# THE RELATIONSHIP OF TRACK AND FIELD TO VARIABLE COMPONENTS OF PHYSICAL FITNESS

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A Research Paper
Presented to
the Graduate Council of
Austin Peay State University

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In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in Education

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by
George Everett Sinor

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To the Graduate Council:

I am submitting herewith a Research Paper written by George Everett Sinor entitled "The Relationship of Track and Field to Variable Components of Physical Fitness." 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 Administration and Supervision.

Dave Aaron
Major Professor

Accepted for the Council:

Wayne E. Stamper
Dean of the Graduate School

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# CHAPTER I

## THE PROBLEM AND DEFINITIONS OF TERMS USED

Varying opinions exist today concerning the benefits of our modern Physical Education programs. Too many people have come to perceive this program as nothing more than a period of social recreation. Very little supportive evidence has been presented to uphold the contention that the Physical Education program has merit in achieving physiological gains in the physical fitness level of its participants.

### I. THE PROBLEM

Statement of the problem. It was the purpose of this study to determine (1) the relationship of a Track and Field unit of Physical Education on variable components of physical fitness, such as (a) cardio-vascular condition, (b) respiratory fitness, (c) subcutaneous adipose tissue, and (d) general fitness level as determined by work output; (2) the value of a Track and Field unit as an integrated part of the Physical Education curriculum.

Justification of the study. Much has been said of the apparent need for a higher level of physical fitness for the youth of our nation. It has been observed, however, that too many of our young people have neglected the development of motor fitness. Former President John F. Kennedy delivered a message to the schools in the physical fitness of youth in which he said, "The softening process of our civilization continues to carry on its persistent erosion."[1] He continued by urging the "expansion of services, increased facilities and time devoted to physical activity, and an invigorating curricula to create a high priority for excellence in health and fitness."[2] However, too many schools neglect the attainment of a higher fitness level in quest of making the curricula enjoyable. Moreover, too little research has been conducted by physical educators themselves to confirm their beliefs so that hypothesized physiological gains can be scientifically proven and stated to students of Physical Education and the general public. The author contends that research of a sufficient quantity has been neglected in establishing the relative merit of Track and Field as a means of attaining this higher level of physical fitness.

## II. DEFINITIONS OF TERMS USED

Adipose tissue. This term refers to fat tissue.

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[1] Howard S. Hayman, Your Health and Safety-For Teachers (Chicago: Harcourt, Brace, and World Inc., 1963), p. 6.

[2] Ibid., p. 6-7.

Fat is widely distributed throughout the body, not uniformly, but rather in a characteristic pattern which varies with the sex of the individual and his hormoral pattern.[3] Fat serves a protective function and is also a source of energy. However, the excessive accumulation of fat is harmful to the health of the body.

Bicycle Ergometer. This term refers to a machine used to measure work output. This machine provides a resistance against which the muscles have to work. A description of the apparatus follows later in the study.

Cardio-respiratory fitness. "An ability to maintain the processes of metabolic exchange as close to the resting state as is mutually possible during performance of a strenuous task with a capacity to reach a higher rate of working than the unfit and to restore promptly all equilibria which are disturbed."[4]

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[3] L. L. Langley, E. Cheraskin, and Ruth Sleeper, Dynamic Anatomy and Physiology (New York: McGraw-Hill Book Company, Inc., 1958), p. 30-31.

[4] R. J. Shepard, "Physiological Determinents of Cardio-respiratory Fitness," The Journal of Sports Medicine and Physical Fitness, Vol. 7, No. 3, (September, 1967), p. 112.

# CHAPTER II

## LIMITATIONS AND HYPOTHESES

### I. LIMITATIONS

The author is limited in his research in that he is not qualified in the medical sciences to the extent that he may investigate deeply the physiological changes brought about by the rise in fitness level. The author was not able at the present time to analyze the correlation between cardiac output and his findings because of the limited scope of the problem.

### II. HYPOTHESES

1. Track and Field units as a part of the Physical Education curricula do improve the overall fitness level of its participants.
2. The effects of Track training are valuable in improving cardio-vascular condition.
3. Track activities serve as a means of improving respiratory fitness.
4. Track and Field activities serve as a useful method for the reduction of subcutaneous adipose tissue.
5. Track and Field activities serve a valuable purpose in the Physical Education program.

# CHAPTER III

## REVIEW OF THE LITERATURE

Much has been written on the general effects of exercise and training on certain components of physical fitness, yet specific information on Track and Field contributions are somewhat lacking. An attempt will be made, however, to summarize closely related research that has been undertaken in this general area.

