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# The Effects of a Ten Week Jogging and Running Program on an Obese Subject

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# THE EFFECTS OF A TEN WEEK JOGGING AND RUNNING PROGRAM ON AN OBESE SUBJECT

(TITLE)

BY

MICHAEL J. CONROY

## THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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# CHAPTER I

## INTRODUCTION

Though, hopefully, the physical fitness of both youth and adults in our country is improving, it is evident that the physical capacity for leading an active life is below what it should be for many people. Looking at the problem from an evolutionary standpoint, it appears that the biological base of man has deteriorated while the sociocultural evolution of man has evolved at a rate dependent upon technological advances. Malina[1] presented two reflective questions.

> How long can man sustain his rapid sociocultural advancement on the same biological base? Do the diseases of modern society, especially cardiovascular disease, suggest signs of breakdown in man's physical machinery?

Is the American population enjoying the niceties of modern living at the cost of becoming "Home Sedentarius Americus?"[2]

Jogging programs have been initiated to primarily assist adults in obtaining an increased level of physical fitness. Little has been done

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[1] Robert M. Malina, "An Anthropological Perspective of Man in Action," New Perspectives of Man in Action, ed. Roscoe E. Brown and Bryant J. Cratty (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969), p. 151.

[2] Carl E. Willgoose, The Curriculum in Physical Education (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969), p. 32.

to provide progressive cardiovascular exercise to overweight and obese youth.

## I. STATEMENT OF THE PROBLEM

It was the purpose of this study to investigate the effects of a ten week progressive jogging and running program on selected metabolic, anthropometric, cardiorespiratory, and performance measurements on an obese subject.

## II. IMPORTANCE OF THE STUDY

Homeostasis provides for stability in body weight as evidenced by adult food consumption averaging a ton a year with a variation in body weight of not more than a few pounds.[3] However, for some persons, the balance between energy expenditure and food intake is being upset by changes in eating and exercising patterns of the present society. Results of a population that is either overfed or underactive has grouped approximately one fifth of all adults in a 10 to 20 per cent heavier than ideal weight category.[4,5] Johnson,[6] et al, found that 10 per cent of

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[3] J. V. G. A. Durnin, "The Influence of Nutrition," Proceedings of the International Symposium on Physical Activity and Cardiovascular Health, Vol. 96, No. 12 (March 25, 1967), p. 717.

[4] Malina, op. cit., p. 151.

[5] Warren R. Young, "Hope for the Many Members of the Obese Corps," Time-Life Books Special Report (New York: Time Inc., 1966), p. 72.

[6] M. L. Johnson, B. S. Burke, and J. Mayer, "The Prevalence and Incidence of Obesity in a Cross Section of Elementary and Secondary School Children," American Journal of Clinical Nutrition, IV (January-February, 1956), p. 24.

6,346 elementary and secondary school children in Boston were obese.

The relationship between childhood obesity and adult obesity was studied by Abraham.[7] He reported on a twenty year longitudinal study that clearly indicated overweight children have a tendency to become overweight adults more often than children of average weight.

In general, investigations reveal that obese children are less fit than they would be if they were not obese.[8, 9, 10, 11]

The studies presented indicate that obesity is prevalent in our society and it exerts an influence on physical fitness.

## III. LIMITATIONS OF THE STUDY

The fact that one subject was involved in the investigation provided information that related to an individual response to cardiovascular

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[7]Sidney Abraham and Marie Nordsieck, "Relationship of Excess Weight in Children and Adults," Public Health Reports, LIIV, (March, 1960), pp. 263-273.

[8]Durnin, op. cit., p. 717.

[9]K. M. Bookwalter, "The Relationship of Body Size and Shape to Physical Performance," Research Quarterly, XIII (October, 1952), p. 279.

[10]G. L. Wear and Kenneth Miller, "Relationship of Physique and Developmental Level to Physical Performances," Research Quarterly, XXXIII (December, 1962), p. 615.

[11]William Buckellew, "A Cross Sectional and Longitudinal Study of Various Factors of Growth and Development of Fifth, Sixth, Seventh, and Eighth Grade Boys," (Dissertation, University of Arkansas, Fayetteville, 1968), pp. 112-115.

exercise. Therefore, inferences to populations based upon the results of this study must be made with extreme caution.

# CHAPTER II

## REVIEW OF THE LITERATURE

Much has been written about obesity with particular concentration on epidemiological aspects. However, there are several studies which help to define the relationship of exercise in terms of cardiovascular fitness and anthropometric measurements to corpulance. In this review a three phased approach has been used to study the literature. Phase I presents the role that exercise plays in the reduction of body weight. The intensity at which exercise must be performed is discussed in Phase II. Phase III deals with the cardiovascular functioning in overweight and obese subjects.

### I. EXERCISE AND BODY WEIGHT

Whether to fast or to exercise in losing excess body weight has long been a controversial issue. Bloom[1] stated:

> The answer to the problem of obesity leaves two choices. Either caloric intake must be reduced below energy expenditure or energy expenditure must be increased above

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[1] Walter L. Bloom, "To Fast or Exercise," The American Journal of Clinical Nutrition, XX (December, 1968), p. 1478.

caloric intake to lose weight. For a fit society, the latter choice is the better.

Hein and Ryan,[2] Mayer,[3] and Stare[4] have suggested a fallacy has been perpetuated about the role that exercise plays in weight control: i.e., the energy demands of exercise are relatively little, and physical activity hardly changes caloric balance. In contrast, the researchers reported that energy cost of exercise was approximately proportional to body weight, and an overweight person will require more energy for the same amount of exercise than a slimmer individual. Consequently, physical activity of overweight people affected their caloric balance.

Johnson, et al,[5] investigated the eating and exercise patterns of 28 obese and 28 nonobese high school girls. The obese group was found to be more inactive and have a lower caloric intake than the

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[2]Fred V. Hein and Allan J. Ryan, "The Contributions of Physical Activity to Physical Health," Research Quarterly, XXXI (May, 1960), p. 265.

[3]Jean Mayer, "Weight Control," A Collection of Papers Presented at the Weight Control Colloquium (Ames: Iowa State College Press, 1955), p. 202.

[4]Jean Mayer and Frederick Stare, "Exercise and Weight Control Frequent Misconceptions," Background Readings for Physical Education (New York: Holt, Rinehart and Winston, 1965), p. 448.

[5]Mary L. Johnson, Bertha S. Burke and Jean Mayer, "Relative Importance of Inactivity and Overeating in the Energy Balance of Obese High School Girls," The American Journal of Clinical Nutrition, VI (January, February, 1956), p. 43.

nonobese group. In a similar study Stenfanik, et al,[6] compared the amount of food eaten to the degree of participation in physical activity of 14 obese adolescent boys. The control group who consisted of 14 nonobese boys had a higher caloric intake than the obese group. Little difference was noted in the amount of time scheduled for light, moderate and very active exercise. However, the obese group was observed to be generally less active than the nonobese group. It was indicated in both of the previous studies that the positive energy balance of the obese adolescents was related to their relative degree of inactivity.

## II. INTENSITY OF EXERCISE

The intensity at which work must be performed in order to significantly reduce body fat in the obese has been examined by several authors. Erber[7] designed a ten week circuit training exercise program in which weights and the body provided the resistance for seven specific exercises. Fourteen undergraduate college men participated in the program while an equal number did not engage in any organized physical

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[6] Patricia A. Stenfanik, Felix P. Heald, and Jean Mayer, "Caloric Intake in Relation to Energy Output of Obese and Nonobese Adolescent Boys," The American Journal of Clinical Nutrition, VIII:I (January-February, 1959), p. 61.

[7] Steven Erber, "The Effects of a Specific Exercise Program in the Body Composition of Young Adult Men," Abstracts of Research Papers (Washington, D.C.: NEA Publications, 1969), p. 45.

activities. It was concluded that the low intensity exercise program does not affect the body weight, body density, or percentage of total body fat of the subjects.

Cooper[8] stated that beneficial effects of cardiovascular exercise will start five minutes after a sustained heart rate of 150 beats per minute or more. If the exercise is not vigorous enough to meet the heart rate criterion even though there is an oxygen demand, the activity must be continued considerably longer than five minutes.

Kurelis and Cureton[9] used three subjects in strenuous treadmill running during a six week training period, thirty minutes each training session and three sessions per week. The authors found that loss was proportional to the miles cumulatively run. However, the subjects increased their muscular density. For this reason, it was felt weight loss was not a good index of fat loss.

A study designed to investigate the effects of a ten week training program with voluntary dietary control was conducted by Knowlton and

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[8] Kenneth H. Cooper, Aerobics (New York: M. Evans and Company, 1968), p. 23.

[9] Ramon W. Kurelis and Thomas K. Cureton, "The Relationship of External Fat to Physical Education Activities and Fitness," Research Quarterly, XVIII (September, 1948), p. 133.

Weber.[10] Eighteen experimental and five control subjects of similar obese physique were measured on physical variables related to fat deposition, metabolic variables related to aerobic efficiency and acid-base balance of capillary blood. The authors indicated that with one exception the experimental group had a mean weight loss of 13 pounds; however, this was not adequate to significantly eliminate obesity.

In a case study reported by Jokl[11] a 15 year old boy who was five feet five and three-fourths inches tall and weighed 209 pounds was admitted to a special rehabilitation boarding school. He received intensive training in calisthenics, apparatus gymnastics, weight lifting, track and field activities, games, swimming and military drill during a ten month period with each daily session lasting approximately three hours. During this time no dietary measures were applied. At the conclusion of the study the subject lost 55 pounds with a development of a noticeable muscle relief over the extremities and trunk.

