A STUDY OF PHYSICAL FITNESS NORMS FOR THE WOMEN AT AUSTIN PEAY STATE UNIVERSITY AND THE RELATIONSHIP OF HEIGHT, WEIGHT, AND PERFORMANCE ON PHYSICAL FITNESS TESTS

BY

JANET FAY SMITH

A STUDY OF PHYSICAL FITNESS NORMS FOR THE WOMEN AT AUSTIN PEAY STATE UNIVERSITY AND THE RELATIONSHIP OF HEIGHT, WEIGHT, AND PERFORMANCE ON PHYSICAL FITNESS TESTS

A Research Paper

Presented to

the Graduate Council of

Austin Peay State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in Education

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by

Janet Fay Smith

August, 1971

To the Graduate Council:

I am submitting herewith a Research Paper written by Janet Fay Smith entitled "A Study of Physical Fitness Norms for the Women at Austin Peay State University and the Relationship of Height, Weight, and Performance on Physical Fitness Tests." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts in Education, with a major in Physical Education.

Major Professor

Accepted for the Council:

Dean of the Graduate School

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CHAPTER I

INTRODUCTION

Many norms and standards for physical fitness have already been established, but these are based on national or state test results. The American Association of Health, Physical Education and Recreation Youth Physical Fitness Test is an example of the former and the North Carolina Physical Fitness Test is an example of the latter. Since these are based on the results of girls throughout the nation, or in a select area, it is felt that a Physical Fitness Test based on the results obtained from testing women at Austin Peay State University would be more accurate for measurement of its students' fitness. Therefore, the Women's Department of Physical Education at Austin Peay State University has encouraged the development of physical fitness norms for its women's physical education classes.

This research problem was designed to seek a correlation between height and weight in the fitness tests utilized to obtain greater testing accuracy. This would allow testing of all individuals and compensating for their body types and performances.

DEFINITION OF TERMS

For clarity, a definition of terms used throughout this study will be given. One of the most reoccuring terms within this paper is physical fitness. There has been much controversy over the definition of this term since it is often used synonymously with motor fitness. Robert N. Singer defines physical fitness as the ability to perform a given task, in other words, having those physical qualities developed to the extent demanded by the task.[1] Further references to physical fitness will reflect Singer's definition.

The American Association of Health, Physical Education, and Recreation (AAHPER) is a national association for instructors and personnel involved in Health, Physical Education, and Recreation. This association has developed many tests and papers that are useful to instructors. One test utilized in this study is the AAHPER Youth Fitness Test.[2] It consists of a battery of tests dealing with agility, strength, speed, coordination, power,

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[1]Robert N. Singer, Motor Learning and Human Performance, New York: The Macmillian Company, 1968, p. 107.

[2]AAHPER, Youth Fitness Test Manual, (Washington, D. C.: American Association of Health Physical Education and Recreation, 1967.

balance, flexibility, and endurance.

It was reported that individual differences in skill has quite an effect upon test results. The differences may be in the form of height, weight, age, motor capacity, agility, ability, etc. This research project utilized individual differences as the basis for fitness relationship. The performance of individuals on a given test can be expressed in norms, values that describe the group's performance. A group norm is basic for this study.

Because of individual differences, a correlation which is the relationship between two items, must be determined. The most common way of determining correlation is by using the Pearson's r. Pearson's r is an acronym for Pearson Product-Moment Coefficient of Correlation (r). This is an accurate means of finding relationships. A scatter diagram or scatterplot is a visual means of finding correlations and can suggest if the Pearson's r is justified.[3]

THE PROBLEM

The purpose of this study is to determine if physical fitness norms can be established for the women at Austin Peay State

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[3] H. H. Remmers, N. L. Gage, and J. Francis Rummel, A Practical Introduction to Measurement and Evaluation, New York: p. 68.

University with a positive degree of reliability and validity and does height and weight have an effect upon the physical fitness performance of an individual.

To solve this problem, it required results from many controlled tests.

