EVALUATION AND ESTABLISHMENT OF NORMS IN FOUR HEALTH-RELATED AREAS OF PHYSICAL FITNESS FOR HIGH SCHOOL SOPHOMORES AND JUNIORS

by

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INTRODUCTION

Physical fitness is rapidly becoming a major concern of countries throughout the world. An ever increasing sedentary life style in the United States has brought with it a decreasing level of physical fitness. This was pointed out markedly by a large percent of young males failing physicals during World War II. Also in a study conducted by Kraus and Weber[1] it was pointed out that the strength and flexibility levels of school age children ages six through sixteen in the United States was far below levels of other countries. Another study conducted using the American Association of Health Physical Education and Recreation Test found that the mean test scores were 24 percent higher for British boys and girls than were the United States counterparts.[2]

No one aspect of man's physical condition has become more prominent than the aspect of body weight. Not only has the appearance factor of too much body fat become of great importance to the American public, but the discovery of many physical problems associated with body fat has opened many avenues into causes of diseases. Overabundance of body fat is now one of the major causes of degenerate diseases of the heart. Degenerative heart disease overshadows all other causes of death in this country.[3]

A large proportion of most testing has dealt with skill-related fitness which includes the areas of speed, power, balance, agility, coordination, and

reaction time.[4] Although skill-related fitness is essential to the total well being of man, there are other aspects which are basic to a healthy existence. These areas are the health-related aspects of fitness which include strength, flexibility, muscular endurance, cardiovascular endurance, and power.[5] This study concerns three of these areas, strength, flexibility and cardiovascular endurance. A fourth area, body fat, is included as an aspect of fitness.

Research has found that negligence of the health-related aspects of physical fitness leaves man more susceptible to hypokinetic diseases.[6] Nevertheless, the major emphasis in the public school physical education testing programs concerns skill-related aspects of physical fitness.

PURPOSE

The purpose of this study was twofold: (1) to determine the levels of health-related fitness for a group of fifty sophomores and a group of fifty juniors enrolled in physical education classes at Manhattan Senior High, and (2) to establish norms for the evaluation of the effectiveness for this class for future classes at Manhattan Senior High.

LIMITATIONS OF STUDY

The participants in the study were not classified in homogeneous groups according to chronological age. The participants were classified according to their academic classification of sophomore or junior. In the sophomore group there were 15 through 17 year-olds, with the majority being 16 years old. In the junior group there were 16 through 18 year-olds, with the majority being 17 years old.

Another limiting factor in regards to the physical education requirements was that of requiring physical education only through the sophomore year; therefore, the juniors tested were those taking physical education as an elective class. Also, no calibration check was run on the strength testing apparatus because of its previous use in testing in the physical education research laboratory. This type of apparatus requires infrequent calibration.

In spite of the stated limitations, the collected data should be of significant value for a comparative analysis of future physical education classes at Manhattan Senior High School. The data also has value as a method of classification for other groups of sophomores and juniors under the same physical education requirements.

DEFINITION OF TERMS

Cardiovascular Endurance:	The ability to sustain a series of repetitions of an activity without unduly taxing the physiological systems that furnish fuel and oxygen to the muscles.
Flexibility:	The ability of a joint to move through 100 percent of its possible movement range.
Obesity:	An overfat condition, usually considered as having more than 20 to 25 percent of the body content as fat.
Strength:	The amount of external force which a muscle can exert.

Footnotes

[1] H. Hirschland and Hans Kraus, "Minimum Muscular Fitness Tests in School Children," Research Quarterly,

[2] Hans Kraus and W. Raab, Hypokinetic Disease (Springfield: Charles C. Thomas Publisher, 1961), p. 31.

[3] Kraus and Raab, pp. 131-39.

[4] C. B. Corbin and others, Concepts in Physical Education (Dubuque: Wm. C. Brown Company Publishers, 1970), p. 4.

[5] Ibid.

[6] Kraus and Raab, pp. 3-5.

Chapter 2

REVIEW OF LITERATURE

The material presented in this section was selected in order to present a brief review of some of the studies that have been conducted on the establishment of norms in the four health-related areas of cardiovascular efficiency, body fat, strength, and flexibility.

The majority of norms that have been established have resulted from physical fitness tests such as the American Association of Health, Physical Education and Recreation[7] test and the Kraus-Weber[8] test of minimal physical fitness. The popularity of this type of testing is exemplified by two masters reports completed at Kansas State University. One, in 1957 by Atkinson, reports the American Association of Health, Physical Education and Recreation physical fitness test was administered to sixty-five ninth grade boys at the Cherokee County Rural High School in Kansas.[9] The second report was completed in 1966 by Goodpaster. Again, the American Association of Health, Physical Education and Recreation physical fitness test was used. Goodposter administered the test to seventh and eighth grade boys in Riley County, Kansas.[10] Both reports established norms. There are numerous studies of this nature that appear in the literature but were deemed unnecessary to mention because of the insignificance of the norms established by them to the norms established by this report.