## III. CARDIOVASCULAR FUNCTIONING

There have been several very interesting studies related to

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[10] Ronald G. Knowlton and Herb Weber, "The Effect of Progressive Endurance Training and Voluntary Diet Restriction on Physique and Metabolic Variables in Markedly Obese Subjects," Carbondale, Illinois: Southern Illinois University, 1969, (Mimeographed)

[11] Ernest Jokl (ed.), "Obesity Due to Physical Inactivity," _Nutrition, Exercise and Body Composition_ (Springfield, Illinois: Charles C. Thomas Publishers, 1964), pp. 43-45.

cardiorespiratory efficiency in obese subjects.

White and Alexander[12] found that the basal metabolic rate of 109 obese subjects was within normal limits while the mean values for oxygen consumption were considerably higher than those predicted at ideal body weight.

Dempsey, et al.[13] used a bicycle ergometer in examining the physiologic cost of performing equal work loads and the aerobic capacity of the oxygen transport system in 14 obese and 14 normal, healthy and sedentary males. The cardiopulmonary responses were taken during two periods of relatively moderate work at 500 and 850 kpm. Maximum values were measurements during the highest work load attained by each subject in one of three or more ergometer tests. Obese subjects' reaction to moderate work demonstrated increased energy expenditure per unit of work load reflected by a higher level of anaerobic work, elevated blood pressure, heart rate, and pulmonary ventilation. In maximal work bouts the oxidative energy available was severely reduced. The authors stated the following in discussion of the results:

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[12] Robert L. White and James K. Alexander, "Body Oxygen Consumption and Pulmonary Ventilation in Obese Subjects," Journal of Applied Physiology, XX (March, 1965), p. 197.

[13] J. A. Dempsey, W. Reddan, B. Balke, and J. Rankin, "Work Capacity Determinants and Physiologic Cost of Weight Supported Work in Obesity," Journal of Applied Physiology, XXI (November, 1966), pp. 1815-1820.

> One unique characteristic of obese subjects--without exception markedly different from what would be expected in young, normal adult males--was that of an extremely narrow exercise cost capacity margin. In other words, the grossly obese person performed a routine task--even of a weight supported nature--with a physiologic cost which was markedly greater than normal, and yet, possessed a capacity for energy expenditure which was less than normal.

Knowlton and Weber[14] observed improvements in aerobic potential in submaximal and maximal exertion tests on a bicycle ergometer at the conclusion of a ten week training program for obese subjects.

The metabolic cost of treadmill running was investigated by Miller and Blyth.[15] Thirty moderately active male college students were selected to provide a wide range of body types and fat content. The treadmill was set at five miles per hour and ten per cent grade. During the last five minutes of a 15 minute run the expired air was collected with an open circuit method using Haldane analysis. It was concluded that height and fat content slightly influenced the metabolic cost of work and cost could be predicted more accurately by gross body weight. Exercise oxygen consumption requirement per unit of lean body mass increased as the body fat content became greater and obesity increased the energy cost of exercise without increasing the

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[14] Knowlton and Weber, loc. cit.

[15] A. T. Miller and Carl S. Blyth, "Influence of Body Type and Body Fat Content on the Metabolic Cost of Work," Journal of Applied Physiology, VII (September, 1955), pp. 139-141.

maximal capacity for oxygen uptake. Welch,[16] et al, found similar results using 28 young men.

The effects of an intense exercise program with a modified caloric intake of 1,700 calories per 24 hours was investigated by Sprynarova and Parizkova.[17] Seven obese boys who had a mean age of 11 years six months participated daily for seven weeks at a recreational therapeutic camp. The results indicated a significant drop in body weight mainly due to a decrease in adipose tissue. While the subjects reduced in lean body mass, the ratio between lean body mass to body weight increased. It was thought that body composition and not functional deterioration lead to a decrease in the absolute values of oxygen consumption.

## IV. SUMMARY

Physical activity of overweight people affects their caloric balance. When caloric values are estimated it should be remembered that an overweight person performs a workload at a greater energy

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[16] B. E. Welch, R. P. Riendeau, C. E. Crisp, and R. S. Isenstein, "Relationship of Maximal Oxygen Consumption to Various Components of Body Composition," Journal of Applied Physiology, XII (May, 1958), p. 395.

[17] Stepanka Sprynarova and Jana Parizkova, "Changes in the Aerobic Capacity and Body Composition in Obese Boys after Reduction," Journal of Applied Physiology, XX (September, 1965), p. 934.

cost than a slimmer individual. Two very interesting studies substantiated the importance of exercise in obese adolescent populations.

Intense physical activity, particularly of a cardiovascular nature, appeared to play an important role in the reduction of excess body weight. A relationship was established between aerobic efficiency and the decreased body weight.

Investigations on cardiovascular functioning clearly indicated that the physiological cost of exercise was greater and the exercise capacity was less in the obese and overweight population when compared to a normal weight group.

# CHAPTER III

# PROCEDURE

The purpose of the study was to investigate the effects of a ten week training program on selected metabolic, anthropometric, cardiorespiratory, and performance measurements on an obese subject.

## I. SUBJECT

One male subject, J. D., was chosen for this investigation. The subject was 17.7 years old and a senior at Charleston High School in Charleston, Illinois, during the spring of 1969. Initially, he weighed 214.8 pounds (97.64 kilograms) and was 5 feet 9 3/4 inches (175 centimeters) tall. A complete description, including pictures taken during the second week and at the conclusion of the training program, can be found in Chapter IV.

### Motivation

It is questionable what combination of factors motivated the subject to do something about his physical condition. The investigator believes the following factors should be considered. The father of J. D. was an active member of the Run for Your Life Program at

Eastern Illinois University. On occasions the subject was encouraged by his father to engage in a daily running program.

Prior to volunteering as a subject for this thesis, J. D. was one of a group of high school students who had indicated a desire to take part in another investigation involving rope jumping. Following a preliminary screening by a local physician and consultation with J. D.'s personal physician, it was felt that his elevated blood pressure and excess body weight should preclude his participation in the rope jumping study.

Other motivational factors may have been J. D.'s interest in performing well on an up-coming physical fitness test and, in general, his physical appearance as it related to social contacts at school.

With this background, J. D. became concerned about his physical health. It was after expressing this concern to the Director of Research in Physical Education at Eastern Illinois University that J. D. was invited to be a subject for research on March 27, 1969.

## Background Information

This investigator became interested in the project and initiated a series of interviews with J. D.'s parents and some of his former teachers. From the discussions, it was found that the subject began to gain excessive weight at age ten. In following years the body weight of the subject steadily increased until he weighed approximately 231 pounds one week prior to initial testing ($T_1$). Pictures of the subject

when he was 12, 13, 15, and 17 years of age are in Appendix A.

It is important to note that J. D. was moderately active and enjoyed physical activity, especially swimming. During the fall, winter, and early spring of 1968-69 he frequently rode a bicycle to and from school, located approximately one and one-fourth miles from his home. In addition, he owned two horses which required daily attention. The subject enjoyed participating in physical education where he received instruction primarily in team sports. Although he did not engage in intramural or interscholastic athletics, he frequently practiced and played team games in his free time.

Academically, the subject ranked in the upper 20th percentile in a class of 234 students. Besides enjoying academic success, he was a popular student.[1]

Between the initial interview with the subject and the testing period ($T_1$), the subject began jogging voluntarily. He used an interval training method with interval runs under 440 yards. J. D. also took diet pills at the suggestion of his local physician three weeks before testing and during the first week of the study, but then ceased to use them. He did not plan on using the tablets in the future. Daily body weights were taken, but not analyzed.

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[1]Personal communication with John Erickson, Physical Education Instructor, Buzzard Laboratory School, Eastern Illinois University, Charleston, Illinois, and Coach Mervin C. Baker, Physical Education Supervisor, Charleston High School, Charleston, Illinois.

## II. TRAINING PROGRAM

The training program began on March 31, 1969, and concluded on June 9, 1969. There were a total of 49 formal training sessions; and with one exception, the writer engaged in all formal training sessions with the subject. J. D., also, voluntarily engaged in ten, informal week-end training sessions throughout the ten week period.

### Description

Thirty-six training sessions occurred in the afternoon at 3:30 p.m. with one session starting as late as 5:15 p.m. Thirteen training sessions were scheduled to start at about 6:30 a.m. because of the excessive afternoon heat. All sessions were approximately 50 minutes in duration.

Frequent pre-exercise blood pressures and heart rates were recorded throughout the training program. In addition, post-exercise heart rates were obtained. The subject was informed of the relationship between the recordings and his level of cardiorespiratory fitness.

Warm-up and cool-down. J. D. performed approximately five minutes of calisthenics to warm-up for the cardiorespiratory phase of training. An emphasis was placed on bending and stretching activities for the purpose of increasing the suppleness of the musculature involved in running.

At the completion of the running phase of the workout, the

subject and the investigator walked from 220 to 440 yards. This cool-down period provided an excellent opportunity to ascertain the subject's physical and psychological reaction to the intensity of the exercise.

