been indicated in related literature. An attempt was made in this study to show that those students who were classified as athletes tend to achieve higher strength indices than do those who are considered as non-athletes. A critical ratio was computed for this analysis using the data in Table V.

TABLE V  
DATA FOR ANALYSIS  
OF STRENGTH INDEX AND ATHLETICS

GROUP	MEAN STRENGTH INDEX	SD	SD <sub>M</sub>	NUMBER OF STUDENTS
Letter-winners	2560.84	470.64	30.77	234
Non-letter- winners	2362.50	755.57	52.38	208

The critical ratio determined from this data is an extremely high 3.26 which is significant at better than the .01 level. This ratio indicates that those Montana students



who earn letters in athletics will better than 99 times out of 100 score higher strength indices than those who do not win letters. Because of the limited information available for this study it is difficult to say that this high relationship results from the greater amount of participation in athletics.

From the analysis of the data in this study the following results were concluded. Eighty-one per cent of the students tested scored below the normal score of 100 in physical fitness; Forty-six per cent of the students were classified in the lowest group; The critical ratio of 1.79 does not show a significant relationship between planned physical education experience and the achieved physical fitness index; That ratios of 2.40 and 3.26 show significant relationships between athletics and the physical fitness index and the strength index respectively. Table VI shows statistical data of the physical fitness indices for the different groups used in this study.

TABLE VI  
PHYSICAL FITNESS INDEX  
DATA BY GROUPS

	PHYSICAL EDUCATION ABOVE AVERAGE	EXPERIENCE BELOW AVERAGE	TOTAL SAMPLE	ATHLETES	NON-ATHLETES
MEAN	84.88	82.15	86.99	88.58	85.21
SD	16.08	13.02	14.96	16.14	13.33
SD <sub>M</sub>	1.27	.85	.71	1.06	.92

## CHAPTER V

### SUMMARY AND CONCLUSIONS

The primary purpose of this study was to determine the physical fitness of a selected group of students at Montana State University. The study proceeded on the following assumptions; (1) that muscular strength reflects the basic fitness of the body, (2) that the Rogers Strength Test was an adequate measure of body strength, and (3) that the physical fitness index indicated the degree of fitness of the individual. These assumptions are supported in the literature referred to in chapter I.

The Rogers Strength Test, a reduction of the ten test elements used by Dr. Dudley A. Sargent, is made up of seven test items; pull-ups, push-ups back lift, leg lift, right and left hand grips, and lung capacity. The test rates high in validity, reliability and objectivity. The validity is based on high correlation with medical judgments as revealed in the study by Chamberlain and Smiley reported in Chapter II of this study.

The Rogers Strength Test had been continually improved since its development. Notable among the improvements are the development of the 'belt technique' by Hathaway and the establishment of new norms for this revision of the test by

Maskel, Lynch, Laveague and Kelly.

The Rogers Strength Test has been applied in a wide range of uses, Hines and Grimsley in their studies related physical fitness index to the I.Q. of college men, and to the selection of men for employment. The 'measurement project' established by Clarke used the test to select boys for follow-up work and evaluate the changes achieved from participation in the physical education program. Significant results revealed by the Clarke 'project' showed average increases of 12 to 15 points per year in physical fitness during the time the project was in progress. One school after discontinuing the 'project' and abandoning the suggested follow-up program showed a decrease of 8 points in average physical fitness index in one year.

In this study the finding of the physical fitness status gave rise to the sub-problem of considering factors which may influence the individual's achieved status. The author attempted to determine the degree of relationship between time spent in planned physical education experiences and the achieved physical fitness indices. Planned physical education experiences were limited to participation in organized physical education classes and school athletics. The degree of participation was calculated in terms of the reported number of hours as given by the testees on the information sheets.

Standard statistical methods were employed for the analysis of data in this study. The critical ratio technique

was the primary method used, and the .05 level of significance the minimum standard for acceptance.