CARDIOVASCULAR EFFICIENCY

In 1948 Larson established norms for the McCurdy-Larson Organic Efficiency Test. The subjects used for the test were soldiers and fliers from eighteen to twenty-four years of age. The test included categories of pulse rate, pulse pressure, breath-holding, and vital capacity.[11]

Cooper, an outstanding authority on aerobics, established norms using the Twelve Minute Run.[12] These norms are geared toward the adult population. Also, the Twelve Minute Run is not considered to be as good a test as the Harvard Step Test. This opinion is expressed by professionals due to the motivational factors and the inexperience of many of the subjects in distance running.

Astrand presents cardiovascular efficiency norms which were established with the bicycle ergometer. The norms presented are for ages twenty through sixty-five.[13] This type of testing involves expensive laboratory equipment and limits the number of subjects tested per test. These limitations make this type of test impractical for high school physical education use. In a study conducted by Rose at Kansas State University in 1972, norms were established for cardiovascular efficiency using the bicycle ergometer. The study consisted of approximately one hundred university male and female faculty members, ranging in age from twenty-two to sixty-five.[14]

In 1969 Montoye and others established norms using a modification of the Harvard Step Test. The modifications consisted of stepping onto an eight inch bench for three minutes at the rate of twenty-four (four-count sequences) per minute. Heart rate was measured by an electrocardiogram and recorded while the subject was reclining, sitting, and standing before exercise, during exercise, and for five minutes after exercise while sitting. The subjects

used for establishing the norms were residents of Tecumseh, Michigan, with ages ranging from pre-adolescent to adult.[15]

Corbin, Dowell, Lindsey and Tolson developed norms in 1970 using the Harvard Step Test. Norms for both men and women were established using college freshmen as subjects.[16]

After reviewing the literature on norms for cardiovascular efficiency, one can see that effort needs to be exerted to establish norms for high school age subjects. These norms should be established using test procedures adaptable to physical education classes, such as the Harvard Step Test.

BODY FAT

Much of the early work done in the area of body composition was done with anthropometric measures such as height and weight. These early measures resulted in the height and weight charts such as the one developed by the Metropolitan Life Insurance Company.[17] The inadequacy of the height and weight chart is readily seen. For example, an individual with a high total body weight having a high percentage of lean body mass would be considered overweight by the height and weight charts. Vice versa, an individual with a low total body weight and a high percentage of fat would be considered underweight by the height and weight charts.

Skinfold measurements are much more accurate in predicting the percentage of body fat. A study conducted by Thompson and others in 1956 used three skinfold measurements: the chest, abdomen, and the triceps. The authors tested male basketball players and hockey players before and after season. Measurements were taken with a Vernier caliper and the changes recorded.[18]

A similar study was conducted in 1968 by Lundgren, using college women basketball players and field hockey players. The changes from pre-season to post-season were recorded.[19]

In 1962, Piscopo conducted a study to establish skinfold percentile norms of ten through twelve-year-old preadolescent boys from three ethnic groups. The Harpenden skinfold caliper was used and five skinfold measurements were taken.[20]

Jean Mayer and C. C. Seltzer in 1965 established a table of obesity standards in Caucasian Americans. Subjects were male and female, with ages ranging from five through fifty. The *triceps skinfold measurement* was used as the evaluating criteria.[21]

In 1970, Corbin and others established body fat norms for men and women. The subjects used were college age freshmen. Individual statistics for men were interpreted with Consolzio's Nomogram for conversion of skinfold thickness to specific gravity and percentage of fat in young men.[22] Individual statistics for women were interpreted with the Nomogram, prepared by Irene Paul.[23] Skinfold measurements were taken with the Lang caliper.

Other studies which are significant to this report but which are not dealt with in depth are as follows: a study by Orpin and Scott concerning the estimation of total body fat using skinfold caliper measurement;[24] a study by Crook and others concerning the evaluation of skinfold measurements and a weight chart to measure body fat, using 235 male subjects;[25] a study by Merron using Vermont adolescents to determine tricep skinfold thickness;[26] and Durnin and Rahaman's study to determine skinfold thickness and body density, involving 105 young men and women and eighty-six adolescent boys and girls.

Upon reviewing the literature on body fat, it is evident that norms for the high school age individual using reliable measuring procedures such as skinfold measurements are lacking. The skinfold procedure used in this report is practical for physical education classes.