### I. LITERATURE ON TRANSITORY EFFECTS OF PHYSICAL ACTIVITY

This concept is by no means new. Research has indicated that many changes brought about in cardio-vascular fitness by a program of physical fitness are soon lost if the program is discontinued. Steinhaus experimented with animals and indicated that gains made as a result of exercise were reversed drastically by prolonged periods of inactivity.[5] Kahn reported a study which indicated that the apparent protection against coronary heart disease

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[5] A. H. Steinhaus, Toward an Understanding of Health and Physical Education (Dubuque, Iowa: William C. Brown Company, 1963), pp. 90-92.

afforded by regular exercise is also transcient.[6] In reviewing the above mentioned studies, Montoye takes the position that while there are certain "residual effects of physical education," it is his opinion that "the most important outcomes of school programs of Physical Education are healthful attitudes toward physical activity as measured by good habits."[7]

## II. LITERATURE ON BENEFITS OF EXERCISE

The main concept of all literature in this area is that "the trained individual has a distinct advantage over the unfit in that the ability to retain during strenuous exercise an internal body environment much like that of the body at rest is greater."[8] E. M. Kagan and P. M. Kaplan showed that "physically untrained mental workers spent twenty-three (23) per cent more energy in a certain

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[6] H. A. Kahn, "Relationship of Reported Coronary Heart Disease Mortality to Physical Activity of Work," (Reported at the Epidemilogical Section, American Public Health Association Meeting, Miami, Florida, October 17, 1962).

[7] Henry J. Montoye, "The Body of Knowledge in Physical Education: Biological," (Presented at the thirty-fourth annual meeting, American Academy of Physical Education, Minneapolis, Minn., May 1, 1963).

[8] F. W. Griffin, _The Scientific Basis of Physical Education_ (London: Oxford University Press, 1937), p. 108.

measured amount of work than did trained manual porters."[9] Research by Bromwell and Ellis[10] conducted with Olympic athletes and F. S. Colton[11] on Olympic swimmers indicated an increase during training of the volume of blood expelled from the heart each minute and the consequent slowing of the pulse rate (six to eight beats slower than when out of condition).[12] Bock, Vancaulaut, et. al., pointed out the relationship of training and lung capacity. In a trained Marathon runner they found training to "increase the lung capacity and to decrease the ratio $\frac{\text{Tidal Air}}{\text{Lung Capacity}}$, showing that the pulmonary reserve may be increased through training."[13]

A maximum lung inflation is rarely used in life. Yet there are reasons for believing that its potential bears an important relationship to the physical fitness of a person. Turner studied 1,337 freshmen at Mount Holyoke College.

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[9] Ibid, p. 108

[10] C. Bromwell and R. Ellis, "Clinical Observations on Olympic Athletes," Arbeitsphysiologic, 2:51, 1929.

[11] F. S. Colton, "Relation of Athletic Status to Pulse Rate in Men and Women," Journal of Physiology, 76:39, 1932.

[12] Griffin, op. cit., p. 108.

[13] A. V. Bock, et. al., Studies in Muscular Activity III, "Dynamical Changes Occurring in Man at Work," Journal of Physiology, 66:136, 1928.

He says, "the young women of low vital capacity were by no means the physical equals of students of high vital capacity."[14] White and McGuire of the United States Army Medical Corps studied students in an army summer training camp and they concluded that "vital capacity is at least in some degree indicative of general physical condition."[15] In an investigation undertaken by Schwartz, Brittan and Thompson of the United States Public Health Service, it was found that "regular exercise over a period of four months increased the vital capacity of sixty-eight adolescent boys, who formed the experimental group, from an average of 3200 to an average of 3330 cc., while a control group of fifty showed almost no change, from 3370 to 3390 cc."[16]

Cureton has suggested that a higher vital capacity means that the subject "very probably has relatively greater flexibility of the chest walls, greater strength of action in the diaphram and in the inspiratory muscles of the chest, and also greater strength and range of action of the

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[14] A. H. Turner, "Vital Capacity in College Women," American Journal of Physiology, 87:667, 1929.

[15] S. A. White and P. F. McGuire, "Vital Capacity in a Citizen's Military Training Camp," American Journal of Physiology, 73:636, 1925.

[16] E. C. Schneider and P. V. Karpovich, Physiology of Muscular Activity, (Philadelphia: W. B. Saunders Company, 1948), p. 86.

expiratory muscles of the abdomen and chest."[17] He, therefore, gives a good indication that vital capacity may give true fitness measures.