Running program. The running phase of the training program was the most important activity used in conjunction with this study. Initially, the sessions were designed to provide the subject with successful experiences while he was developing his aerobic capacity, legs, and feet. During the first six weeks the interval method of training was utilized. Goals were established so that as the program progressed he was challenged by either the distance of the run or the number of repetitions completed. J. D. was gradually conditioned until he could perform continuous submaximal runs without rest intervals. The values of a submaximal training program in developing a maximal cardiorespiratory response has been reported by several investigators.[2, 3]

While the interval training method was used frequently throughout this investigation, it in no way infers that J. D. was engaged in maximal work of a short duration. It was assumed that some degree

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[2]Han Karlsson, Per-Olof Astrand, and Fjorn Edblom, "Training of the Oxygen Transport System in Man," Journal of Applied Physiology, XXXII (June, 1967), pp. 1061-1065.

[3]Donald K. Mathews, Richard Bowers, Edward Fox, William Wilgus, "Aerobic and Anaerobic Work Efficiency," Research Quarterly, XXXIV (October, 1963), pp. 356-360.

of anaerobic work was performed during training especially since the subject enjoyed increasing his pace in the later phase of his run. However, in all cases the submaximal workouts were designed to improve aerobic power. A complete description of the daily running program can be found in Appendix B.

On the last day of the training week, usually on Friday, the subject participated in one of two performance runs held on an indoor track. In one he walked or ran for 30 minutes with the intent of covering as much distance as possible. The other was designed to evaluate the speed at which he could run a two mile distance. The high intensity and long duration of the performance runs was designed to provide a meaningful indication of J. D.'s running improvement and an indirect assessment of his aerobic power. It was hypothesized that in a laboratory testing situation the subject would have found it difficult to become aware of his advancements in cardiorespiratory performance.

At the completion of each training session J. D. recorded the total number of miles he had traveled walking and running. Later he transferred this mileage to an Illinois map in an attempt to reach a geographical location about 218 miles from Charleston, Illinois (Horseshoe Lake Conservation--Southern Illinois) on or before the final training day. The subject selected this goal after discussing the training program format with the investigator. Periodically throughout the training program the investigator questioned J. D. about the

number of miles he had accumulated.

Modifications of the training program. The incidence of calf and thigh muscle soreness, particularly in the second, third, and fourth training weeks, was an occurrance that could have been related to the rapid progression in the number of miles run during training.

While the investigator was very concerned about the physical health of J. D., it was felt that without initial observable success in weight reduction he might have continued taking diet pills beyond the first week of training. It was also interesting to note that J. D. expected to work hard and when the investigator was forced to modify the training program, the subject became somewhat discouraged. After the third week of training he attributed his weight loss primarily to the training progression.

Exercise phase of the training program. Since running does not adequately exercise many of the upper torso muscles, weight resistant exercises were performed periodically throughout the training program.[4] J. D.'s progress in the exercise phase of the training program could have helped motivate him in the cardiorespiratory phases of training (refer to Appendix C, D, and E). On many occasions the

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[4] Thomas K. Cureton, "Improvements In Oxygen Intake Capacity Resulting from Sports and Exercise Training Programs: A Review," American Corrective Therapy Journal, XXIII (September-October, 1969), pp. 144-147.

time required to complete the running program made it impossible to schedule the calisthenics and weight training.

Facilities

Numerous facilities were used for the running phase of the program. During inclement weather the indoor track at Eastern Illinois University was used. The track was oval-shaped, asphalt surfaced and 220 yards around. When the indoor track was not available, the subject used the corridor (with square corners) encompassing the basketball court and wrestling room on the bottom floor of the Lantz Gymnasium. The corridor was 215 yards in length with a tile and cement floor; therefore, a slow pace was maintained to avoid slipping and bumping into people. Four workouts were held using this facility.

During nice weather the training program was held on three different outdoor sites. In the initial stages of the outdoor program a one-fourth mile cinder track and a grass cross country running path were used. In the last two weeks of training the workouts were held on roads in close proximity to Eastern Illinois University. To avoid unnecessary hazards, either lightly traveled roads were used or the workout time was scheduled early in the morning. One of the "road courses" was 4.6 miles and contained a 300 yard uphill grade of approximately 12 per cent.

Periodically, the Eastern Illinois University Weight Training Room was used for the exercise phase of the program.

# III. MEASUREMENTS

Three evaluative tools were used to observe the response of J. D. to the training program. They included the following: (1) Initial, intermediate and final laboratory testing; (2) Blood pressures and heart rates throughout the training program; and (3) Performance runs during the training program. In addition, daily caloric intakes were recorded.

## Initial, Intermediate, and Final Laboratory Testing

Metabolic, anthropometric, and cardiorespiratory measurements were taken at $T_1$ (during the week preceeding the first training session), at $T_2$ (during the sixth week of training), and at $T_3$ (in the week following the last training session). Each test ($T_1$, $T_2$, $T_3$) consisted of four parts: (1) Basal metabolic rate; (2) Resting heart rate and blood pressure; (3) Anthropometric measurements; and (4) Cardiorespiratory measures during a submaximal and maximal treadmill run. The basal metabolic rate and anthropometric tests were administered early in the morning. One to five days later the submaximal and maximal treadmill running teste were administered. Treadmill testing was performed in the afternoon. All testing was conducted in the Physical Education Research Laboratory at Eastern Illinois University.

Basal metabolic rate. A closed circuit Colline 13.5 Liter Respirometer wae used to measure basal metabolic rate. The subject

received approximately eight hours sleep and had no food or liquid intake for 12 hours before the examination. The testing started after the subject rested lying one-half hour in a comfortable position. It was emphasized that the subject try to concentrate on subject matters other than breathing so that a quiet tracing without hyperventilation spikes could be obtained. The subject was also instructed to keep his lips tightly around the mouthpiece. One hundred per cent pure oxygen was used to flush the respirometer bell. After two flushings the bell was approximately three-fourths full with pure oxygen. The closed circuit system sent expired air through a soda lime canister thus absorbing the carbon dioxide. The kymograph was set at 32 mm. per minute. A nose clip was applied and a sterilized rubber mouthpiece attached to a free breathing valve was placed between the teeth and lips of the subject. The subject was allowed to acquaint himself with breathing through a mouthpiece for a few minutes. When the subject was ventilating at a near constant rate and depth the ten minute basal metabolic rate examination started. Pure oxygen was reintroduced when the bell appeared to be less than one-fourth full. A three minute sample that appeared representative was analyzed. Measurements were corrected to standard temperature, pressure, dry bulb (S.T.P.D.).

Resting heart rate and blood pressure. At the conclusion of the ten minute basal metabolic rate test, a fifteen second heart rate

and a blood pressure reading were obtained. The heart rate was obtained manually at the carotid artery while the subject was in a supine position. Refer to page 32 for the procedures used in determining the blood pressure readings.

Anthropometric measurements. Girth, skinfold, width, and depth measurements were taken immediately following the resting heart and blood pressure determinations. During this phase of testing J. D. had an empty bladder. Wearing only an athletic supporter, he was weighed to the nearest quarter pound on a caliberated Healthometer Scale and then the reading was converted to kilograms by dividing by 2.2. Height was recorded to the nearest one-half centimeter.

1. Girth measurements. Ten circumference measurements were taken. A two meter Lufkin anthropometric tape with a spring tension cylinder was used. Table I describes the area, specific location, and the procedures used in obtaining the girth measurements.

2. Skinfold measurements. Skinfold thickness measurements were made on 14 locations. Table II describes 12 of the areas including specific location and procedures used to obtain the readings. Figure I displays the location of two gluteal folds. All meaeurements were taken on the right side of the body using a Lange Skinfold Caliper. The procedures used were deecribed by Consolasio, et al.[5]

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[5]Frank Consolazio, Robert Johnson, and Louis Pecora, Physiologic Measurements and Metabolic Functions in Man (New York: McGraw-Hill Book Company, 1963), p. 24.

TABLE I

AREA, SPECIFIC LOCATION, AND PROCEDURES USED IN OBTAINING GIRTH MEASUREMENTS

| AREA | SPECIFIC LOCATION | PROCEDURE |
|---|---|---|
| Neck | Tape crossing the hyoid bone. | Lying down--neck muscles relaxed. |
| Shoulder | Tape level with a point 1" below the acromium process. | Standing--taken at the end of normal expiration. Tape held on shoulders. Tape read at a point even with the vertebra. |
| $Chest_1$ | Tape level with the xiphoid process. | Standing--taken at the end of normal expiration. |
| $Chest_2$ | Tape level with the xiphoid process. | Standing--taken at the end of maximal expiration. |
| Right Upper Arm | Tape level with a point 6" above the olecranon process. | Sitting--arms hanging straight. |
| Right Lower Arm | Tape level with a point 2" below the olecranon process. | Standing--arms hanging straight. |
| Abdomen | Tape level with the umbilicus. | Standing--taken at the end of normal expiration. |
| Hip | Tape level with a point 6" below the umbilicus. | Standing--Gluteal muscles contracted. |
| Right Thigh | Tape level with a point 9" above top of the patella. | Standing |
| Right Calf | Tape level with a point 5" below the base of the patella. | Standing |