FLEXIBILITY

Cureton was one of the first to develop standardized flexibility tests. Up to 1941, Cureton's four flexibility tests were considered to be the best standardized tests for which norms had been established. The four tests were trunk flexion, trunk extension, shoulder elevation, and ankle flexibility.[28]

In 1952, Wells and Dillion administered the Wells Sit and Reach Flexibility Test and the Standing-Bobbing Test to one hundred students at Wellesley College. Norms established were for college age students.[29]

One hundred and fifty-eight elementary boys were tested by Mathews, Shaw and Wood in 1959. These boys were measured on two hip flexibility tests and several anthropometric measures. The primary purpose of this study was to determine the relationships among the flexibility tests in the anterio-posterior plane and the selected anthropometric measures. The study also revealed that 46.8 percent of the subjects failed the Wells Sit and Reach Test.[30]

In 1957, Leighton established flexibility means and standard deviations for a group of fifty sixteen-year-old California boys. Norms were established in thirty joint movements using a flexometer.[31]

The Kraus-Weber test of minimum physical fitness has been used extensively to measure flexibility. It is one measure of flexibility measured on a pass-fail system and is of no significance to this report.[32]

Corbin and others established flexibility norms using Fleischman's Static Upper Trunk Flexibility Test, Shoulder Flexibility Test, and the Dynamic Flexibility Test. Also used was the Wells Sit and Reach Test. These norms were established at Texas A. and M. using college freshman men and women.[33]

Rose also established flexibility norms in his 1972 masters report.[34]

The literature again reveals a need for the development of norms in the health-related area of flexibility for the secondary level.

STRENGTH

In 1901, Smedley established grip strength norms using the Smedley style dynomometer. In the Smedley study, 2788 boys and 3471 girls were tested. Ages ranged from four through eighteen. Subjects tested were in the Chicago Public Schools.[35]

Baldwin in 1921 established grip strength norms using the Smedley style dynomometer. Sixty boys and sixty girls ranging in age seven through seventeen were tested in the New York City private schools.[36]

Meredith in 1935 also established grip strength norms using the Smedley style dynomometer. Meredith tested 4999 boys, ages ranging from three to eighteen years, in Iowa City private schools.[37]

In 1941, Stafford, a professor of physical education at the University of Illinois, established norms for college freshmen using the Larson Chinning, Dipping and Vertical Jump Test.[38]

Bookwalter in 1950 established grip strength percentile norms for men ages nine through twenty-four. The norms were presented in three areas: age, weight, and a classification index. No effort was made to indicate a good or

a poor rating. The data for the study was collected from the states of Colorado, Illinois, Indiana, Kentucky and Missouri.[39] Aspects of the study were undertaken by several authors at different times. It was felt by Bookwalter that a sufficient sample was involved to give stability to the scales.

Norms were also established by Montpetit, Montoye and Leading. Norms for height, weight, and grip strength were established. Males and females ranging from eight through seventeen were used as subjects. The better score with either hand was recorded.[40]

Corbin and others developed norms for grip strength, leg strength, and back strength. The subjects used were college freshman, men and women, at Texas A. and M. The Smedley style grip dynomometer and the back and leg dynomometer were used to record the data.[41]

Rose, in his study at Kansas State University, established norms for grip strength, leg strength, and back strength. Norms were established for both men and women. Subjects were one hundred faculty members, with ages ranging from twenty-two to sixty-five.[42]

Two other studies bearing significance to this study concerning the establishment of norms are as follows: Bitcon established norms for a four item physical fitness test for high school boys and percentile tables were constructed for grades nine through twelve using 2054 male subjects from Iowa high schools;[43] the other study by Crawford established physical fitness norms for fifteen-year-old boys and girls using 8176 subjects from the Virginia schools.[44]

Upon reviewing the literature on strength norms, it is evident that most of the norms established have been for elementary age individuals or for college age individuals. More research has been done in the area of strength

than the other areas of health-related fitness.

In summary, it was found that relatively few norms have been established using high school age subjects. The norms established in a single study were usually in only one area of health-related fitness, making a comparison of a battery of health-related tests difficult.

Footnotes

[7] Charles B. Corbin, Becoming Physically Educated in the Elementary School (Philadelphia: Lea and Febiger, 1971), pp. 355-67.

[8] Ibid., pp. 345-46.

[9] R. Atkinson, "An Analysis of Physical Fitness Program in Cherokee Rural High School" (unpublished Master's report, Kansas State University, 1957).

[10] L. Goodpaster, "A Study of Physical Fitness of Seventh-Eighth Grade Boys of Unified School District #378, Riley County, Kansas" (unpublished Master's report, Kansas State University, 1965).

[11] L. A. Larson, "Cardio-Respiratory Items," Research Quarterly, 19:290, December, 1948.

[12] K. H. Cooper, The New Aerobics (New York: M. Evans and Co., 1970).

[13] Per-Olg Astrand, M.D., Work Tests with the Bicycle Ergometer (Stockholm: Dept. of Physiology, Gymnastiska Central Institute).