Peter V. Karpovich, Research Professor of Physiology, Springfield College, Springfield, Massachusetts, summarizes other experimental work carried on by Bock and his associates:

> Two men performed work of equal intensity (requiring about 2000 cc. of oxygen per minute). In one man, De Mar, in excellent physical condition, the systolic blood pressure rose to 150 mm. Hg.; whereas in the other man, who had never before taken part in strenuous exercise, the systolic blood pressure rose to 230 mm. Hg. The resting systolic blood pressures of these men were about equal--100 and 105 mm. Hg. respectively.[18]

Training causes a lesser rise in blood pressure during any exercise and consequently the post exercise blood pressure was less. The increase of 50 mm. Hg. in De Mar as compared to 125 mm. Hg. of the untrained man clearly illustrates this. Much research has been attempted on the effects of training on resting blood pressure. Most researchers have difficulty finding a correlation. Dawson stated, "The effects of training are neither striking nor constant."[19] Most educators agree.

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[17] T. K. Cureton, Physical Fitness Appraisal and Guidance (St. Louis: C. V. Mosby Company, 1947), p. 341

[18] P. V. Karpovich, Physiology of Muscular Activity (Philadelphia: W. B. Saunders Company, 1959), p. 216.

[19] Ibid, Karpovich, p. 217.

Gould and Dye have made several revealing studies concerning pulse rate, stroke volume, and heart efficiency:

> The slow pulse of the trained individual is related to the magnitude of the systolic output, or stroke volume, of his heart. The stroke volume under resting conditions may be twice that of an untrained individual of comparable size. With this increase in stroke volume the net minute heart output of blood, even under resting conditions, is appreciably greater in trained than untrained individuals. Through training, the heart adjustments to the venous return and minute heart output are such as to increase its mechanical efficiency and thus diminish the burden placed upon it. Thus the efficiency of the heart rises as the stroke volume and minute output are increased relative to the heart rate.[20]

An increase in work output as a result of training has been observed in track and treadmill runners and in bicycle riders. Much has been contributed by Robinson and Harmon.[21] They trained a random selection of students for six months in Track and Treadmill activities. The students averaged reducing the time required for the mile run by one minute. Treadmill efficiency was increased fifty per cent. Another experiment was conducted, the results of which were that students trained on a bicycle ergometer for a sufficient period of time were capable of three times the work output as

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[20] A. G. Gould and Joseph A. Dye, Exercise and Its Physiology (New York: A. S. Barnes and Company, 1932), pp. 383-384.

[21] S. Robinson and P. M. Harmon, "Effects of Training Upon Certain Factors Which Limit Muscular Work," American Journal of Physiology, 133:161, 1941.

compared to the untrained students.[22]

Very little research has been accomplished correlating the relationship of Track and Field and reduction of subcutaneous adipose tissue. A few pertinent statements concerning adipose distribution throughout the body are necessary, however. Body components may be regarded as fat, water, protein, and minerals with the greatest variable being fat.[23] The thickness of subcutaneous fat shows a "rise in infancy, a decrease in childhood, and another rise in adolescence. When vertical growth stops, there is often noted the beginning of fat accumulation and progressive changes in the surface contours of the body."[24]

The mistake must not be made that overweight and overfat have the same meaning. Brozek and Keys, in their study, found that physically active men were in certain instances overweight, yet somewhat underfat.[25] All subjects

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[22]Lawrence E. Morehouse and A. T. Miller, *Physiology of Exercise* (St. Louis: C. V. Mosby Company, 1953), p. 272.

[23]R. W. Newman, "Skin-fold Changes With the Increasing Obesity in Young American Males," *Human Biology*, 27:53, May, 1955.

[24]S. M. Garn and R. V. Harper, "Fat Accumulation and Weight Gain in the Adult Male," *Human Biology*, 27:39, February, 1953.

[25]J. Brozek and A. Keys, "Relative Body Weight, Age, and Fatness," *Geriatrics*, 8:70, February, 1953.

were free of any abnormalities, matched in age and height, and were engaged in executive and clerical work. The only difference was the extent of their exercise and physical activity.[26] "The active men were heavier, thus relatively overweight. However, their fat content was lower. They were leaner than the inactive men, their lean body mass (body weight-weight of body fat) being considerably larger than in the inactive group."[27]

Little can be said for obesity as it refers to excess body fat. Smith and Gips call attention to the fact that "excess body fat is associated often with arteriosclerosis, high blood pressure, diabetes, social rejection, and an early death."[28] They continue by stating that "obesity increases the risk of death from cardiovascular disease by more than fifty per cent."[29]

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[26] Lederle Laboratories (Pearl River, New York: American Cyanomid Company, 1967), p. 3.

[27] Ibid, p. 5.

[28] D. W. Smith and C. D. Gips, Care of the Adult Patient (Philadelphia: J. P. Lippincott Company, 1963), p. 132.

[29] Ibid, p. 132.

# CHAPTER IV

## REPORT OF THE STUDY

The author attempted by means of this study to show that Track activities are important tools for the Physical Educator in improving the total fitness level of his students.