TABLE II

AREA, SPECIFIC LOCATION, AND PROCEDURES USED IN OBTAINING TWELVE SKINFOLD MEASUREMENTS

| AREA | SPECIFIC LOCATION | PROCEDURE |
|---|---|---|
| $Face_1$ | Caliper over the zygomatic bone. | Vertical fold. |
| $Face_2$ | Caliper over posterior crest of the mandible. | Standing--head and shoulders against a wall. Diagonal fold. |
| Neck | Caliper over the hyoid bone. | Standing--head and shoulders against a wall. Vertical fold. |
| Anterior Chest | Nipple in the middle of the caliper. | Taken at the end of normal expiration. Diagonal fold. |
| Posterior Chest | Caliper 1" below and medial to the axilla. | Taken at the end of normal expiration. Diagonal fold. |
| Upper Arm | Caliper 1" above the olecranon process. | Forearm on table, $90^{\circ}$ angle in arm. Muscles contracted. Vertical fold. |
| $Abdomen_1$ | Caliper 4 1/2" above the umbilicus. | Caliper immediately right of abdominal mid-line. Contracted abdominal muscles. Vertical fold. |
| $Abdomen_2$ | Caliper 1" right of the umbilicus. | Vertical fold. |
| $Abdomen_3$ | Caliper 2" right of the umbilicus. | Stationary arm of the caliper at naval level. Horizontal fold. |
| Hip | Caliper on anterior spine of the illium. | Taken at the end of normal expiration. Contracted abdominal muscles. Vertical fold. |
| Anterior Thigh | Caliper 8" from the top of the patella. | Sitting--leg at a $90^{\circ}$ angle. Vertical fold. |
| Posterior Calf | Caliper level with a point 10 1/2 inches above the superior aspect of the external malleous. | Sitting--leg at a $90^{\circ}$ angle. Gastrocnemius contracted. Vertical fold. |

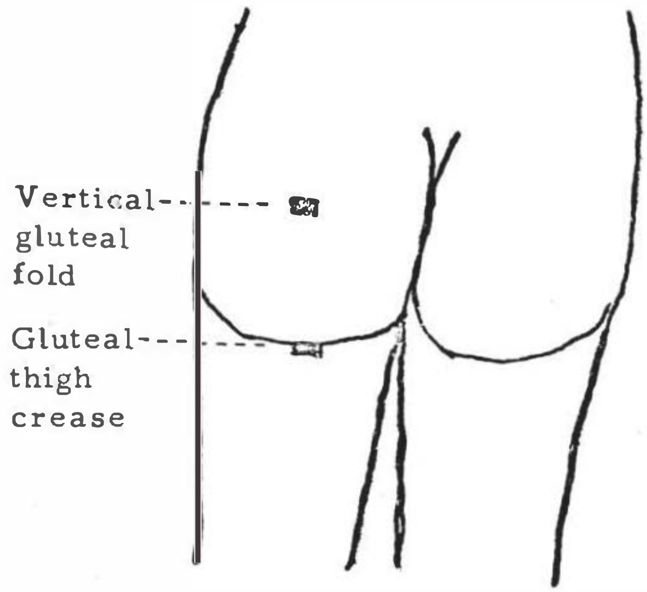


FIGURE I

LOCATION OF TWO GLUTEAL FOLDS

3. Width measurements. Employing a shoulder breadth caliper the shoulder, chest, and hip width measurements were determined. The instrument consists of a wooden bar which slides along a graduated measuring arm. In recording the shoulder width, the fixed and moveable arm of the instrument were touching the acromium processes. The reading was taken from a posterior position after the subject finished a normal expiration. In measuring the chest width the fixed and moveable arm of the caliper were touching opposite sides of the thorax, level with the xiphoid process. Otherwise, the procedures were the same as those listed above. The hip width measurement was taken at a level six inches below the umbilicus with the subject standing.

4. Depth measurement. The chest depth was recorded by using a chest depth caliper. The instrument was level with the xiphoid process, and the reading was taken at the end of normal expiration. The subject was standing.

Cardiorespiratory measures during treadmill running. Data was obtained on the cardiorespiratory response of the subject to a submaximal and maximal treadmill run. An A. R. Young treadmill was used for this phase of testing.

1. Submaximal treadmill run. The test consisted of a five minute run at six miles per hour (no grade) followed by a ten minute and 20 second recovery period. Besides this test serving as a warm-up for the maximal treadmill run, data was obtained on submaximal

recovery blood pressures and heart rates.

a. Blood pressure. A pre-run blood pressure reading was taken approximately three minutes prior to the run with the subject seated in a chair on the treadmill. Recovery measurements occured at one minute and 20 seconds and every minute thereafter throughout an eleven minute and 20 second recovery period. The basic procedures used were the same as those found on page 34.

b. Heart rates. A telemetry system was used to monitor the heart rate during exercise and recovery periods. The skin in the immediate area of the $V_5$ and $V_{5R}$ chest lead location was prepared while the subject was in a supine position. Procedures used for the preparation were similar to those employed by Kobayashi.[6] The skin was shaved and a small amount of electrode jelly was applied with a cotton Q-tip and briskly rubbed until the skin appeared red in color. Then, the excess jelly was removed. A pea sized drop of electrode jelly was placed on the electrode contact screen. Two electrodes were positioned on the skin, the patient cable was snapped into place and secured by placing surgical tape over each electrode and several inches of the cables. The electrocardiogram was transmitted to an RKG Model 100 receiving unit. The signal was then sent to a Sanborn Model 500 Viso

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[6] Yoshio Kobayashi, "The Effects of Rope Jumping on Cardio-respiratory Fitness of High School Students," (Unpublished Master's Thesis, Eastern Illinois University, 1969.)

Cardiette and a physio-scope, which allowed a constant visual inspection of the E.C.G.

A five second sample of the heart rate was taken approximately three minutes prior to the submaximal treadmill running with the subject seated. In addition, recordings were made during the last five seconds of each minute of the testing and recovery (15 minutes) period. During $T_3$ the RKG Model 100 transmitter did not function. Consequently, heart rates were not recorded.

c. Orientation to open circuit respirometry. The respiratory data obtained during the submaximal treadmill run was not analyzed in this study. The subject used the submaximal treadmill run as an orientation to the open circuit respirometry procedures employed during the maximal treadmill run.

2. Maximal treadmill run. Immediately following the submaximal treadmill run a 20 minute recovery and rest period commenced. The subject began the maximal treadmill run at the completion of the rest period.

$T_1$ and $T_2$ maximal treadmill runs consisted of the subject running as long as possible with the treadmill set at six miles per hour and four per cent grade. At $T_3$, in order to create a greater physiological stress on the subject, the treadmill speed was increased to seven miles per hour. During the first two minutes the grade was set at four per cent. In each succeeding minute, the grade was increased

to 6, 8, 10, 12, and 14 per cent respectively.

a. Blood pressure and heart rate. The procedures used to obtain the data have been described on page 32. Blood pressure readings were taken at each minute during seven minutes of the recovery period. The heart rate was determined by telemetry and recordings were made during the maximal treadmill run and eight minutes into the recovery period. At $T_3$, do to a nonfunctioning telemetry unit, the only pulse rate recorded was a 15 second sample taken at the carotid artery immediately following the run. Recovery blood pressures were not taken during $T_3$.

b. Pulmonary ventilation. A 30 second sample was taken at a time the subject felt that he could not continue running for one additional minute. J. D. ventilated into a Collins "Triple J" valve which was connected by a hose to a 600 Liter Chain Compensated Gasometer ($T_1$) and a Model $CD_4$ Parkinson-Cowan Gas Meter ($T_2$ and $T_3$).

c. Oxygen uptake. Expired air passed through a plexiglass sampling chamber before entering the 600 Liter Chain Compensated Gasometer ($T_1$). In $T_2$ and $T_3$ the expired air passed through the Model $CD_4$ Parkinson-Cowen Gas Meter, then to the plexiglass sampling chamber where it was drawn out by a small vacuum pump utilizing the metalized bag technique.[7] Samples were analyzed by a Beckman Model

[7]Robert E. Johnson, Francis Robbins, et al, "A Versatile System for Measuring Oxygen Consumption in Man," Journal of Applied Physiology, XXII (February, 1967), pp. 377-379.

$E_2$ Oxygen Analyzer.

Blood Pressure and Heart Rates Throughout the Training Program

In addition to $T_1$, $T_2$, $T_3$, tests, resting pre-exercise blood pressures and heart rates were taken and recorded throughout the training program. Post-exercise heart rates were also recorded periodically throughout the training program.

Blood pressure. Blood pressure readings were taken before 25 of the workout sessions. The Baumanometer Sphygmomanometer with a V - Lok Cuff and a Rieger Bowles Stethoscope were the instruments used for this measurement. The subject was comfortably seated, however, no appreciable time was allowed for complete relaxation. The investigator did attempt to keep the subject at ease as much as possible by informal discussion. The arm was slightly flexed, abducted and relaxed with the forearm supported at approximately the level of the heart. It was found the best readings were obtained when the hand was in a supinated position. The cuff was applied evenly and snugly around the arm. The lower edge of the cuff was about one inch above the antecebital space. A stethoscope was placed snugly over the artery in the antecebital space and the cuff pressure was quickly elevated to approximately 180 mm Hg. At that point it was decreased slowly until the first sound was heard. This reading was recorded as the systolic blood pressure while deflation was continued at a rate of two to three mm Hg. per heart beat. When the heart beat

could no longer be heard, the diastolic pressure was recorded.[8]

Basal conditions were not established for the blood pressure readings. It was felt by the writer that familiarization with the administration of frequent blood pressure readings helped establish validity during the testing periods. High blood pressure was one of the primary reasons the subject was excluded from the study by Mr. Kobayashi.[9] Consequently, the subject expressed an interest in this measurement.