[14] K. Rose, "Measurement and Testing of an Adult Fitness Class" (unpublished Master's report, Kansas State University, 1972).

[15] J. H. Montoye and others, "Heart Rate Response to a Modified Harvard Step Test," Research Quarterly, 40:153, March, 1969.

[16] C. B. Corbin and others, Concepts in Physical Education (Dubuque: Wm. C. Brown Co., 1971).

[17] Metropolitan Life Insurance Co., 1 Madison Ave., New York.

[18] C. W. Thompson, E. R. Buskirk, and R. F. Goldman, "Skinfold Measurements of Body Fat in Basketball Players and Hockey Players," Research Quarterly, 27:418, December, 1956.

[19] H. M. Lundgren, "Changes in Skinfold and Girth Measures of Women Varsity Basketball and Field Hockey Players: Pre-season, Post-season Test," Research Quarterly, 39:1, December, 1968.

[20] J. Piscopo, "Skinfold and Other Anthropometrical Measurements of Preadolescent Boys from Three Ethnic Groups," Research Quarterly, 33:255, May, 1962.

[21] Jean Mayer, Overweight, Causes, Cost, and Control (Englewood Cliffs: Prentice-Hall Publishers, 1968), p. 34.

[22] C. F. Consolazio, Physiological Measurements of Metabolic Functions in Man (New York: McGraw Hill, 1963), p. 307.

[23] Corbin and others, Concepts in Physical Education, p. 170.

[24] M. J. Orpin and P. J. Scott, "Estimation of Total Body Fat Using Skinfold Caliper Measurements," Nutrition Abstracts and Reviews, 26:07:3741.

[25] G. H. Crook and others, "Evaluation of Skinfold Measurements and Weight Chart to Measure Body Fat," Nutrition Abstracts and Reviews, 37:02:3067.

[26] S. B. Merrow, "Triceps Skinfold Thickness of Vermont Adolescents," Nutrition Abstracts and Reviews, 38:02:3237.

[27] J. V. G. A. Durnin and M. M. Rahaman, "Skinfold Thickness and Body Density," Nutrition Abstracts and Reviews, 38:02:3229.

[28] T. K. Cureton, "Flexibility as an Aspect of Physical Fitness," Research Quarterly, 12:381, May, 1941.

[29] K. F. Wells and E. K. Dillion, "Test of Back and Leg," Research Quarterly, 23:115, March, 1952.

[30] D. K. Mathews, V. Shaw, and J. B. Wood, "Hip Flexibility and Elementary School Boys as Related to Body Segments," Research Quarterly, 30:295, October, 1959.

[31] D. K. Mathews, Measurements in Physical Education (Philadelphia: W. B. Saunders Co., 1963), p. 274.

[32] Corbin, Becoming Physically Educated in the Elementary School, pp. 345-6.

[33] Corbin and others, Concepts in Physical Education.

[34] Rose, "Measurement and Testing of an Adult Fitness Class."

[35] E. Metheny, "The Present Status of Strength Testing for Children of Elementary School and Pre-school Age," Research Quarterly, 12:115, 1941.

[36] Ibid.

[37] Ibid.

[38] R. T. Stafford, "The Larson Chinning, Dipping and Vertical Jump Test," Research Quarterly, 12:291, May, 1941.

[39] K. W. Bookwalter, "Grip Strength for Males," Research Quarterly, 21:249, October, 1950.

[40] R. R. Montpetit, H. S. Montoye, and L. Leading, "Grip Strength of School Children, Saginaw, Michigan: 1899 and 1964," Research Quarterly, 39:231, May, 1967.

[41] Corbin and others, Concepts in Physical Education.

[42] Rose, "Measurement and Testing of an Adult Fitness Class."

[43] L. E. Bitcon, "Establishment of Norms for a Four Item Physical Fitness Test for High School Boys" (unpublished Doctor's dissertation, University of Arkansas, 1965), p. 7.

[44] C. W. Crawford, "Establishment of Physical Fitness Norms for 15-year-old Boys and Girls" (unpublished Doctor's dissertation, University of Virginia, 1961).

Chapter 3

PROCEDURE

All tests were administered in the high school gymnasium by experienced personnel. The subjects were tested in four different areas: strength, flexibility, cardiovascular endurance, and body fat. Subjects were tested between 9:30 A.M. and 11:30 A.M. during their regular class period.

SUBJECTS

The subjects consisted of high school male students academically classified as sophomores and juniors. The total number of subjects tested included fifty sophomores and fifty juniors. Sophomore subjects were students required to enroll in physical education, while junior subjects were students taking physical education as an elective course. The classes tested were selected at the instructor's convenience.

At the beginning of the regular class period subjects were presented an instructional demonstration on proper technique and testing procedures, then subjects were tested in the following order: strength, body fat, flexibility and cardiovascular endurance.