### I. SELECTION OF STUDENTS

Eleven students (boys) from a Physical Education class at Hillsboro High School, Nashville, Tennessee volunteered to assist the author in this study. Selection was not based on their physical fitness level. The author, in his efforts, attempted to prove that gains would be achieved in their fitness level regardless of the pre-training fitness level.

### II. PROCEDURES

Each of the students received a prepared form letter from the author and secured their parent's signature granting permission for them to take part in the study. Each student was then given a complete physical examination to determine his capacity to endure the vigorous course of training and physical exertion to which he would encounter during the study.

Before the Track and Field unit was conducted, each student underwent several tests and measurements at the Research Laboratory, George Peabody College, Nashville, Tennessee. These tests and measurements were used to determine the physiological state of the body before the unit was attempted. After all tests were completed, the students underwent a six-weeks training program of Track and Field activities. At the conclusion of the unit, the students were again submitted to identical tests and measurements under the same conditions to which they had been administered before the unit.

## CHAPTER V

## TESTS AND EQUIPMENT

Following is a description of the tests and measurements. A description of the equipment used for each test will also be given.

### I. PULSE RATE

The pulse rate was taken both before and after the unit of Track activities. The pulse rate was taken during a resting state (prone) and also after a period of physical exertion on the bicycle ergometer. The author administered the test by placing the index and middle finger of his hand on the superficial blood vessels of the anterior portion of the wrist. The pulsations were indicative of the rapidity at which the heart was beating. The author recorded the number of pulsations per minute with the use of the sweeping second hand on his watch which was previously tested for accuracy.

### II. BLOOD PRESSURE

A Mercurette 260 mm. model sphygmomanometer by Propper, and a Fleischer stethoscope were used to determine the blood pressure before and after the Track unit. The sphygmomanometer consists of a rubber cuff attached by a rubber tube to a compressable bulb and by another tube to a column of mercury (Hg.) which is graduated in millimeters (mm.).[30] The cuff was wrapped around the brachial artery and air was pumped into the cuff by depressing the bulb. When the air pressure in the cuff exceeded the blood pressure in the artery, the blood flow to the forearm was interrupted. As air was released in the cuff, the pressure reached a point which equaled that of the pressure in the artery. The first sound of blood beginning to spurt through the blood vessel was recorded as the systolic blood pressure. When the sound diminished, the reading on the manometer was recorded as the diastolic pressure. Of this test, Anthony states, "systolic pressure gives valuable information about the force of the left ventricular contraction and diastolic pressure gives valuable information about the resistance of the blood vessels."[31]

## III. BICYCLE ERGOMETER

Essentially, the test consisted of recording the amount of time that each student could spend on the bicycle.

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[30] Catherine P. Anthony, Textbook of Anatomy and Physiology (St. Louis: C. V. Mosby Company, 1959), pp. 325-326.

[31] Ibid, p. 326.

The students were told to keep the pedal turning at a rate of fifty revolutions per minute. There was a visual gauge provided for the students for this purpose. At the end of one minute, a force of friction was placed on the wheel cylinder equal to one-half footpound of weight. Thereafter, each successive minute spent on the bicycle saw the addition of another one-half footpound of pressure on the wheel. This test was used as a device to measure the general fitness level of the individual because, as David Cardus points out, "success indicates an increased cooperation of many of the physiological functions of the body."[32]

The students pedaled the ergometer as long as possible indicating at the end of the test a near complete state of fatigue. Time spent on the ergometer was recorded on a wall clock apparatus especially prepared for such experiments. The time was double-checked by the use of a stop-watch. Time was recorded in minutes and seconds rounded off to the nearest second.

## IV. SKIN-FOLD TEST

The most direct, simple, and accurate method for

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[32]David Cardus, "Computer Processing of Data Generated by a Bicycle Ergometer Test," The Journal of Sports Medicine and Physical Fitness, Vol. 7 No. 3, (September) 1967, p. 155.

estimating subcutaneous fat is measuring the thickness of skin-folds by constanttension calipers.[33] For the purpose of this test, a Lange Skin-fold Caliper was used. It meets the requirements of accuracy and pressure established by Lederle Laboratories of Pearl River, New York.

Three sites were chosen for measurement. The tricep measurement was taken at a point approximately midway between the acromial process of the scapula and the tip of the elbow. Precaution was taken to measure the skin-fold in the near identical location both before and after the unit of Track activities because the adipose tissue is not uniform from the elbow to the shoulder.[34] The scapular measurement was then taken. This site offered a fairly uniform layer of subcutaneous fat tissue. The measurement was taken just beneath the inferior angle of the right scapula. Another skin-fold measurement was taken at the flank area close to the unbilicus. Precaution was again taken to be as accurate as possible to attain the same position before and after the Track unit.