Heart rates. Twenty-one pre- and post-exercise heart rates were recorded. The pre-exercise 15 second heart rate was taken after the subject completed several light warm-up activities. Immediately following the running phase of the training session, the post-exercise heart rate was recorded. Both pre- and post-exercise rates were obtained manually for 15 seconds at the carotid artery while the subject was in a seated position.

Performance Runs During the Training Program

On four occasions J. D. was timed at two miles, while on four other days, he walked and ran as far as possible in 30 minutes. These runs were conducted weekly on the indoor track so that environmental

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[8] Sidney Grollman, Laboratory Manual of Human Anatomy and Physiology (Minneapolis, Minn.: Burgess Publishing Company, 1955), p. 136.

[9] Kobayashi, loc. cit.

factors, such as wind, rain, temperature, and running surface, could be controlled.

Daily Food Consumption

Records were also maintained on the type of food and the number of servings consumed during meals and snacks.

# CHAPTER IV

## ANALYSIS OF THE DATA

A case study was the vehicle used to investigate the effects of an aerobic training program on selected metabolic, anthropometric, cardiorespiratory and performance measurements. A total of 59 fifty-minute training sessions were performed during the ten week training program. Progress was evaluated through a three-phased testing program that was administered three times during the investigation ($T_1$, $T_2$, and $T_3$). In addition, performance measurements were taken throughout the training program.

## I. FINDINGS AND DISCUSSION

### Initial, Intermediate, and Final Laboratory Testing

Basal metabolic rate, resting heart rate and blood pressure, anthropometric measurements and cardiorespiratory measurements taken during treadmill running were the tests administered on three occasions ($T_1$, $T_2$, and $T_3$) during the study.

Basal metabolic rate. A three minute representative sample of a ten minute closed circuit basal metabolic rate examination revealed that J. D. required fewer calories for maintenance functions as the

investigation progressed. (See Figure 2.)

In this study J. D. had a more noticeable decrease in basal metabolic rate than those reported in other investigations.[1, 2, 3] This could be attributed to anticipation causing a non-basal condition at $T_1$ even though the subject was orientated to the testing procedures several days prior to the initial test. Also, the parameters were based on the subject's total body weight, not his lean body mass.

Resting heart rate and blood pressure. Figure 3 reveals the economizing effect of training upon resting heart rate of the subject. The greatest improvement was observed in the initial six weeks of training. However, the most striking example of a trained individual was observed in $T_3$ with a resting heart rate reading of 56 beats per minute.

It is interesting to note that Costill[4] concluded that resting

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[1] Laurence E. Morehouse and Augustus T. Miller, Physiology of Exercise (St. Louis: C. V. Mosby Company, 1967), p. 254.

[2] C. Frank Consolozio, Robert E. Johnson, and Louis J. Pecora, Physiological Measurements of Metabolic Functions in Man (New York: McGraw-Hill Book Company, 1963), p. 355.

[3] Robert I. White and James K. Alexander, "Body Oxygen Consumption and Pulmonary Ventilation in Obese Subjects," Journal of Applied Physiology, XX (March, 1965), p. 197.

[4] David L. Costill, "The Relationship Between Selected Physiological Variables and Distance Running Performance," The Journal of Sports Medicine and Physical Fitness, VII (March, 1967), pp. 61-66.

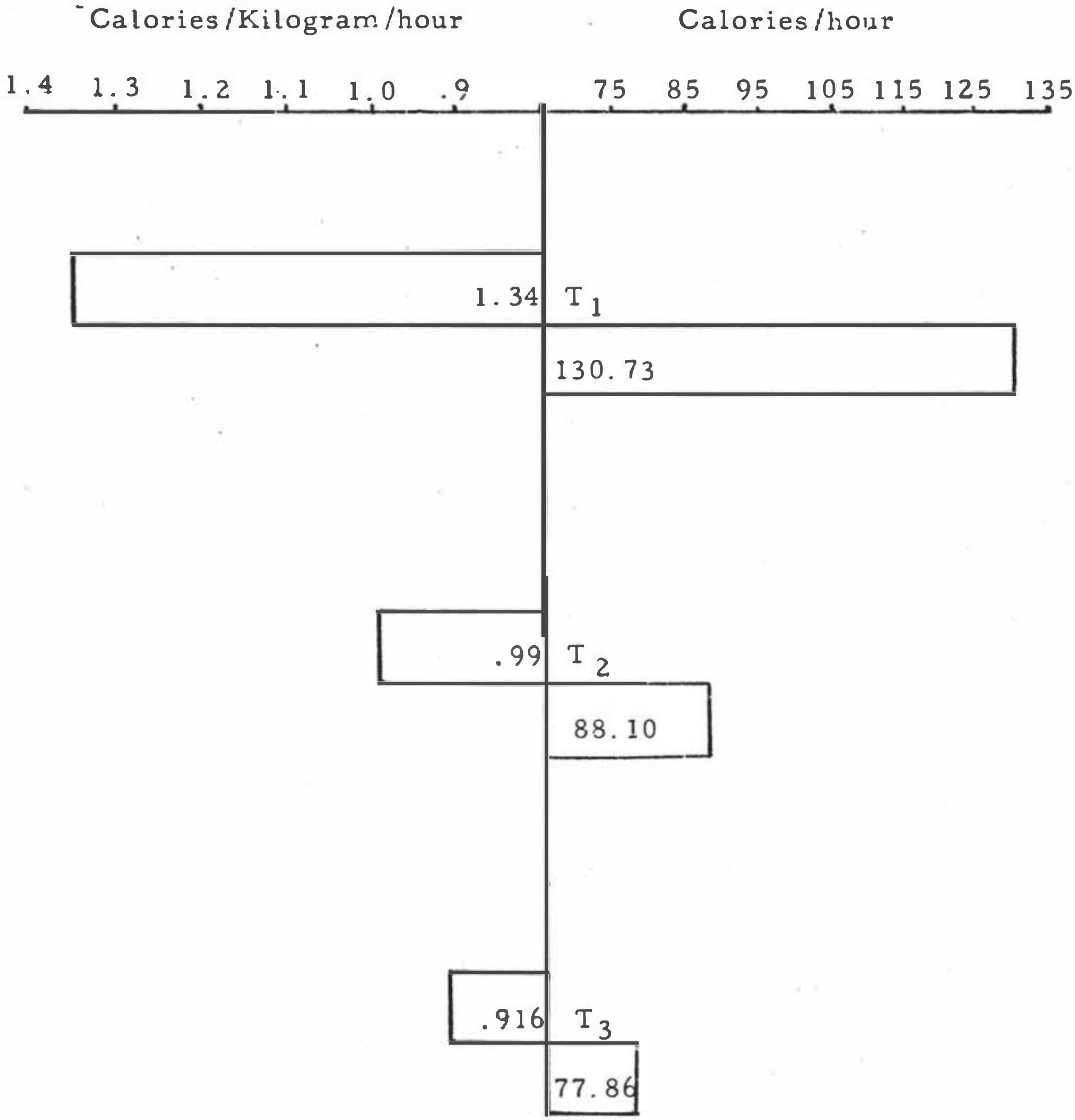


FIGURE 2

BASAL METABOLIC RATE IN CALORIES PER KILOGRAM OF BODY WEIGHT PER HOUR AND CALORIES PER HOUR AT $T_1$, $T_2$ AND $T_3$.