Strength

Strength testing consisted of four tests: right and left grip strength, leg strength and back strength. Grip strength was measured by using the Smedley hand dynomometer. Subjects were instructed to start with the right

hand and adjust the handle to fit the grip. Then with the arm hanging at the side, the subject was instructed to grip the dynomometer with 100 percent effort without allowing the arm to exceed a 90 percent angle and without allowing the elbow or forearm to touch the body. Back and leg strength was measured with the back and leg dynomometer. Leg strength was tested first. Subjects were instructed to stand with the toes at the front edge of the platform, keep the head up, keep the back straight, flex at the knees and grasp the bar with a mixed grip. From this position the subjects were instructed to apply as much pressure as possible to the bar, using only the legs.

In testing back strength the subjects were instructed to lock the legs, round the shoulders, slightly round the back and grasp the bar with a mixed grip. From this position the subjects were instructed to apply as much pressure as possible to the bar by rolling the shoulders back and extending the chest without bending the knees.

The total strength score could have been affected because neither wrist straps nor a belt was used in testing the back and legs. Although this might be a limiting factor as to the total strength score, it is felt by the author that the results are adequate for comparative analysis. The four strength test scores were then totaled and divided by the subjects' body weight to determine strength per pound body weight.

Body Fat

Percent body fat was determined by taking three skinfold measurements using the large skinfold calipers. Measurements were taken halfway between the acromion and olecranon process on the right arm, two inches to the right of the navel, two inches to the right and two inches above the right nipple.

The three measurements were then plotted on Consolazio's Nomogram[45] for the determination of body fat for men.

Flexibility

Only one area of flexibility was tested, that of hip flexibility. This was done using a modification of the Wells Sit and Reach Bench,[46] the modification being an adjustment of the lowest possible reading from eleven to six inches. Subjects were instructed to sit with feet flat against the bench and legs straight. From this position the subjects were to slowly lean forward as far as possible and hold for one second. The score was recorded at the furthest point reached with the finger tips.

Cardiovascular Endurance

The Harvard Step Test[47] was used to measure cardiovascular endurance. Subjects were instructed to step up and down on a twenty-inch bench at a certain rate. This sequence was repeated for a duration of five minutes or the subject's personal limit. At the discontinuation of exercise the subjects were instructed to sit. After a one minute rest period the pulse rate was recorded for a thirty second duration. Using a combination of the total heart beats for the thirty second period and the duration of effort, the score was plotted on Consolazio's table.[48]

Statistical Procedure

Personal information and the test scores were recorded on individual data sheets (Appendix A). The percentile scores used in the report are the results of computer calculations. The mean and standard deviation were also compiled through use of the computer (Appendix B).

Footnotes

[45] C. F. Consolazio, Physiological Measurements of Metabolic Functions in Man (New York: McGraw Hill, 1963), p. 307.

[46] Donald Mathews, Measurements in Physical Education (Philadelphia: W. B. Saunders Co., 1963), p. 28.

[47] C. B. Corbin and others, Concepts in Physical Education (Dubuque: Wm. C. Brown Company Publishers, 1970), p. 183.

[48] Consolazio, Physiological Measurements of Metabolic Functions in Man, p. 384.

Chapter 4

RESULTS

For each of the tests given, percentile tables were constructed using 10 percent intervals. No attempt was made to assign desirable levels of fitness, for this was not the purpose of this study.

Table 1 shows the percentile scores for percent body fat. The 90th through 100th percentile scores were higher for the sophomore group. This could be due to the rapid growth experienced by many during this age. However, from the 30th percentile through the 80th percentile scores sophomores ranked below the juniors. Maturation and muscle development may account for this on the part of the juniors. The 10th through the 20th percentile scores were again greater for the sophomore group. Mean score for the sophomore group was 6.98 and the mean for the junior group was 7.44.

Percentile scores for cardiovascular endurance are shown in Table 2. Percentile scores for the sophomore group ranked above the junior group at all levels except the 100th percentile. This was due to the fact that one junior subject scored extremely high on the cardiovascular test. The sophomore group's mean score was 84.54, and the junior group's mean was 78.64.