The results of testing each individual was recorded. Several quarters were necessary to gather the needed data. The individuals tested were women students enrolled in Physical Education conditioning classes. The test was given at the beginning of the quarter in all instances and results obtained from all girls between the ages of seventeen and twenty-two were used.

The physical fitness test employed was the one produced by the American Association of Health, Physical Education, and Recreation.

To determine the effect of height and weight upon physical fitness performances, it was necessary to determine a correlation between: (1) height and fitness test, and (2) weight and fitness test, for every test given. The Pearson's r was used to find the correlations. After all correlations between height, weight, and fitness tests were established, then a relationship was obtained between height and weight. This enabled the writer to relate both height and weight to physical fitness.

RELATED MATERIAL

Searching the literature for material related to the two areas of the study uncovered many articles and books dealing with some aspects of the study, but upon further investigation many of the sources proved to be of little value. Nevertheless, there was enought pertinent material to establish a basis for the study.

Establishing norms necessitated the use of knowledge found in the field of measurement and evaluation. Many studies were found that recorded norms for skill and fitness levels. A Practical Approach to Measurement in Physical Education, by Harold M. Barrow and Rosemary McGee, descirbes many tests with established norms.[4] Their discussion contributed some basic principles of evaluation. These basic principles forces one to question the objectivity and reliability of each physical fitness test.

H. H. Reemers, N. L. Gage, and J. Francis Rummel wrote A Practical Introduction to Measurement and Evaluation.[5] They discuss norms and standards. This book was used to

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[4] Harold M. Barrow and Rosemary McGee, A Practical Approach to Measurement in Physical Education, Philadelphia: Lea and Fehiger, 1968.

[5] Remmers, op. cit., pp. 27-28, 64-69.

help calculate the norms and correlations. There is a very descriptive section dealing with the Pearson's r used in this study.[6] A discussion of the result interpretation was included in this book.

The AAHPER published a manual[7] dealing with the AAHPER Youth Fitness Test. This book was used to establish the test battery given to the students.

Gladys Scott and Esther French[8] reported research along similar lines as this study, but did not use the same statistical calculations.

Other books used in computations were Practical Measurement for Evaluation in Physical Education by Barry L. Johnson and Jack K. Nelson,[9] Test and Measurement in Health and Physical Education by Charles H. McCloy and Dorothy Y. Young,[10] and

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[6]Remmers, op. cit., pp. 68-69.

[7]AAHPER, op. cit., pp. 3-10.

[8]M. Gladys Scott and Esther French, Measurement and Evaluation in Physical Education, Dubuque, Iowa, William C. Brown Company, Publishers, 1959, pp. 323-337.

[9]Barry L. Johnson and Jack K. Nelson, Practical Measurement for Evaluation in Physical Education, Minneapolis, Minn., Burgess Publishing Company, 1969, pp. 37-43.

[10]Charles H. McCloy and Dorothy Y. Young, Test and Measurement in Health and Physical Education, New York, Appleton-Century-Crafts, Inc., 1954, pp. 35-36, 60.

Statistical Inference by Helen M. Walker and Joseph Lev.[11]

Johnson and Nelson[12] cited a case dealing with height and weight and fitness:

> Gross and Casscini utilized data of over 13,000 students to determine the value of age, height, and weight as a classification device for the AAHPER Youth Fitness Test. They reported that in all four groups - senior high school girls, junior high school girls, senior high school boys, and junior high school boys - the factor of age, height, and weight had practically no value, single or in combination, as classified for the seven test items. In other words, each group could be considered as a homogenous group with respect to the effects of these factors on fitness.

Singer[13] reporting on physical fitness states:

> In 1937 Cozens stated that there is no relationship between body height and weight of girls with fundamental skill achievement in a variety of spots, whereas Adams, in 1934 found little predictive value in height and weight to track and field performance of 200 high school girls.
>
> Another study which was conducted by Espanschade (1903) involved the testing of boys and girls, ranging in age from ten to eighteen, in the 50 yard dash, standing broad jump, throw for distance, sit-ups, and pull-ups. Her results indicated low correlations most often of no significance, between the test performance and height and weight.