In the analysis of the physical fitness indices of 442 men in the required physical education program it was found that 81 per cent of those tested scored below the normal score of 100, and that 46 per cent were classified "D", the lowest classification. These results indicate that the majority of those tested tend to have a degree of fitness physically inferior to the considered normal score. To say that they are sub-strength based on this single test would be presumptuous. The author realizes that many factors influence the score as is indicated partially in the review of the literature with reference to the case studies. Motivation, one of the factors, is difficult to obtain in a single study. Having a possible effect was the large number of testers used, which was necessary because of the test scheduling. The results however, are significant to provide a basis for more detailed and complete follow-up studies.

Because the study was limited in the time available for its completion, only the time spent in planned physical education experiences could be considered in analyzing the relationship of planned physical education experiences to the achieved physical fitness index. The study was also limited to considering the time spent in planned physical education classes and school athletics as reported by the testees. Personal interview or a detailed check list of the

physical education programs would increase the validity of the data obtained for the study. The calculation of the data obtained for this study revealed a critical ratio of 1.79, which is considered as not significant. Inasmuch as Clarke's 'measurement project' revealed that physical education programs of a type do tend to increase the fitness status, we cannot completely disregard the role of physical education as an influencing factor in physical fitness. In future studies of this type it is recommended that better methods of collecting data regarding the types of programs and activities participated in, be more completely considered.

Final consideration in the analysis of the data for this study was given to the effect of athletics on both the achieved physical fitness index and the strength index. The criteria used to distinguish between the athlete and non-athlete was the same as used by Rogers and Granger in their reported studies, that being letter-winners and non-letter-winners. In studying the relationship between physical fitness index and athletic participation two statistical methods were employed, the coefficient of correlation and the critical ratio. The attained correlation of .14 was slightly significant, while the ratio of 2.40 was significant at better than the .05 level. This indicates that those persons who participate in school athletics sufficiently to earn an award will tend to achieve higher physical fitness status. This information would give some support for the inclusion of various types of athletic activities in the physical educa-

tion program. Since, in this study, a variety of sports were considered together, future studies might consider each sport separately to determine the degree to which each sport influences the physical fitness index.

The predictability of general athletic ability from the strength index has been previously established by Rogers in a correlation of the strength index with performance in selected track and field skills. The author in considering different sports together attempted to show that sufficient participation in the athletics (enough to win an award) influenced the achieved strength indices. The ratio which resulted was an extremely high 3.26, even better than the ratio of 2.40 with the physical fitness index. This indicated that those who won awards tended to achieve higher strength indices than did those who did not win awards. More research is needed to conclude that participation in athletics increases the strength index.

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APPENDIX A  
TESTING STATIONS AND EQUIPMENT  
INSTRUCTIONS FOR CLASS INSTRUCTOR  
INFORMATION SHEET — ROGERS STRENGTH TEST RECORD FORM  
DIRECTIONS FOR SCORING  
INSTRUCTIONS OF TESTING STATIONS  
TABLE FOR DETERMINING THE HOURS IN PHYSICAL EDUCATION  
TABLE FOR DETERMINING THE HOURS IN SCHOOL ATHLETICS

TESTING ARRANGEMENT AND EQUIPMENT

Station I	Height and Weight	Stadiometer and Scale
Station II	Grip Strength	Hand Dynamometer
Station III	Push-ups (dips)	Parallel Bars
Station IV	Lung Capacity	Wet Spirometer
Station V	Back and Leg Lift	Back and Leg Dynamometer
Station VI	Pull-ups (chins)	Suspended Rings
Station VII	Administration	Table

Station I

Station II

Station III

CLASS AREA

Station IV   Station V   Station VI   Station VII

## INSTRUCTIONS FOR CLASS INSTRUCTORS

### TO BE READ IN CLASS

All students at Montana State University participating in physical education activity classes during winter quarter 1956, will be given a test to determine their physical fitness status as measured by the Rogers Strength Test.

This test will be conducted for each activity section during the next two weeks at regular class sessions. This test is used by many colleges and universities through-out the nation. It is chiefly used for classifying students in terms of physical fitness, in order to place those who receive the "D" classification in special classes. Those who rate better are allowed to elect their own activities.