The skin-fold was picked up in a standard manner.

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[33]J. Brozek and A. Keys, "Evaluation of Leanness-Fatness in Man," Nutrition Abstract and Review, 20:247, October, 1950.

[34]Lederle Laboratories, op. cit., p. 6.

The thumb and forefinger of the left hand were placed just far enough apart that a full fold could be pinched up firmly from the underlying tissue. Tanner suggests that the calipers be applied to the fold below the fingers so that the pressure at the point measured will be exerted by the caliper forces and not by the fingers.[35]

## V. VITAL CAPACITY

The Maragonsett Standard Spirometer was used to measure the vital capacity. Vital capacity is described as the maximum voluntary air displacement from the lungs after the deepest possible inspiration.[36] The spirometer used had a capacity of four liters and was graduated in millilities. Connected to the spirometer was a one-fourth inch diameter tube into which each student forceably exhaled air. Each student was given three attempts at which time the highest measurement was recorded. This method was used before and after the unit of Track activities. A nose clamp was used each time to insure that air could not escape through the nostrils during the period of forced expiration.

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[35]J. M. Tanner, "The Measurement of Body Fat in Man," Human Biology, 31:48, March, 1959.

[36]T. G. Lawrence, J. W. Clemenson, and R. W. Burnett, Your Health and Safety (Chicago: Harcourt, Brace, and World, 1963), p. 81.

# CHAPTER VI

## DESCRIPTION OF TRACK ACTIVITIES

Each student participated in a unit of Track and Field activities for a period of six weeks. The boys participated for fifty minutes each day, five days a week. The class was originally set up three days a week alternating with a study hall period the other two days. It was the contention of the author, however, that a more effective program could be conducted if the students were extended the opportunity to train every day. During the course of this study, the students were also encouraged to continue their training period during the week-end days although this was not required.

The first four days of the unit were spent mainly in general conditioning running. This program included distance running, intermediate dashes, and short sprints. Each student was given a daily schedule to follow. The next three weeks were spent concentrating on individualized style in running. The students were offered instruction as to (1) how to run gracefully with the least wasted motion, (2) how to pace one's self in order to accomplish maximum results, (3) knowledge in the competitive style of running, and (4) achieving maximum results from the starting blocks.

During this three week period, instruction was also provided in the field event skills. Each student had the opportunity to practice the long jump, high jump, and shot put events. The discus and pole vault events as well as the running of the hurdles were omitted for reasons deemed by the author as valid and reasonable. The author felt that these events provided an element of danger beyond that to which inexperienced boys should be subjected.

The last two weeks were spent in competition among the students. A decathlon was staged whereby each boy was availed the opportunity to put forth his best effort and receive points for the order in which he finished in each event. Each boy participated in the 50 yard dash, 100 yard dash, 220 yard dash, 440 yard dash, 880 yard dash, mile run, long jump, high jump, and shot put. The results were tallied and the scores were posted. The author was of the opinion that proper motivation was needed during such a strenuous unit of physical activity to insure maximum effort during the training period.

## CHAPTER VII

## RESULTS OF THE TESTS

An attempt will be made to record the findings of the tests by figuring the mean or average of the scores in the distribution. It is calculated by adding all the scores ($\Sigma M$) and dividing by the total number of cases (N). The formula used was: Mean (M) = $\frac{\Sigma M}{N}$ [37]

### I. VITAL CAPACITY TEST

(scores recorded in milliliters)

| | BEFORE TRACK UNIT | AFTER TRACK UNIT |
|---|---|---|
| 1. | 246 ml. | 244 ml. |
| 2. | 306 ml. | 314 ml. |
| 3. | 301 ml. | 302 ml. |
| 4. | 260 ml. | 276 ml. |
| 5. | 268 ml. | 274 ml. |
| 6. | 286 ml. | 284 ml. |
| 7. | 226 ml. | 223 ml. |
| 8. | 294 ml. | 294 ml. |
| 9. | 249 ml. | 254 ml. |
| 10. | 270 ml. | 292 ml. |
| 11. | 240 ml. | 242 ml. |

Mean Vital Capacity before Track unit . . . . 267.8 ml.

Mean Vital Capacity after Track unit . . . . 272.6 ml.

Mean increase in Vital Capacity . . . . . . . 4.8 ml.

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[37] P. A. Smithells and P. E. Cameron, *Principles of Evaluation In Physical Education* (New York: Harper and Brothers, 1962), p. 166.