Table 3 shows percentile scores for hip flexibility. The sophomores' percentile scores were higher than the juniors' scores from the 60th through 100th percentiles. From the 10th through the 50th percentiles the sophomores scored lower than the juniors. Mean score for the sophomore group was 9.18,

Table 1

Body Fat

Sophomore Percentile	Percent Body Fat	Junior Percentile
100	1.50	
	3.00	100
90	3.20	
	3.95	90
	4.10	80
80	4.40	
	4.70	70
	4.95	60
70	5.05	
60	5.30	
	5.60	50
50	5.80	
	6.10	40
40	7.20	
	7.50	30
30	8.20	
20	9.00	
	9.50	20
10	11.80	
	14.00	10

Table 2

Cardiovascular Endurance

Sophomore Percentile	Cardiovascular Endurance Score	Junior Percentile
	116.00	100
100	105.00	
90	98.00	
	96.00	90
80	93.00	
70	90.00	80
60	86.00	
	85.00	70
50	83.00	
40	81.00	60
30	77.00	50
	75.50	40
20	75.00	
	73.50	30
10	72.00	
	70.00	20
	65.00	10

Table 3

Hip Flexibility

Sophomore Percentile	Flexibility Score (Inches)	Junior Percentile
100	16.50	
	13.50	100
90	13.25	
	12.50	90
80	12.25	
	11.70	80
70	11.40	
	11.30	70
60	10.50	
	10.20	60
	9.75	50
50	9.70	
40	9.40	40
	8.25	30
	7.60	20
30	7.20	
	6.70	10
20	6.40	
10	3.80	

and the mean score for the junior group was 9.54. It is generally accepted that the younger an individual is the more flexible he is, but not so in this study. The concentrated effort on strength building in the sophomore curriculum without an equal concentration in the area of flexibility is thought to be the reason for the sophomores' being less flexible than the juniors.

Percentile scores are shown for right grip strength in Table 4. Table 4 shows the juniors scoring higher from the 70th percentile through the 100th percentile. The sophomores scored higher from the 40th percentile through the 60th percentile. The juniors again scored higher from the 10th through the 30th percentiles. Mean score for the sophomores was 106.08, with a mean of 108.80 for the juniors.

Table 5 shows percentile scores for left grip strength. The sophomore percentiles 40 through 100 were higher than for the juniors. Junior percentiles 10 through 30 were higher than those of the sophomores. Mean scores were 101.28 for the sophomores and 102.94 for the juniors. The two grip strength tables show a normal maturation trend, the older juniors being stronger. This could be due to the fact that the strength program in the sophomore classes specifies no grip strength exercise.

Percentiles for leg strength are shown in Table 6. Sophomore percentiles 50 through 100 were higher than those of the juniors. Junior percentiles were higher from the 20th through the 40th percentiles, with the 10th percentile being equal. Mean score for the sophomores was 361.39, with a mean of 359.25 for the juniors. Again the emphasis on strength in the sophomore curriculum enabled the younger group to outscore the juniors.

Percentile scores for back strength are shown in Table 7. The 100th, the 50th through the 80th, and the 10th through the 20th percentiles were

Table 4

RIGHT GRIP STRENGTH

Sophomore Percentile	Right Grip Score (Pounds)	Junior Percentile
	158	100
100	156	
	132	90
90	128	
	123	80
80	119	
	118	70
70	117	
60	115.5	
	110	60
50	109	
40	105	50
	101	40
	98	30
	95	20
30	93	
20	88	
	86	10
10	53	

Table 5

LEFT GRIP STRENGTH

Sophomore Percentile	Left Grip Score (Pounds)	Junior Percentile
100	163	
	160	100
90	121.5	
80	119	90
70	114	80
	110	70
60	108	
	104.5	60
50	103	
	101	50
40	98.5	
	96.5	40
	94	30
30	88	20
20	80	
	79	10
10	70	

Table 6

LEG STRENGTH

Sophomore Percentile	Leg Strength Score (Pounds)	Junior Percentile
100	616	
	628	100
90	480	
80	462	90
	429	80
70	394	
	390	70
60	375	
	364	60
50	355	
	351.5	50
	340	40
40	310	30
	285	20
30	280	
20	250	
10	235	10

Table 7

BACK STRENGTH

Sophomore Percentile	Back Strength Score (Pounds)	Junior Percentile
100	550	
	495	100
	396	90
90	390	
80	380	
70	350	80
	327.3	70
60	319.5	
	312.5	60
50	308	
	309	50
	292.5	40
40	286	
	270	30
30	265	
20	240	
	232	20
10	217.5	
	212.5	10

higher for the sophomores, with the juniors scoring higher in the 90th, and the 30th through the 40th percentiles. Mean score for the sophomore group was 313.20, with 307.39 for the juniors.

Table 8 shows percentile scores for total strength. The sophomore group scored consecutively higher from the 40th through the 100th percentiles. Juniors scored higher in the lower 10th through the 30th percentiles. The low-scoring juniors out-scoring the low-scoring sophomores was probably due to a slow maturation factor for a small number of sophomores. Mean score for the sophomore group was 881.12, and 875.00 was the mean for the juniors.

Percentiles for strength per pound body weight are shown in Table 9. This was the only area in which sophomores scored higher at all percentile levels. This table takes away all maturation factors and shows the true effectiveness of a strength building program. Mean score for the sophomore group was 6.12, and mean score for the junior group was 5.75.