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[11]Helen M. Walker and Joseph Lev, Statistical Inference, New York: Henry Holt and Company, 1953, pp. 32-37, 237-239.

[12]Johnson, op. cit., p. 75.

[13]Singer, op. cit., p. 56.

> Miller in 1952, tested 1,559 college men over seven test items. He reported that height and weight measures were unsatisfactory for classification purposes. This was based on the low relationship obtained between these factors and test performances.

All previous quotes indicated that height and weight had no effect upon physical fitness performances. The findings of Laurence E. Morehouse and Augustas T. Miller[14] proved contrary to the previous reports. They felt that maximum skill was influenced by height, weight, and other factors.

> The heavier the weight of the individual in relation to his musculature the greater the limitation of his physical skill. Also the taller person's center of gravity is always farther from his base of support. When exercise required the displacement of the center of gravity in any direction except along a horizontal plane, the taller individual having the greater displacement requires more muscle activity to achieve the position and maintaining posture during the exercise.

Charles McCloy[15] agreed with Morehouse and Miller. He reported that, "height and weight influence physical performance and that you cannot classify students into groups by these variables only."

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[14] Laurence E. Morehouse and Augustas T. Miller, Physiology of Exercise, St. Louis: The C. V. Mosby Company, 1953, p. 219.

[15] McCloy, op. cit., p. 58.

These references have shown two different opinions. In most instances researchers report that physical fitness does not correlate to any significant degree with height and weight.

CHAPTER II

THE METHOD OF INVESTIGATION

The Test Battery

A battery of tests was used measuring speed, endurance, agility, and body strength in initiating the investigation. This battery, consisting of six tests, was used by the AAHPER to establish their youth fitness test. Each test is listed below with the instruction suggested by the AAHPER.[16]

Test 1 - Flexed Arm Hang

Equipment: A bar (wooden or metal approximately 1-1/2 inches in diameter placed just above the individual's height. It may be necessary to improvise, such as using a mat stand. A stop watch is also needed.

Purpose: Strength, arm and shoulder

Instruction: The bar is grasped with the palms facing away from the body and the individual must pull himself up or be lifted into position, with the chin above the bar. The student hangs in this position as long as possible. It is a violation for the chin to touch the bar, fall below the bar, or to tilt the head backward to keep the chin from touching the bar.

Scoring: The score is the time that the individual has held his position. The time is to be figured to the nearest second.

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[16] AAHPER, op. cit., pp. 3-10.

Test II - Sit-up

Equipment: Mats if available, but the floor is satisfactory.

Purpose: Endurance and abdominal strength

Instructions: The individual lies flat on the floor with his knees bent and feet placed on floor. The hands should be behind the head with the fingers interlocked. The head is lifted up so as to touch the knees and then returns to the floor.

Scoring: One point is scored for each sit-up.

Test III - Standing Broad Jump

Equipment: Tape measure and floor space.

Purpose: To measure power

Instructions: A tape measure is taped to the floor. A starting line is placed at the end of the tape measure. The individual is to take off from the starting line by jumping forward as far as possible. The student must take off from both feet and land on both. If he should feel that he is going to fall after landing, he should try to fall forward, not backward. Swinging the arms and crouching may help the student jump further.

Scoring: The distance from the take-off line to the nearest point where any part of the student's body has touched. Measurement should be to the nearest inch. Individuals should be given three trials and take the best for their score.

Test IV - 50 Yard Dash

Equipment: Large area, such as a track or softball field. There should be a starting line and a finish line with 50 yards between. Two or three stop watches will be needed.

Purpose: To measure speed

Instructions: Any positions may be taken behind the starting line. On the command signal the student will run as hard and as fast as possible until they cross the finish line.

Scoring: The score is the time passed to the nearest second between the starting signal and the moment the individual crosses the finish line.

Test V - Shuttle Run

Equipment: Two lines parallel to each other are placed on the floor 30 feet apart. Two wood blocks 2 by 2 by 4 inches and a stop watch are needed.

Purpose: To measure speed and agility.