# II. SKIN-FOLD TEST

(scores recorded in millimeters)

| | TRICEP | | SCAPULA | | FLANK | |
|---|---|---|---|---|---|---|
| | BEFORE | AFTER | BEFORE | AFTER | BEFORE | AFTER |
| 1. | 5.0 mm. | 5.0 mm. | 6.0 mm. | 6.0 mm. | 7.0 mm. | 6.5 mm. |
| 2. | 6.5 mm. | 6.0 mm. | 7.0 mm. | 7.0 mm. | 8.5 mm. | 7.2 mm. |
| 3. | 6.0 mm. | 6.0 mm. | 5.0 mm. | 5.0 mm. | 6.5 mm. | 6.0 mm. |
| 4. | 8.0 mm. | 7.5 mm. | 5.5 mm. | 5.0 mm. | 8.0 mm. | 8.0 mm. |
| 5. | 4.0 mm. | 4.0 mm. | 5.0 mm. | 5.0 mm. | 6.0 mm. | 5.3 mm. |
| 6. | 8.0 mm. | 8.0 mm. | 7.0 mm. | 6.9 mm. | 18.0 mm. | 14.2 mm. |
| 7. | 16.0 mm. | 12.0 mm. | 23.0 mm. | 19.0 mm. | 34.0 mm. | 32.0 mm. |
| 8. | 8.0 mm. | 8.0 mm. | 7.0 mm. | 7.0 mm. | 13.0 mm. | 13.0 mm. |
| 9. | 5.0 mm. | 5.0 mm. | 8.0 mm. | 7.0 mm. | 14.0 mm. | 12.5 mm. |
| 10. | 8.0 mm. | 7.5 mm. | 8.5 mm. | 7.0 mm. | 12.0 mm. | 12.0 mm. |
| 11. | 5.5 mm. | 5.0 mm. | 6.0 mm. | 6.0 mm. | 6.0 mm. | 4.5 mm. |

Mean tricep measurement before Track training . . . 7.27 mm.

Mean tricep measurement after Track training . . . 6.72 mm.

Mean reduction of tricep adipose tissue . . . . . . . 0.55 mm.

Mean scapular measurement before Track training . . 8.00 mm.

Mean scapular measurement after Track training . . 7.35 mm.

Mean reduction of scapular adipose tissue . . . . . . 0.65 mm.

Mean flank measurement before Track training . . . 12.10 mm.

Mean flank measurement after Track training . . . . 11.02 mm.

Mean reduction of flank adipose tissue . . . . . . . 1.08 mm.

III. PULSE RATE TEST

(Scores indicate beats per minute)

| | RESTING | | POST-EXERCISE | |
|---|---|---|---|---|
| | BEFORE | AFTER | BEFORE | AFTER |
| 1. | 64 b/min. | 64 b/min. | 160 b/min. | 172 b/min. |
| 2. | 80 b/min. | 68 b/min. | 176 b/min. | 156 b/min. |
| 3. | 64 b/min. | 64 b/min. | 172 b/min. | 160 b/min. |
| 4. | 68 b/min. | 64 b/min. | 176 b/min. | 180 b/min. |
| 5. | 84 b/min. | 80 b/min. | 164 b/min. | 172 b/min. |
| 6. | 70 b/min. | 68 b/min. | 188 b/min. | 176 b/min. |
| 7. | 60 b/min. | 60 b/min. | 172 b/min. | 132 b/min. |
| 8. | 66 b/min. | 68 b/min. | 172 b/min. | 168 b/min. |
| 9. | 72 b/min. | 72 b/min. | 164 b/min. | 152 b/min. |
| 10. | 60 b/min. | 60 b/min. | 184 b/min. | 180 b/min. |
| 11. | 74 b/min. | 68 b/min. | 176 b/min. | 176 b/min. |

Mean resting pulse rate before Track training. . . 69.27 b/min.

Mean resting pulse rate after Track training . . . 66.90 b/min.

Mean reduction of resting pulse rate . . . . . . . . 2.37 b/min.

Mean post-exercise pulse rate before Track training.173.1 b/min.

Mean post-exercise pulse rate after Track training .165.8 b/min.

Mean reduction of post-exercise pulse rate . . . . . 7.3 b/min.