The test consists of measuring and recording age, weight, arm strength, grip strength, back and leg strength, and lung capacity. The total of these items gives the strength index, which is divided by a normal index for each age and weight, this gives the individual's physical fitness index.

Score sheets have been made for each student, which includes besides the test items provisions for additional information that is necessary for further consideration. (Hand out score sheets -- they are to be filled in at this time.)

Each score sheet has a group number placed on it and certain sheets have the words "group leader" on them. Those persons who have these words on their sheets are the assigned

group leaders for the group also indicated and as such are responsible for that group during the testing. They will record the measurements obtained by the members of their groups as indicated by the testor at each station.

On the day of testing students will report to the east end of the gym floor, where the testing stations will be set up. (There is no need to change into gym clothes for the testing.) At each station there will be a sign with a roman numeral indicating the station number and the group which begins its testing at that station. Each group leader will find the score sheets for the individual at the station which has the same numeral as his group number. Each group will move as a group, with the group leader in charge, from station to station at the direction of the testor at each station.

Absences from testing is the same as an absence from class and will be made up at a future date.

Score sheets will be handed in by the group leaders upon completion of the testing period.

DIRECTION FOR COMPLETING THE SCORE SHEET

Question # 1. Do not count classes in health.

Question # 2. Under the word years, indicate the number of years.

Question # 2b. This means the number of days a week, counting the day of the game as one day.

Question # 3. After you have indicated the number of sports, show the number of years in each sport. Example:  
0, 1, 2, (3) Football 2  
Basketball 1  
Track 1

Indicate the age in terms of years and months.

All answers are either filling in the blanks or by circling the appropriate number.

Varsity athletics does not mean intramural.

## DIRECTIONS FOR SCORING

**Arm Strength:** Arm strength is scored according to the following formula: (pull-ups plus push-ups) x (weight divided by ten, plus, the height minus sixty).

**Strength Index:** The strength index is the total score determined by adding together the scores made on each test item: lung capacity, right grip, left grip, back strength, leg strength, and arm strength.

**The Norm:** The norm charts are based upon sex, weight, and age, the normal score being changed for each two-pound increase in weight and for each half-year increase in age. Instead of interpolating to determine the norm for those individuals between points on the norm chart, the weight above and the age below should be taken.

**Physical Fitness Index:** The physical fitness index is computed from the following formula:

$$\text{PFI equals } \frac{\text{Achieved Strength Index}}{\text{Normal Strength Index}} \times 100$$

## INSTRUCTIONS FOR HEIGHT AND WEIGHT

Measure the height in inches to the nearest one-half inch.

Measure the weight in pounds to the nearest one-half pound.

### INSTRUCTIONS FOR PUSH-UPS (DIPS)

With the parallel bars at shoulder height, the subject stands at the end of the parallel bars and grasps one bar in each hand. The subject jumps to a front support with the arms straight. The subject lowers the body until the angle of the upper arm and forearm are less than a right angle.

The subject pushes up to the front support and continues above as long as possible.

(Four half counts are allowed in this test. Half count: subject does not lower to less than right angle, does not straighten completely to front support, jerking, or kicking on push-ups.)

### INSTRUCTIONS FOR PULL-UPS (CHINS)

Subject stands below rings which are high enough from the floor so that the subjects feet do not touch the floor when performing the test.

The subject hangs from the rings with any grip desired and pulls up until the chin is even with the hands.

Subject lowers to the straight arm hanging position and repeats as many times as possible.

(Four half counts may be given during the test. Half count: not pulling even with the hands and chin level, tipping, swinging, and jerking.)



### INSTRUCTIONS FOR LUNG CAPACITY

Subject should take several deep breaths before blowing into the tube.

Make the fullest possible inhalation and exhale slowly through the tube.

While exhaling slowly bend over the hose until all of the air possible is expelled.

### INSTRUCTIONS FOR THE HAND DYNAMOMETER

The test administrator holds the dynamometer in the right hand between the thumb and forefinger, with the dial down and set at zero.

The subject's right hand (or left hand if testing left grip) is held palm up in the administrator's left hand.

Lower dynamometer, dial down into subject's upturned palm.

The subject closes hand over dynamometer with the thumb overlapping the index finger.