Instructions: The two wood blocks are placed on the opposing line from the starting line. On the starting signal the student runs as fast as possible to the blocks, picks up one block, runs back to the starting line, lays the block down, goes back for the other block, and runs as fast as possible with the block until he has crossed the starting line. The second block does not have to be placed on the floor. It is a violation if the first block is thrown down instead of being laid down.

Scoring: The score is the time in seconds and tenth of seconds for the best of two trials.

Test VI - Push Ups

Equipment: Mats, if available.

Purpose: Strength, arm and shoulder

Instructions: The body should be straight with the knees on the floor, feet in the air. The arm should be straight with the palms on the floor. Bend the

arms, lower the body within an inch of the floor, then raise the body by straightening the arms.

Scoring: One point is given every time the body is lowered and raised.

Testing

There were approximately 480 girls enrolled in P. E. 101, Conditioning Exercises, during the years 1969 and 1970 who were tested. The test was administered the first week the classes met during the quarter.

Results obtained from many of the 480 tested were discarded because of insufficient data or because of the age of the individual tested. The number of individuals for each test varied. Many students did not complete the battery for various reasons. The number of students tested for each test was recorded in Table I.

TABLE I

STUDENTS TESTED ON PHYSICAL FITNESS TESTS

Battery Test	Number of Students
Flexed-Arm Hang	155
Sit-Up	333
Standing Broad Jump	333
50 Yard Dash	152
Shuttle Run	329
Push-Ups	243

Each student recorded their test results on individual score cards. These cards were filed until all data were collected.

Calculations

After all the data were collected, test scores were recorded on separate sheets. Included with each test score was the height, weight, and age of the individual. Norms and correlations were calculated from the test results.

To calculate norms, the test scores for each test were placed on a scatter diagram. For each diagram the weight was on the vertical plane, with an interval of ten and height on the longitunal plane, with no interval. The weight ranged from ninety to one hundred and ninety-nine pounds, while the height ranged from fifty-seven to seventy-two inches. The blocks on the diagram with less than four scores were eliminated. Each block was then added and averaged to find a norm for a certain height within a specific weight range. These norms were then recorded on separate diagrams with the same range and intervals. The last diagrams showed the finished results, the norms.

Establishment of the relationships between height, weight, and test performances required two scatterplots for each test. One scatterplot consisted of height and the test results while the other was made up of weight and test results. The intervals for

the height and weight range were consistent throughout the twelve plots. Again the interval for weight is ten, but the range is eighty-four to two hundred and thirteen pounds, while the interval and range for height is the same as above. The interval for the test results varied according to the range of scores. Weight and height were placed on the horizontal plane of the plot, while the scores were placed on the vertical plane. Table II lists the ranges for the test scores.

TABLE II

THE RANGE OF SCORES ON PHYSICAL FITNESS TESTS

Battery Test	Range
Flexed Arm Hang	1 - 55 seconds
Sit-Ups	3 - 102
Standing Broad Jump	35 - 82 inches
50 Yard Dash	6.5 - 10.6 seconds
Shuttle Run	8.9 - 14.5 seconds
Push-Ups	1 - 30

Plotting the scores was the next step. Each score was first entered on the vertical axis at the proper point for the size of the score of one of the variables and then moved across horizontally until the proper point was reached for the score on the other variable. At this intersection a mark was made for the pair of scores. This process was repeated until all scores had been

plotted.[17]

After plotting all scores, a visual relationship was evident. To establish a more accurate relationship, the writer proceeded with Pearson's r.

[17] Remmers, op. cit., p. 65.

CHAPTER III

TABULATION OF DATA

The Norms

The norms obtained were unreliable because of the low number of students tested. Although it was believed when initiating the study there were enough data collected to accrue a reliable norm for each test, the final analysis failed to prove this belief. There was no definite pattern followed by the norms, nor were there enough figures to establish partial norms.

Correlations

The scatter diagrams visualized an absence of relationship between height, weight, and performance. The Pearson's r confirmed the absence of significant correlations.

The correlations for height and performance were shown in Table III.