## IV. BLOOD PRESSURE TEST

(scores indicate millimeters of Mercury)

| | SYSTOLIC | | DIASTOLIC | |
|---|---|---|---|---|
| | BEFORE | AFTER | BEFORE | AFTER |
| 1. | 142 mm. of Hg. | 138 mm. of Hg. | 64 mm. of Hg. | 68 mm. of Hg. |
| 2. | 128 mm. of Hg. | 130 mm. of Hg. | 64 mm. of Hg. | 64 mm. of Hg. |
| 3. | 124 mm. of Hg. | 118 mm. of Hg. | 68 mm. of Hg. | 70 mm. of Hg. |
| 4. | 124 mm. of Hg. | 120 mm. of Hg. | 72 mm. of Hg. | 68 mm. of Hg. |
| 5. | 138 mm. of Hg. | 130 mm. of Hg. | 68 mm. of Hg. | 62 mm. of Hg. |
| 6. | 140 mm. of Hg. | 138 mm. of Hg. | 70 mm. of Hg. | 68 mm. of Hg. |
| 7. | 138 mm. of Hg. | 138 mm. of Hg. | 80 mm. of Hg. | 72 mm. of Hg. |
| 8. | 122 mm. of Hg. | 120 mm. of Hg. | 70 mm. of Hg. | 64 mm. of Hg. |
| 9. | 160 mm. of Hg. | 136 mm. of Hg. | 80 mm. of Hg. | 68 mm. of Hg. |
| 10. | 134 mm. of Hg. | 134 mm. of Hg. | 72 mm. of Hg. | 70 mm. of Hg. |
| 11. | 128 mm. of Hg. | 122 mm. of Hg. | 84 mm. of Hg. | 76 mm. of Hg. |

Mean systolic blood pressure before Track unit. .134.3 mm. of Hg.

Mean systolic blood pressure after Track unit . .129.8 mm. of Hg.

Mean reduction of systolic blood pressure . . . . 4.5 mm. of Hg.

Mean diastolic blood pressure before Track unit . 72.0 mm. of Hg.

Mean diastolic blood pressure after Track unit. . 68.1 mm. of Hg.

Mean reduction of diastolic blood pressure . . . 3.9 mm. of Hg.

## V. BICYCLE ERGOMETER TEST

(Level of physical fitness determined by time spent on ergometer--expressed in minutes and seconds)

| | BEFORE TRAINING | AFTER TRAINING |
|---|---|---|
| 1. | 10 min. 06 sec. | 11 min. 02 sec. |
| 2. | 11 min. 12 sec. | 11 min. 14 sec. |
| 3. | 9 min. 10 sec. | 9 min. 22 sec. |
| 4. | 9 min. 30 sec. | 10 min. 00 sec. |
| 5. | 8 min. 19 sec. | 8 min. 40 sec. |
| 6. | 8 min. 30 sec. | 10 min. 00 sec. |
| 7. | 7 min. 00 sec. | 8 min. 55 sec. |
| 8. | 10 min. 43 sec. | 11 min. 32 sec. |
| 9. | 9 min. 02 sec. | 9 min. 10 sec. |
| 10. | 10 min. 20 sec. | 10 min. 00 sec. |
| 11. | 9 min. 15 sec. | 10 min. 08 sec. |

Mean time spent on bicycle ergometer before training . . . .

9 min. 22 sec.

Mean time spent on bicycle ergometer after training . . . .

10 min. 00 sec.

Mean increase of time spent on bicycle ergometer . . . . . .

0 min. 38 sec.

# CHAPTER VIII

## SUMMARY AND CONCLUSION

The author has attempted in this study to define a correlation between Track and Field training as an integrated part of the Physical Education curriculum and improvement in the total physical fitness level of the participants. The students who volunteered for the project were given the aforementioned physiological tests both before and after they had subjected themselves to a six-weeks period of Track training. Physiological data was gathered and assimilated to determine the actual effects of the Track program on the physiological state of the body. The skin-fold test indicated that each boy averaged a reduction of 0.55 millimeters of subcutaneous adipose tissue on the tricep site, 0.65 millimeters on the scapular site, and 1.08 millimeters on the flank site. Further study revealed (1) a mean reduction of 2.37 beats per minute in resting pulse rate, (2) a mean reduction of 7.30 beats per minute in post-exercise pulse rate, (3) a mean reduction in systolic blood pressure of 4.5 millimeters of Mercury, (4) a mean reduction of diastolic blood pressure of 3.9 millimeters of Mercury, (5) an average increase in vital capacity per person of 4.8 milliliters, and (6) a mean improvement in time spent on the bicycle ergometer of 38 seconds per person.

The author contends that the bicycle ergometer test affords the amateur researcher the greatest evaluative information on training-fitness correlations because he can readily visualize the improvements made in work output. The other tests aforementioned, also aid the Physical Educator in evaluating the results of his program.

While there were gains made in all aspects of this testing program, the author is of the opinion that further research is necessary to determine if the gains are sufficient to merit acceptance of the hypotheses earlier established. It would be necessary to submit the scores to a "T" test to determine the elements of chance and significance. This work is being considered by the author for a later follow-up study. The author can state without reservation, however, that in this study, after a six-weeks period of Track training, there were definite reductions of subcutaneous fat tissue, pulse rate, and blood pressure while observing increases in vital capacity and work output as measured on the bicycle ergometer.