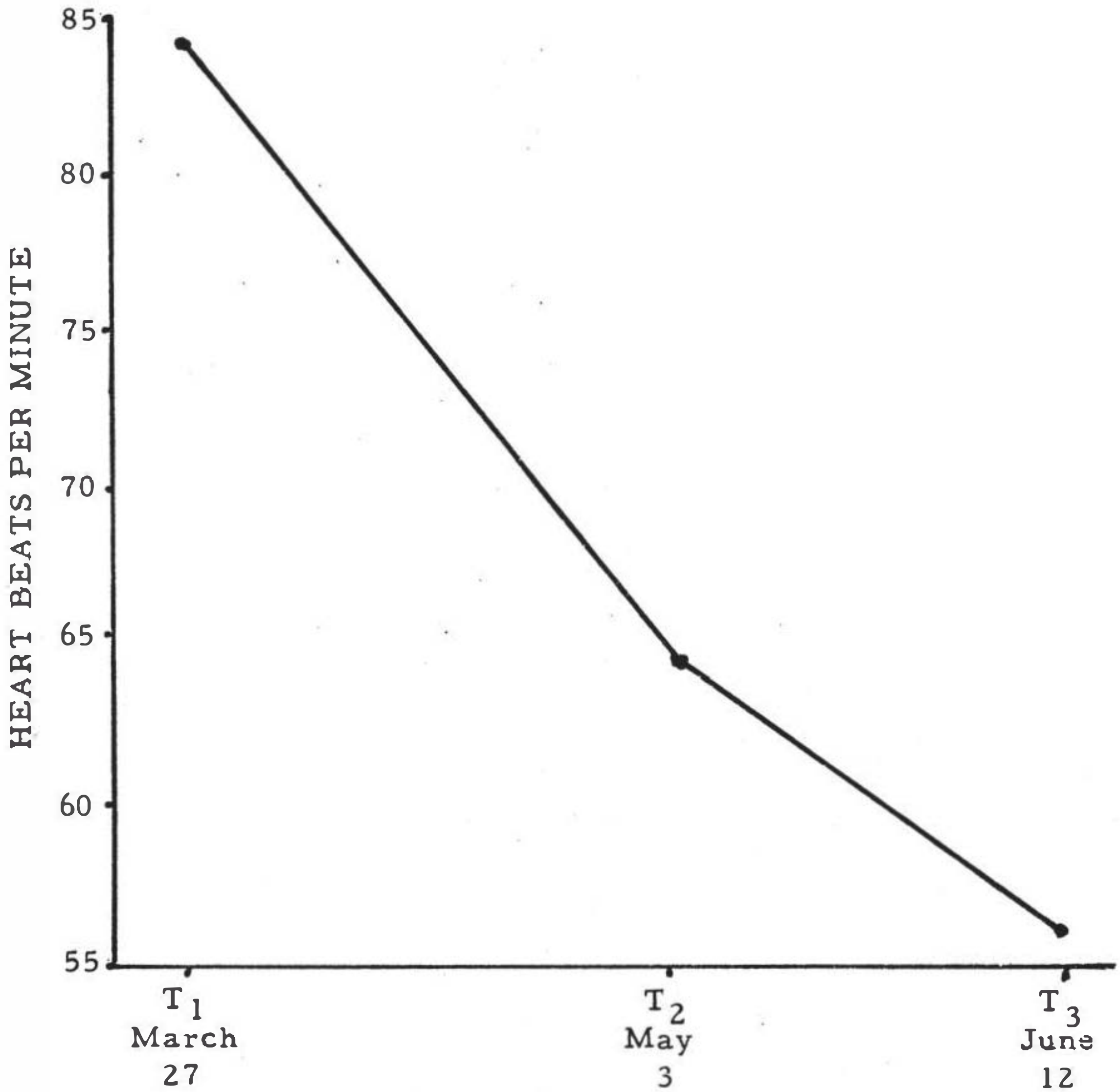


FIGURE 3

RESTING HEART RATES
AT $T_1$, $T_2$, AND $T_3$

heart rates for better cross country runners were lower and closely related to distance running performance.

The basal diastolic and systolic blood pressures are presented in Figure 4. In comparing the results of the blood pressure readings taken throughout the training program (Figure 13) there appeared to be only a noticeable decrease in systolic blood pressures.

The concept that resting systolic blood pressures are affected more than resting diastolic blood pressures as a long range result of cardiorespiratory condition is in agreement with other studies.[5]

Anthropometric measurements. Body weight, girths, skinfolds, width and depth measurements were recorded in this phase of testing. The pictures that were taken of J. D. during the second week and at the conclusion of the training program will provide the reader with a means of observing anthropometric changes recorded in this study. Both the anterior and lateral views (Figures 5 and 6 respectively) display a very noticeable decrease, especially in the abdominal area.

1. Body weight and height. J. D. experienced a weight reduction of 12.64 kilograms (13 per cent) during the study. Nine per cent of this reduction occurred between $T_1$ and $T_2$. (Refer to Figure 7.)

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[5]Ernest D. Michael and Arthur J. Gallon, "Pulse Wave and Blood Pressure Change Occurring During Physical Training Program," Research Quarterly, XXXI (March, 1960), pp. 43-59.

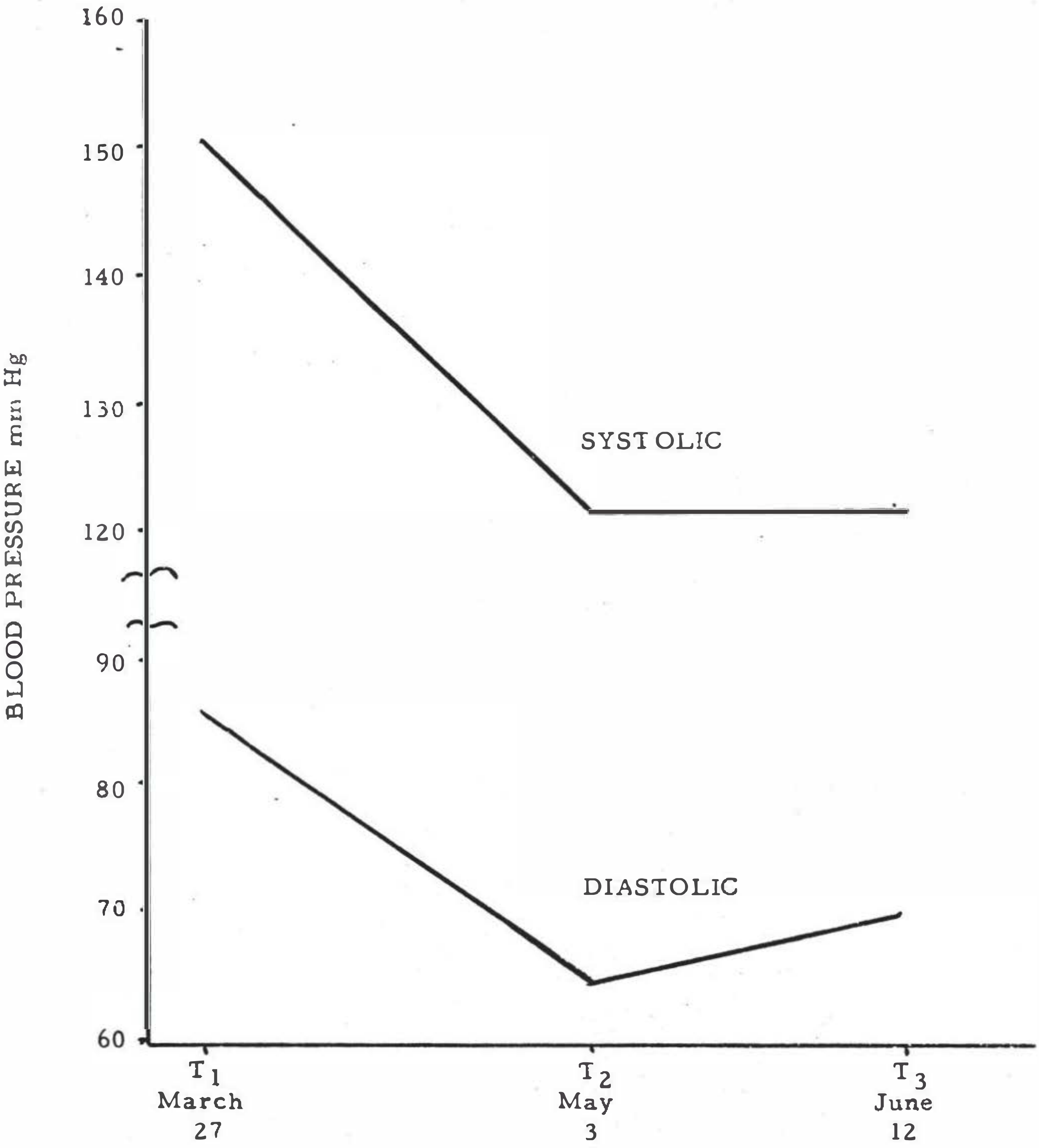
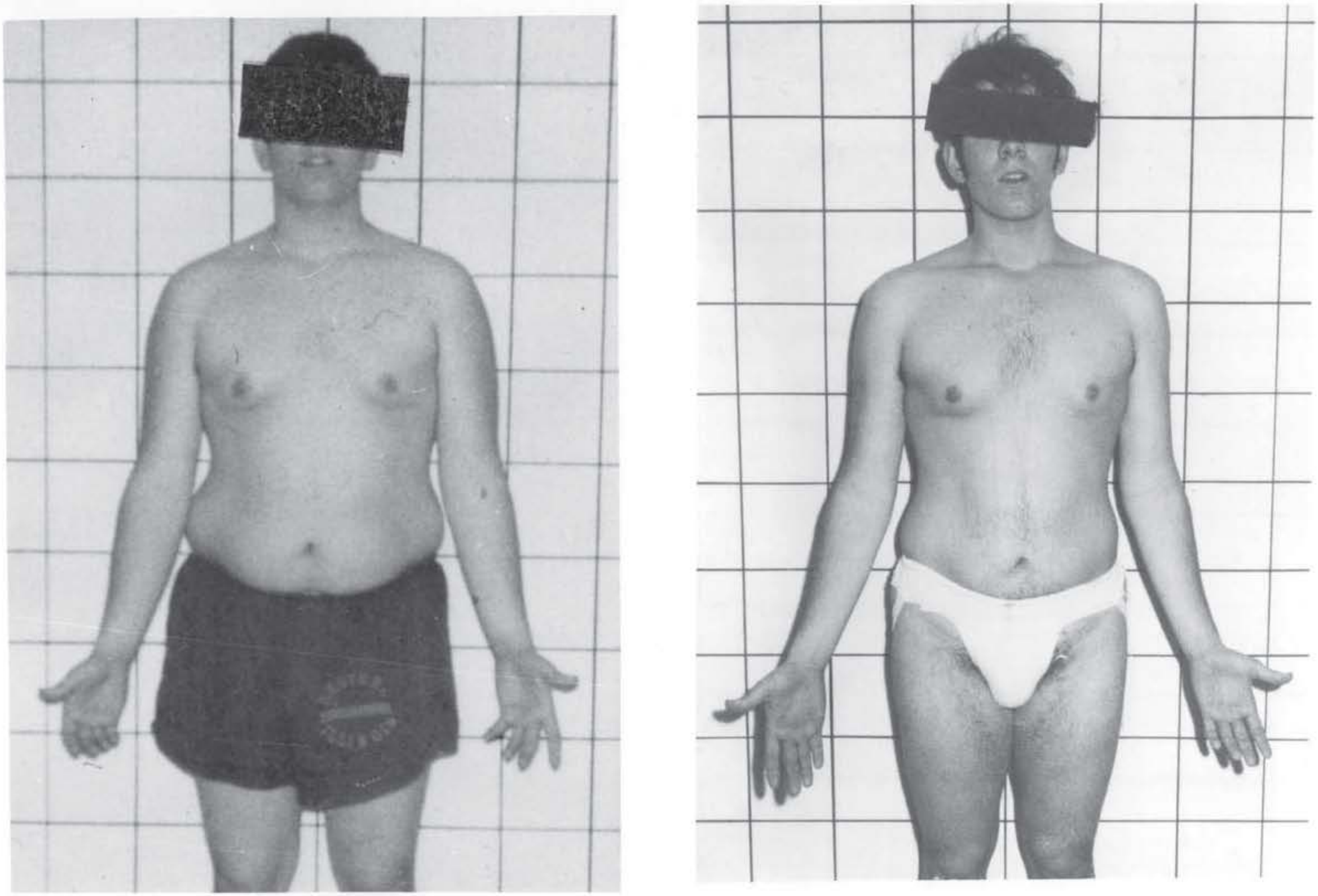