TABLE III

A COMPARISON OF HEIGHT AND PHYSICAL FITNESS TEST PERFORMANCES

Test	N	Assumed Mean Height (in.)	Assumed Mean Test	r
Flexed Arm Hang	68	64	18 -20	.17
Sit-Ups	193	64	28 -32	.10
Standing Broad Jump	194	64	59 -61	.02
50 Yard Dash	66	64	8.3- 8.5	.01
Shuttle Run	192	64	11.6-11.8	.003
Push-Ups	180	65	9 -10	.31

Correlation coefficients range from +1.00 to -1.00. If the coefficient is high, .83, .92, etc., for example, then there is a good relationship between the variables. If the coefficient is low, .16, .02, -.02, etc., the relationship would be small and of little value.

As noted in Table II all coefficients are low, showing no significant relationship between height and the test performances. The taller girl will not necessarily run faster than the shorter girl.

The coefficients for weight and test performances were low also. The correlation for flexed arm hang and weight has the highest coefficient of any in this group, r = .41. There is almost a relationship, but it is not significant. The 50 yard dash had the

lowest coefficient, .01, indicating no relationship between the weight and the performance of the individual in running short distances. The coefficients for each test were listed in Table IV, with the number of individuals plotted and the assumed mean.

TABLE IV

A COMPARISON OF WEIGHT AND PHYSICAL FITNESS TEST PERFORMANCES

		Assumed Mean		
Test	N	Weight (lb.)	Test	r
Flexed Arm Hang	65	114-123	18 -20*	.41
Sit-Ups	229	124-133	23 -27**	.16
Standing Broad Jump	231	124-133	59 -61**	.12
50 Yard Dash	102	124-133	8.3- 8.5*	.01
Shuttle Run	230	124-133	11.6-11.8*	.08
Push-Ups	211	114-123	7 - 8	.25

*seconds

**inches

Coefficients from this grouping imply that weight did not have any particular effect upon these fitness test performances.

The last correlation figured was between height and weight. The assumed mean fell at sixty-four inches for height and one hundred twenty-four to one hundred thirty-three pounds for weight. These means were the same as the majority of means in the other correlations. The number of subjects plotted was one hundred

eighty-eight. The scatter diagram showed a rectilinear relationship. Pearson's r produced a significant correlation, the coefficient being .52. The findings of this study indicated that height was related to weight although it should be noted that the relation was not that significant.

CHAPTER IV

DISCUSSION

Setting up a physical fitness norm using height and weight requires many more test results than produced by this study. From the literature cited, it was felt that for the amount of material collected, a percentile rank would have been more effective. A percentile rank would have established some type of standard, whereas the norms revealed nothing. Unfortunately, this was not discovered until the study had been completed.

The figures that were listed for norms were very inconsistent. The variables that could have caused this situation were lack of data, incorrect recording, and scoring.

Testing of several hundred students at different times allows for error. This error relates to using different timers and recorders for each group tested. A selected group, instructed in test administration, scoring, and recording, would remove this error, providing that this group did the scoring and recording for all groups tested.

In the testing process, students were used in the class to help with scoring and recording. There were several classes tested, therefore, numerous student involvement permitted mistakes.

Although all tests were given by the same instructors, each class had individual situations and conditions. These situations and conditions could affect test results. To explain this statement an example will be given. It should be noted that some classes had available mats to do push-ups and sit-ups while others did not. This could produce a difference in the results. The mat allows for relaxed muscles, bounce, less irritation to the vertebrae, expecially the fifth sacrum, and less pressure against the knees. The mats enabled the students to perform more efficiently which resulted in better test scores. It should also be noted that a psychological condition could have existed. Some classes were tested in the gym, whereas others were tested in a recreation room. In the recreation room there was a feeling of enclosure. If the student had an awareness of this, then efficiency in performance would have been lower.

Many variables that may have affected test results could have been eliminated under proper conditions. However, these conditions were not always available.

To conclude this portion of the generalization phase, it is the writer's theory that if more data had been collected a reasonably reliable set of norms would have been established.