DISCUSSION

The boys' physical education curriculum was discussed with staff members at Manhattan High School. Through this discussion it was found that only sophomores were required to enroll in physical education. Concerning the sophomore curriculum, it was also found that a strong emphasis was placed on all health-related aspects of physical fitness except flexibility. The junior curriculum emphasized more strongly the development of skill. Appendix C includes the sophomore physical education curriculum outline as an example of an effective program in building cardiovascular endurance and strength.

In comparison to norms established by other studies, the norms established in this study were found to be higher than those for the general popu-

Table 8

TOTAL STRENGTH

Sophomore Percentile	Total Strength Score (Pounds)	Junior Percentile
100	1485	
	1306	100
90	1105	
	1077	90
80	1021	
	989	80
70	983	
	940	70
60	938	
	913	60
50	890	
	870	50
40	845	
	840	40
	810	30
30	756	
	729	20
20	678	
	618	10
10	615	

Table 9

STRENGTH PER POUND BODY WEIGHT

Sophomore Percentile	Strength/lbs. Score	Junior Percentile
100	8.50	
	7.90	100
90	7.20	
	7.05	90
80	6.85	
	6.55	80
70	6.60	
60	6.20	
	6.10	70
50	6.05	
	5.95	60
40	5.85	
	5.75	50
30	5.65	
20	5.45	40
	5.25	30
10	5.00	
	4.80	20
	4.45	10

lation. This is quite apparent when comparing the 50th percentiles of the norms established by this author with the average classifications of previously established norms by Corbin, using college freshmen as subjects.

The 50th percentile score for body fat was 5.80 percent for sophomores and 5.60 percent for juniors, as compared to a 10.50 percent average established by Corbin using college freshmen as subjects. This would imply that between the junior year in high school and the freshman year in college there is a significant deposition of adipose tissue. Also implicated is that the high degree of fitness in relation to percent body fat for the sophomores and juniors is above the excellent rating established by Corbin.

The cardiovascular endurance 50th percentile score was 83.00 for the sophomores and 77.00 for the juniors. The average norm established by Corbin was 69.00. This suggests that the subjects attain their maximum cardiovascular endurance at approximately sixteen years of age and then progressively decrease.

The 50th percentile score for hip flexibility was 9.70 inches for sophomores and 9.75 inches for juniors. The average for Corbin's college freshmen norms was 12.00 inches. It is generally accepted that the older an individual becomes the less flexible he will be, however this comparison of norms does not show this to be true. A possible explanation could be the emphasis on strength building with the exclusion of flexibility development, thus decreasing the subjects' natural flexibility. In noting the increase in flexibility from the strength program during the sophomore year to the skill development during the junior year, the preceding statement would appear to be true.

Right and left grip 50th percentile scores fell considerably below Corbin's college freshmen norms. As previously stated, no specific exercises

were contained in the strength building program. The increasing grip scores with age would indicate normal maturation as the controlling factor of grip strength.

The 50th percentile score for leg strength was 355 pounds for sophomores and 351.5 pounds for juniors. The average classification for college freshmen as established by Corbin was 445 pounds. The difference of only 100 pounds between the sophomores and the college freshmen would indicate highly fit sophomores and juniors in relation to leg strength.

The average back strength score for college freshmen was 243 pounds. The 50th percentile scores for sophomores and juniors were 308 pounds and 309 pounds, respectively. The sophomores and juniors scored slightly below the excellent classification for college freshmen. This points out the high level of strength fitness of the subjects tested.

The sophomores' and juniors' total strength scores were significantly lower compared to the college freshmen norms, due to the lower grip strength score previously mentioned.

The 50th percentile scores for strength per pound body weight were 5.95 for sophomores and 5.75 for juniors. The average classification for college freshmen was 5.83. Once again the effectiveness of the strength building program was shown.

General results showed a slightly higher fitness level for the sophomore group except in two areas, flexibility and grip strength, a possible explanation being the exclusion of flexibility exercises and grip strength exercises in the sophomore program. Thus, the juniors would have a year's maturation to develop a stronger grip and a year to regain natural flexibility lost in the sophomore strength program.

The norms established by this study are atypical norms due to the following reasons: (1) the physical education curriculum was geared specifically to develop cardiovascular endurance and strength, and (2) the norms established were higher in most cases than those established for college freshmen by Corbin.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

It was the purpose of this study (1) to determine levels of health fitness for a group of male sophomores and a group of male juniors enrolled in physical education classes at Manhattan Senior High School, and (2) to establish norms for the evaluation of the effectiveness of the class on health-related conditions of the subjects involved.

One hundred subjects participated in the study. Subjects were classified into two groups of fifty, according to their academic classification as sophomores or juniors.