FIGURE 4

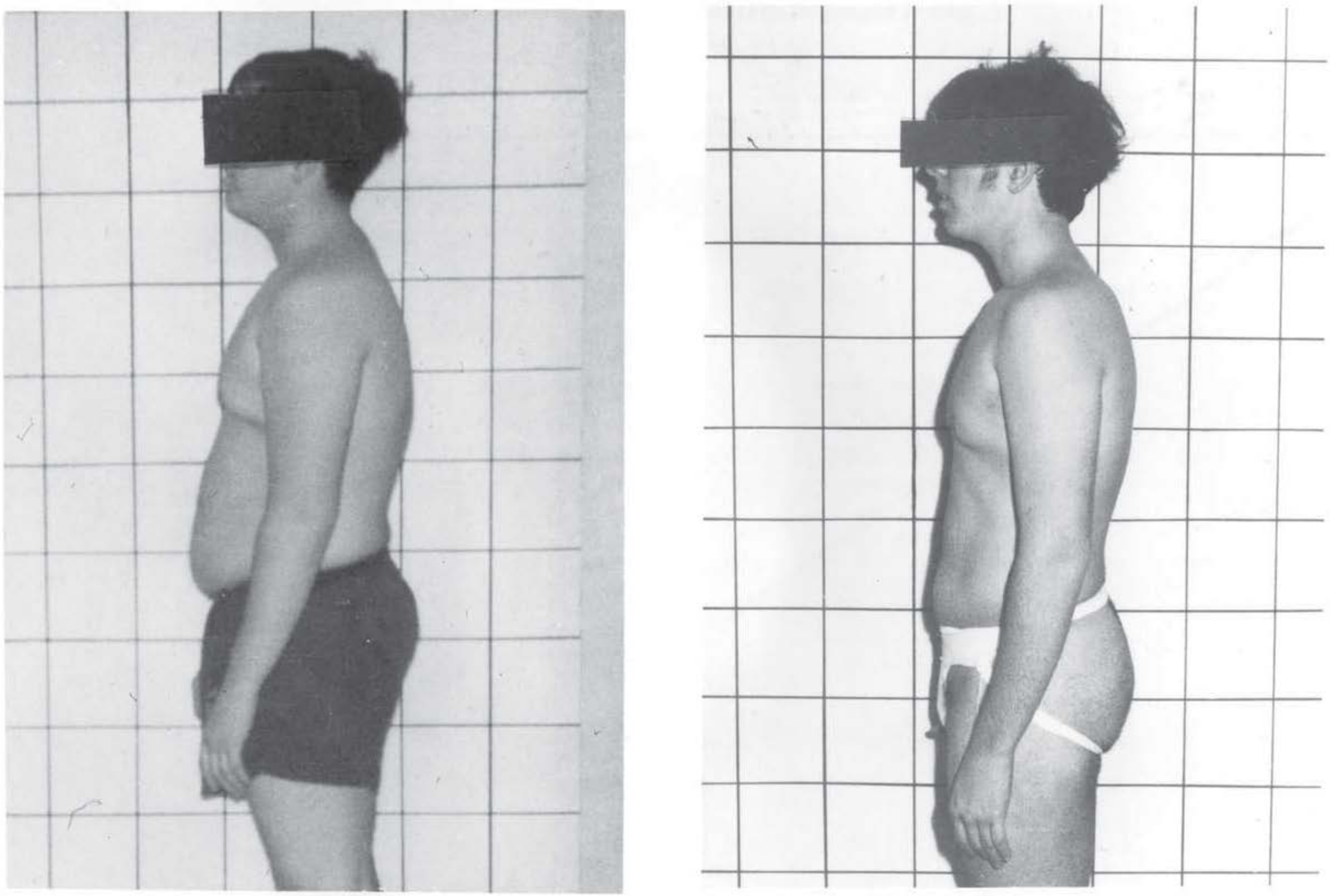
RESTING BLOOD PRESSURES
AT $T_1$, $T_2$, AND $T_3$



BEFORE AFTER

FIGURE 5

ANTERIOR VIEW



BEFORE

AFTER

FIGURE 6

LATERAL VIEW

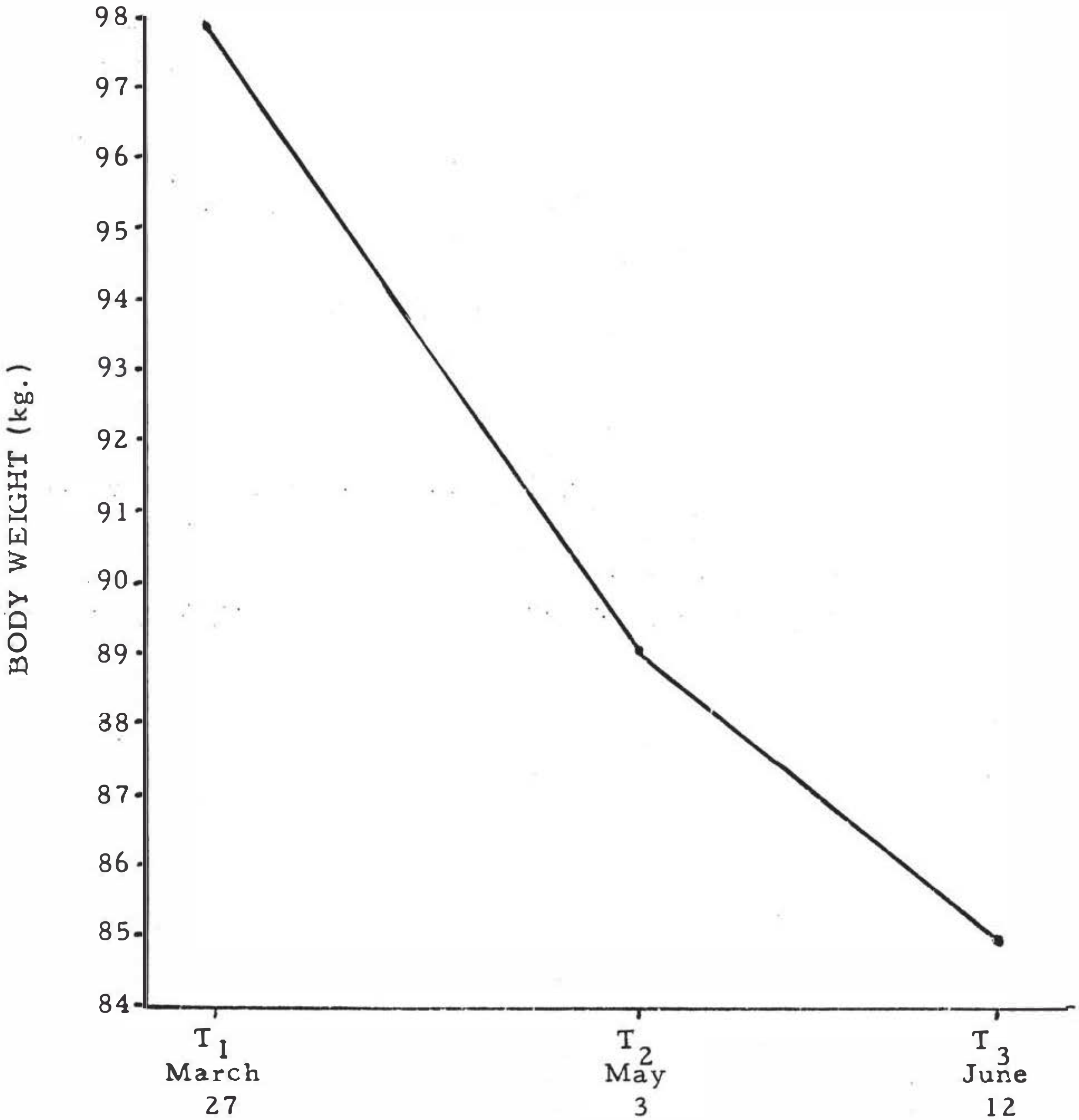



FIGURE 7

BODY WEIGHT AT
$T_1$, $T_2$, AND $T_3$

The height of the subject remained at 175 centimeters throughout the investigation.