As Track and Field units in the high school Physical Education program may bring about a greater level of physical fitness, the author stresses his contention that more individualized instruction in this area is needed in our curriculum. Of paramount importance is the need for all Physical Educators to strive for greater attainment among their students of a higher level of fitness consciousness. Only then, can their other goals be attainable.

# BIBLIOGRAPHY

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## A. BOOKS


Anthony, Catherine P. _Textbook of Anatomy and Physiology._ St. Louis: C. V. Mosby Company, 1959.

Cureton, T. K. _Physical Fitness Appraisal and Guidance._ St. Louis: C. V. Mosby Company, 1947.

Gould, A. G. and Joseph A. Dye. _Exercise and Its Physiology._ New York: A. S. Barnes and Company, 1932.

Griffin, F. W. _The Scientific Basis of Physical Education._ London: The Oxford University Press, 1937.

Hayman, Howard S. _Your Health and Safety--For Teachers._ Chicago: Harcourt, Brace, and World Inc., 1963.

Karpovich, Peter V. _Physiology of Muscular Activity._ Philadelphia: W. B. Saunders Company, 1959.

Langley, L. L., E. Cheraskin, and Ruth Sleeper. _Dynamic Anatomy and Physiology._ New York: McGraw-Hill Book Company Inc., 1958.

Lawrence, T. G., J. W. Clemenson, and R. W. Burnett. _Your Health and Safety._ Chicago: Harcourt, Brace, and World Inc., 1963.

Morehouse, Lawrence E., and A. T. Miller. _Physiology of Exercise._ St. Louis: C. V. Mosby Company, 1953.

Schneider, E. C., and Peter V. Karpovich. _Physiology of Muscular Activity._ Philadelphia: W. B. Saunders Company, 1948.

Smith, D. W., and C. D. Gips. _Care of the Adult Patient._ Philadelphia: J. P. Lippincott Company, 1963.

Smithells, P. A., and P. E. Cameron. _Principles of Evaluation In Physical Education._ New York: Harper and Brothers, 1962.

Steinhaus, A. H. _Toward an Understanding of Health and Physical Education._ Dubuque, Iowa: William C. Brown Company, 1963.

## B. UNPUBLISHED MATERIALS


Kahn, H. A. "Relationship of Reported Coronary Heart Disease Mortality to Physical Activity of Work." Reported at the Epidemilogical Section, American Public Health Association Meeting, Miami, Florida, October 17, 1962.

Montoye, Henry J. "The Body of Knowledge in Physical Education: Biological." Presented at the thirty-fourth annual meeting, American Academy of Physical Education, Minneapolis, Minnesota, May 1, 1963. (Mimeographed.)


## C. PAMPHLETS


Lederle Laboratories. American Cyanomid Company, Pearl River, New York, 1967.


## D. PERIODICALS


Bock, A. V., C. Vancaulaut, D. B. Dill, A. Folling, and L. M. Hurxthal. "Dynamical Changes Occurring in Man at Work," Journal of Physiology, 66:136-143, 1928.

Bromwell, C., and R. Ellis. "Clinical Observations on Olympic Athletes," Arbeitsphysiologic, 2:51-59, 1929.

Brozek, J., and A. Keys. "Evaluation of Leanness-fatness in Man," Nutrition Abstract and Review, 20:247-252, October, 1950.

Brozek, J., and A. Keys. "Relative Body Weight, Age, and Fatness," Geriatrics, 8:70-76, February, 1953.

Cardus, David. "Computer Processing of Data Generated by A Bicycle Ergometer Test," The Journal of Sports Medicine and Physical Fitness. Vol. 7, No. 3 (September, 1967), 148-157.

Colton, F. S. "Relation of Athletic Status to Pulse Rate in Men and Women," Journal of Physiology, 76:39-42, 1932.

Garn, S. M., and R. V. Harper. "Fat Accumulation and Weight Gain in the Adult Male," Human Biology, 27:39-44, February, 1955.

Newman, R. W. "Skin-fold Changes With the Increasing Obesity In Young American Males," Human Biology, 27:53-61, May, 1955.

Robinson, S., and P. M. Harmon. "Effects of Training Upon Certain Factors Which Limit Muscular Work," American Journal of Physiology, 133:161-167, 1941.

Shepard, R. J. "Physiological Determinents of Cardio-respiratory Fitness," *The Journal of Sports Medicine and Physical Fitness*, Vol. 7, No. 3 (September, 1967), 112-117.

Tanner, A. H. "Vital Capacity in College Women," *American Journal of Physiology*, 87:667-671, 1929.

White, S. A. and P. F. McGuire. "Vital Capacity in a Citizen's Military Training Camp," *American Journal of Physiology*, 73:636-639, 1925.