Tests were determined in four areas to determine levels of health-related fitness. Areas tested were cardiovascular endurance, body fat, flexibility, and strength. The Harvard Step Test was used to determine cardiovascular endurance, the Lang skinfold caliper was used for the determination of body fat, the Wells Sit and Reach Bench was used for determination of hip flexibility, and dynomometers were used to determine right and left grip strength, back and leg strength, and per pound body strength.

Test results were calculated through the use of a computer, and made to establish percentile scores for each group for all tests. Analysis of the results revealed an unexpected trend, with the sophomores scoring higher in all categories except grip strength and hip flexibility.

CONCLUSIONS

The following conclusions were reached on the basis of the data compiled:

1. Emphasis is needed on the development of flexibility in the sophomore curriculum.
2. Emphasis is needed on the development of back and leg strength and cardiovascular endurance in the junior curriculum.
3. All aspects of health-related fitness, with the exception of flexibility and grip strength, are inadequate for the junior group.
4. All aspects of health-related fitness, with the exception of flexibility, are adequate for the sophomore group.
5. The junior group may not be a typical group since enrollment was not required.
6. The norms established were higher than those for a general population.

RECOMMENDATIONS

The following recommendations were based on the review of literature, statistical analysis, and conclusions.

1. Levels of desirability should be established for both sophomore and junior groups in all tests.
2. Further testing should be done before using data compiled on the junior group for evaluation of future groups.
3. Future testing should be done using the compiled data for the sophomore group as criteria for evaluation of future sophomore groups.

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APPENDIX A

FITNESS DATA SHEET

Date _____

Name _____ Age _____ wt _____

Harvard step test HR _____ MO _____

Body fat TR _____ CH _____ AB _____ % _____

Flexibility (static) Hip _____ Trunk _____

Strength RG _____ LG _____ Leg _____ Back _____

TOTAL _____ P/lb. _____

NOTES:

APPENDIX B

STANDARD DEVIATION AND MEAN

STANDARD DEVIATION AND MEAN

Test	Mean		Standard Deviation	
	Sophomore	Junior	Sophomore	Junior
Body Fat	6.98	7.44	3.48	5.22
Cardiovascular	84.54	78.64	9.44	16.37
Hip Flexibility	9.18	9.54	3.69	2.54
Right Grip	106.08	108.80	20.76	18.03
Left Grip	101.28	102.94	21.40	19.46
Leg Strength	361.39	359.26	101.57	79.13
Back Strength	313.20	307.39	79.53	69.24
Strength/pounds	6.12	5.75	1.01	0.97
Total Strength	881.12	875.00	196.32	171.59

APPENDIX C

TENTH GRADE PHYSICAL EDUCATION CURRICULUM

TENTH GRADE PHYSICAL EDUCATION CURRICULUM

Activities	Date
Orientation & Military Drill	8/25 - 8/27
Flag Football	8/30 - 10/8
Wrestling & Weight Training (Alternating)	10/11 - 11/26
Basketball	11/29 - 1/14
Volleyball	1/17 - 2/18
Gymnastics & Weight Training (Alternating)	2/21 - 4/21
Soccer & Softball	4/24 - 5/29

Note: The following exercises are done at the beginning of each class period:

Ten sets of 10 to 18 push-ups

Ten sets of 10 to 18 squat thrusts

Forty jumping jacks

Twenty toe-touch

Twenty sit-ups

All exercises are done with 5 to 10 second intervals between each set.

EVALUATION AND ESTABLISHMENT OF NORMS IN FOUR HEALTH RELATED AREAS OF PHYSICAL FITNESS FOR HIGH SCHOOL SOPHOMORES AND JUNIORS

by

CLYDE CHARLES ALBRIGHT

B. S., Kansas State University, 1969

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Physical Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1972

There are areas of physical fitness which have been proven to be directly related to the healthy existence of man. These areas are those of health-related fitness which includes cardiovascular endurance, flexibility, muscle strength, muscle endurance and power. Percent body fat was included by the author as another area of health-related fitness.

The purposes of this study were to (1) determine levels of health-related fitness of a group of fifty male sophomores and fifty male juniors enrolled in physical education classes at Manhattan Senior High School; and (2) establish norms for the evaluation of the effectiveness of the class.

One hundred male subjects from Manhattan Senior High School physical education classes were tested in four areas of health-related fitness, cardiovascular endurance, percent body fat, flexibility, and strength. Tests used included: the Harvard Step Test for cardiovascular endurance, dynamometer test for strength, skinfold measurements for percent body fat, and the Wells Sit and Reach Test for hip flexibility.

Results were presented by means of percentile tables. Analysis revealed that the sophomores outscored the juniors on all tests except grip strength and flexibility. Reasons were as follows: (1) the sophomores were required to enroll in physical education, the juniors were not; (2) the sophomore program was geared toward cardiovascular endurance and strength; and (3) the sophomore program failed to include flexibility exercises.