(Note the rounded end of the dynamometer is at the base of the palm.)

After placing the dynamometer as indicated, the subject begins to squeeze with the elbow bent, and while squeezing makes a sweeping downward arc with the arm.

Read and record.

Move pointer back to zero and test the other hand.

### INSTRUCTIONS FOR BACK LIFT

Place the feet parallel, and six inches apart with the center of the feet opposite the chain.

Stand erect with the hands on the thighs and fingers pointing down.

With the dial set at zero, the testor hooks the chain so the bar is level with the finger tips.

The subject grasps the bar firmly with one palm forward and one palm backward. The thumbs clenches the fingers, back slightly bent, head up, and eyes straight ahead.

Maintain the position and pull, nearly straightening the back. Read and record.

### INSTRUCTIONS FOR LEG LIFT

Hold the bar, both hands together in the center, palms down at the junction of thighs and trunk.

Feet parallel, six inches apart with the center of the feet opposite the chain. The legs are bent at 115 to 124 degrees, and the arms and back are straight.

The test administrator places the looped end of the belt over one end of the cross bar. Carry the other end of the belt across the hip around the back just below the waist and loop the free end of belt around the end of the bar tucking the free end under the belt at the hips.

with the arms straight and the subject is in position for the pull or lift.

Be sure the arms are straight, back straight, head erect, and chest up on the leg lift.

Straighten the legs to lift.

Read and record.

TABLE FOR DETERMINING HOURS IN PHYSICAL EDUCATION

Days meeting per week	Number of years of participation	Total number of hours of participation				
		$\frac{1}{2}$	$\frac{2}{3}$	$\frac{3}{4}$	$\frac{5}{6}$	1*
1	1	18	24	27	30	36
1	2	36	48	54	60	72
1	3	54	72	81	90	108
1	4	72	96	108	120	144
1	5	90	120	136	150	180
2	2	72	96	108	120	144
2	3	108	144	162	180	216
2	4	144	192	216	240	288
2	5	180	240	270	300	360
3	3	162	216	243	270	324
3	4	216	288	324	360	432
3	5	270	360	400	450	540
4	4	288	384	432	480	576
4	5	360	480	540	600	720
5	5	450	600	675	750	900

Note: This table is based on a school year or 36 weeks. Fractional parts of an hour not indicated are found by using the nearest division indicated. This table reads as a person participating one day a week for one year, with the length of class period of 30 minutes, participates a total of 18 hours. Combinations which are duplicated are not indicated.

\*Fractional part of an hour's  
scheduled class time                       $\frac{1}{2}$      $\frac{2}{3}$      $\frac{3}{4}$      $\frac{5}{6}$     1

TABLE FOR DETERMINING HOURS IN SCHOOL ATHLETICS

Number of seasons	Number of days per week	Total number of hours of participation				Group I
		1	1½	2	2½ *	
1	5	50	75	100	125	Football
2	5	100	150	200	250	Swimming
3	5	150	225	300	375	Soccer
4	5	200	300	400	500	Gymnastics
1	6	60	90	120	150	Wrestling
2	6	120	180	240	300	(golf) ½
3	6	180	270	360	450	
4	6	240	360	480	600	
<hr/>						
1	5	Total number of hours of participation				Group II
		1	1½	2	2½ *	
1	5	60	90	120	150	Basketball
2	5	120	180	240	300	Hockey
3	5	180	270	360	450	Skiing
4	5	240	360	480	600	(tennis) (Track) ½ (Baseball)
1	6	72	108	144	180	
2	6	144	216	288	360	
3	6	216	324	432	540	
4	6	288	432	576	720	

Note: Because of the varying length of the seasons for the different sports two groups were formed. Group I the consensus length was 10 weeks while Group II the consensus length was 12 weeks. The sports which are indicated as one half had a consensus length one-half of the group in which placed. This table reads as follows: A person who participated for one season, five days a week for one hour would have participated a total of 50 hours for a group I sport or 60 hours for a group II sport.

\*Reported number of hours of session 1 1½ 2 2½

\*Reported number of hours of session 1 1½ 2 2½