It was anticipated that the correlational study would reveal no relationship between height, weight, and performance, since this type of study had been run by many individuals previously. The number of subjects in other studies ranged from two hundred to thirteen hundred. In most cases there was no relationship between height and performance, but there were instances where results definitely indicated a correlation, such as the study of Morehouse and Miller.[18]

To consider height and weight in relation to performance, it is easy to conceive that they would affect the physical ability of an individual. If more thought was given the matter, it would be understandable why this would not be true. To theorize, the muscular system of most individuals is developed according to her body type. Therefore allowing her the same physical ability as someone of a completely different body type. There are exceptions to this theory, the athlete and the obese person. The athlete has conditioned his body to perform to obtain optimum

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[18] Morehouse and Miller, op. cit., p. 219.

ability. The obese person is at the other end of the scale, he has let his physical ability deteriorate into fat.

Questions could be asked to dispute the validity of the results. For example: Was this a select group? Could this have been an extraordinary group? Was there a wide range in height? Was there a wide range in weight? Was there corrections figured for Y (height or weight) and X (test results) when computing the coefficient?

The subjects for these tests were not a select group, nor were they extraordinary groups. The girls chose to be subjected to the tests when they registered for conditioning. They did not know when the tests would be administered until the day before the tests. There was a wide range in height, weight, and ability. The subjects were a very typical group of college girls with different capacities. A correction was determined when the Pearson's r[19] was computed to cover any variables.

In analyzing and comparing the study of correlation, the results indicated that it was reliable and confirmed previous studies in this area.

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[19] Remmers, op. cit., pp. 68-69.

CHAPTER V

SUMMARY

This study revolved around Physical Fitness Norms for the women at Austin Peay State University and the relationship of height, weight, and performance on fitness tests.

A battery of six tests, taken from the AAPHER Youth Fitness Test manual, was administered to approximately four hundred and ninety-nine girls enrolled in P. E. 101, Conditioning Exercises, at Austin Peay State University. The age of these girls ranged from seventeen to twenty-two, height from 54 to 72 inches, and weight 90 to 199 pounds.

The test results were recorded on individual score sheets then transferred to data sheets. From these sheets they were recorded on plots with height on the horizontal plane and weight on the vertical plane. The scores of the individuals were recorded at the intersection of height and weights of the individuals tested. All blocks on the plot with less than four scores were eliminated, the remainder were averaged to complete the norms.

Pearson Product-Moment Coefficient of Correlation was used to compute the relationship between height and weight and performance. A scatterplot for height and weight was used for each test. On each scatterplot, height and weight were on the horizontal axis and test scores on the vertical axis. Each score was plotted to form a visual relationship, then Pearson's r was calculated. The coefficient revealed the relationship.

The results of the study were not altogether conclusive. There were no norms established. The figures computed for norms were so inconsistent and limited that partial norms could not be established. Based on the findings of this study, it was concluded that height and weight did not have any direct relationship upon physical performances. This was substantiated by the coefficient of each correlation. All coefficients, except one, were below .19. To have any significance it would have to be at the .5 level.

The correlations proved very significant and were backed by the research of Cozens (1937), Espenschade (1903), and Gross and Casscini, as reported by Singer.[20] To conclude there is no practical reason for height and weight to affect the performance

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[20] Singer, op. cit., p. 56.

of an individual on physical fitness ability.

There were many variables that could have affected the results of the norms, but the biggest problem was the lack of data. After scores were eliminated due to insufficient data or age, the norms were lost.

The complete study was of great importance although the physical fitness norms were not established. The sections on correlations can be very usefull in classifying students. The results of this study not only showed the relationship between height, weight, and performance, but also revealed the usefulness of test data other than for grading purposes.

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Rt. 3, Box 26A
Rutherfordton, N. C. 28139

July 19, 1971

AAHPER
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The nature of this letter is to request permission for reproduction of this material.

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I would appreciate it if permission is granted and you can send a quick reply.

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Janet F. Smith

Janet Fay Smith

Dear Miss Smith:

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Sincerely,

Nancy Rosenberg

Nancy Rosenberg
AAHPER Periodicals Director

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Janet F. Smith

Janet Fay Smith

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I would appreciate it if permission is granted and you can send a quick reply.

Sincerely,

Janet F. Smith

Janet Fay Smith

July 23, 1971

Dear Miss Smith: We will grant permission to use the quotation on p. 47, but please use the following credit line.

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Sincerely

Richard A. Purser

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July 29, 1971

Miss Janet Fay Smith
Rt. 3, Box 26A
Rutherfordton, N.C. 28139

Dear Miss Smith:

Thank you for your letter of July 19, 1971, requesting permission to quote the following material from the second edition of Morehouse and Miller's Physiology of exercise, 1953, in your research paper entitled "A study of physical fitness norms for the women at Austin Peay State University and the relationship of height, weight, and performance on fitness tests" for your Master of Arts Degree in Physical Education, to be shelved in the library at Austin Peay State University, Clarksville, Tenn.:

p. 219--"The heavier the weight of the individual...a skill exercise."
p. 219--"A tall person...during the exercise."

We are pleased to grant permission for the use of these paragraphs contingent upon the approval of the authors. Please enclose in quotation marks and, since essentially the same material appears in the sixth edition of the book published this year, include the following footnote credit (subject to modification in accordance with your style preference) on the same page on which it appears in your paper:

From Morehouse, Laurence E., and Miller, Augustus T., Jr.: Physiology of exercise, ed. 6, St. Louis, 1971, The C. V. Mosby Co.

To ensure accuracy of quotation, enclosed please find copy of the material as it appears in the sixth edition.

Best wishes.

Sincerely,

THE C. V. MOSBY COMPANY

Marjorie McCoy

Marjorie McCoy
Director, Library Services
and Permissions

MM:GW
Enclosure
cc Dr. Laurence E. Morehouse
Professor of Physical Education
University of California
at Los Angeles
Los Angeles, California

cc Dr. Augustus T. Miller, Jr.
Professor of Physiology
University of North Carolina
Medical School
Chapel Hill, N.C.

of the legs, and a reduction in the side-to-side movement of the hips as a result of the lessening of the lateral oscillation of the trunk.

The movements of skilled workmen in industry are often as graceful as those of the athlete. The easy, graceful movements of the woodcutter conceal the force applied to the ax.

An error common to the beginner in attempting most physical activities is that of using strength as a substitute for skill. He even calls for muscles to push, forgetting that muscles only pull. He actually ties himself up with his own muscles until he learns that the movement is more skillful when fewer muscle groups are involved in the primary action.

Factors that limit skill

The maximum skill that can be achieved may be limited by the following factors: (1) body weight, (2) body height, (3) timing, (4) accuracy of movement, which includes eye-muscle coordination, kinesthesis, balance, reaction time, speed of movement, precision, and visual aim, and (5) muscular tension.

Body weight. The heavier the weight of a person in relation to his musculature, the greater the limitation of his physical skill. Added weight in the form of fat increases the effort needed to perform a movement. The fatty tissue may also be considered to have a hobbling effect on movement. A reduction of this inactive tissue will aid in improving performance of a skill exercise.

Body height. A tall person displaces his center of gravity through a greater distance than does a short person when the same movement is performed by each. The taller person's center of gravity is always farther from his base of support. When the exercise requires displacement of the center of gravity in any direction except along a horizontal plane, the taller person having the greater displacement requires more muscle activity to achieve the positions and maintain posture during the exercise. The shorter athlete has the advantage in many skill exercises. Errors in diving form are magnified in the tall diver and are less noticeable in the short diver. The same is true in gymnastics. The taller basketball player or baseball pitcher, however, may have better control by being able to guide the ball through a larger range of movement. Tall tennis players have an advantage in covering the court and placing the serve and the return.

Timing. A skill exercise requires a fine coordination in the timing of the muscular contractions. As the movements of an exercise proceed, each muscle involved must contract or relax at the proper instant or the movement will be interfered with or misdirected entirely.