2. Girth measurements. Circumference measurements (see Figure 8) revealed a loss in all categories. The most noticeable losses ($T_1$ to $T_3$) were in the abdomen (13.3 per cent), thigh (11.5 per cent), chest (9.6 per cent), and upper arm (9.0 per cent).

3. Skinfold measurements. The trend of all the skinfold measurements decreasing as the investigation progressed was evident. Figure 9 portrays the most observable per cent losses in the thigh (68.3 per cent), neck (63.6 per cent), upper arm (44.8 per cent), hip (42 per cent), $abdomen_2$ (36.36 per cent), posterior chest (31.3 per cent) and calf (31.3 per cent).

In general, the high per cent loss in the skinfold measurements was an indication that J. D. lost much of his weight in fat layers located in the subcutaneous area. This hypothesis concurs with anthropometric observations reported by Dempsey.[6]

4. Width and depth measurements. As might be expected with great losses in body weight and skinfold, width and depth measurements also decreased. The decrease was evident in all areas observed, as shown in Figure 10.

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[6] Jerry A. Dempsey, Anthropometric Observations on Obese and Nonobese Young Men Undergoing a Program of Vigorous Physical Exercise," Research Quarterly, XXXV (October, 1964), p. 282.

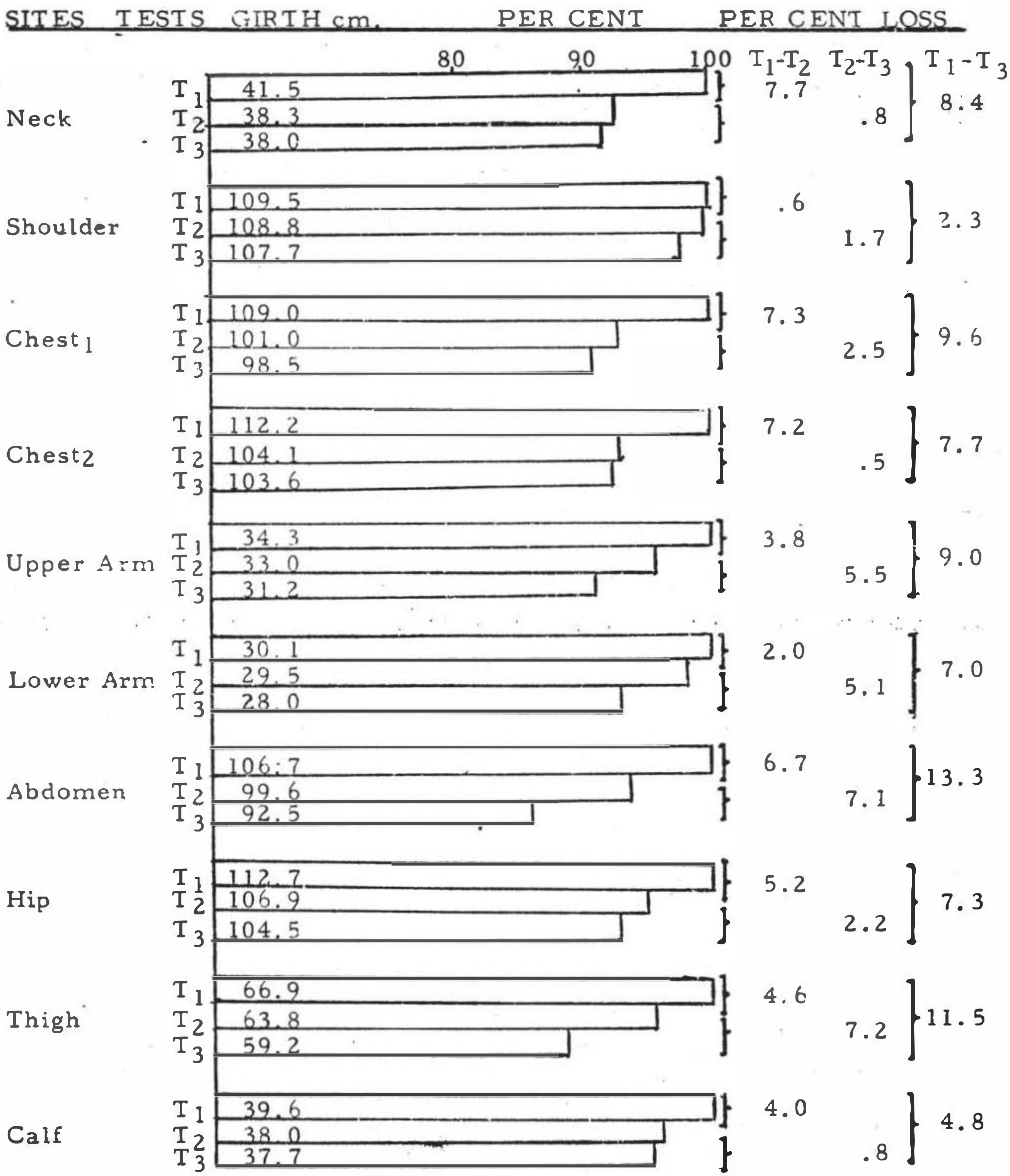


FIGURE 8

PER CENT AND PER CENT LOSS OF TEN GIRTH MEASUREMENTS TAKEN AT $T_1$, $T_2$, AND $T_3$

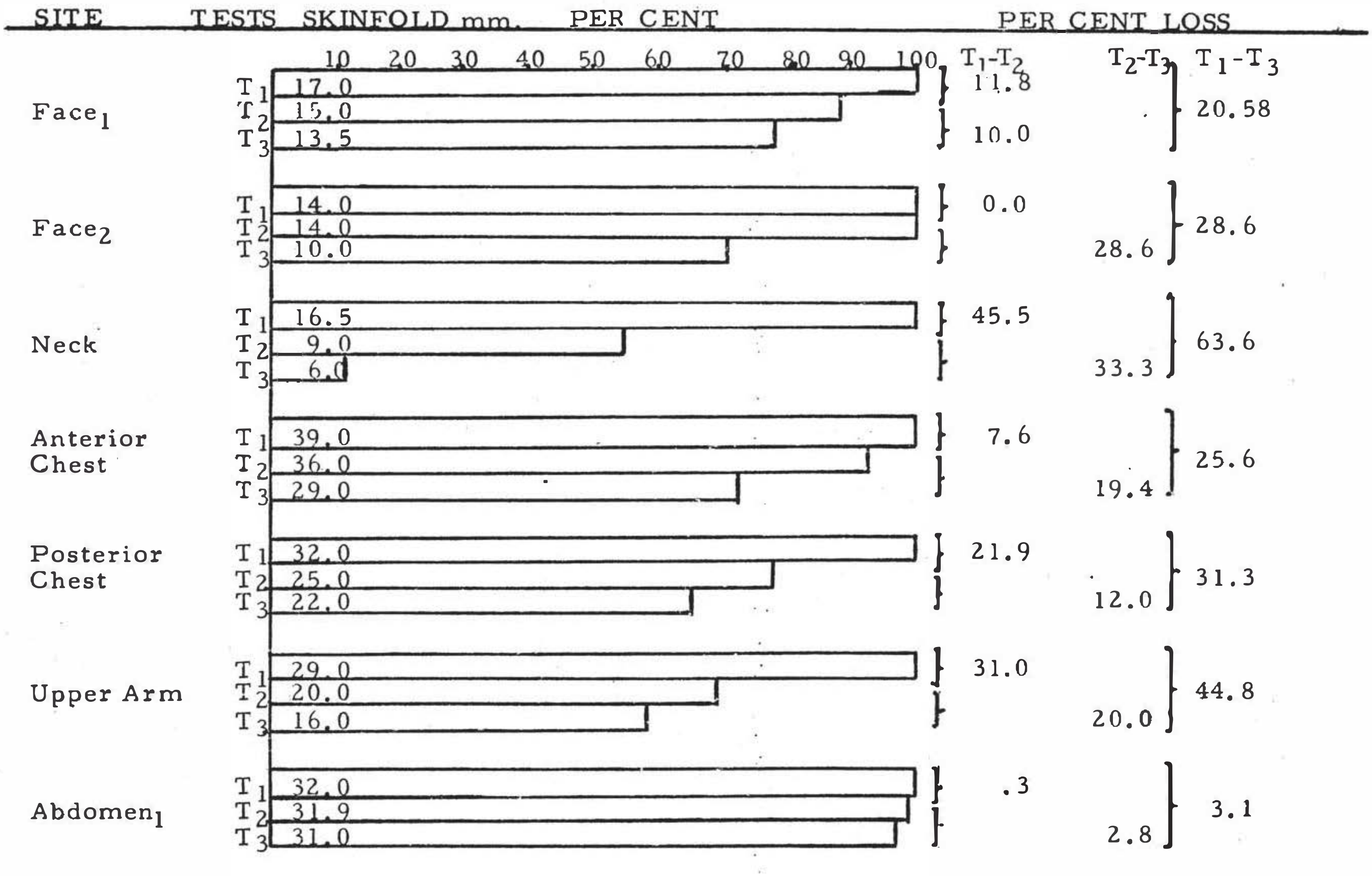


FIGURE 9

PER CENT AND PER CENT LOSS OF FOURTEEN SKINFOLD MEASUREMENTS TAKEN AT $T_1$, $T_2$, AND $T_3$

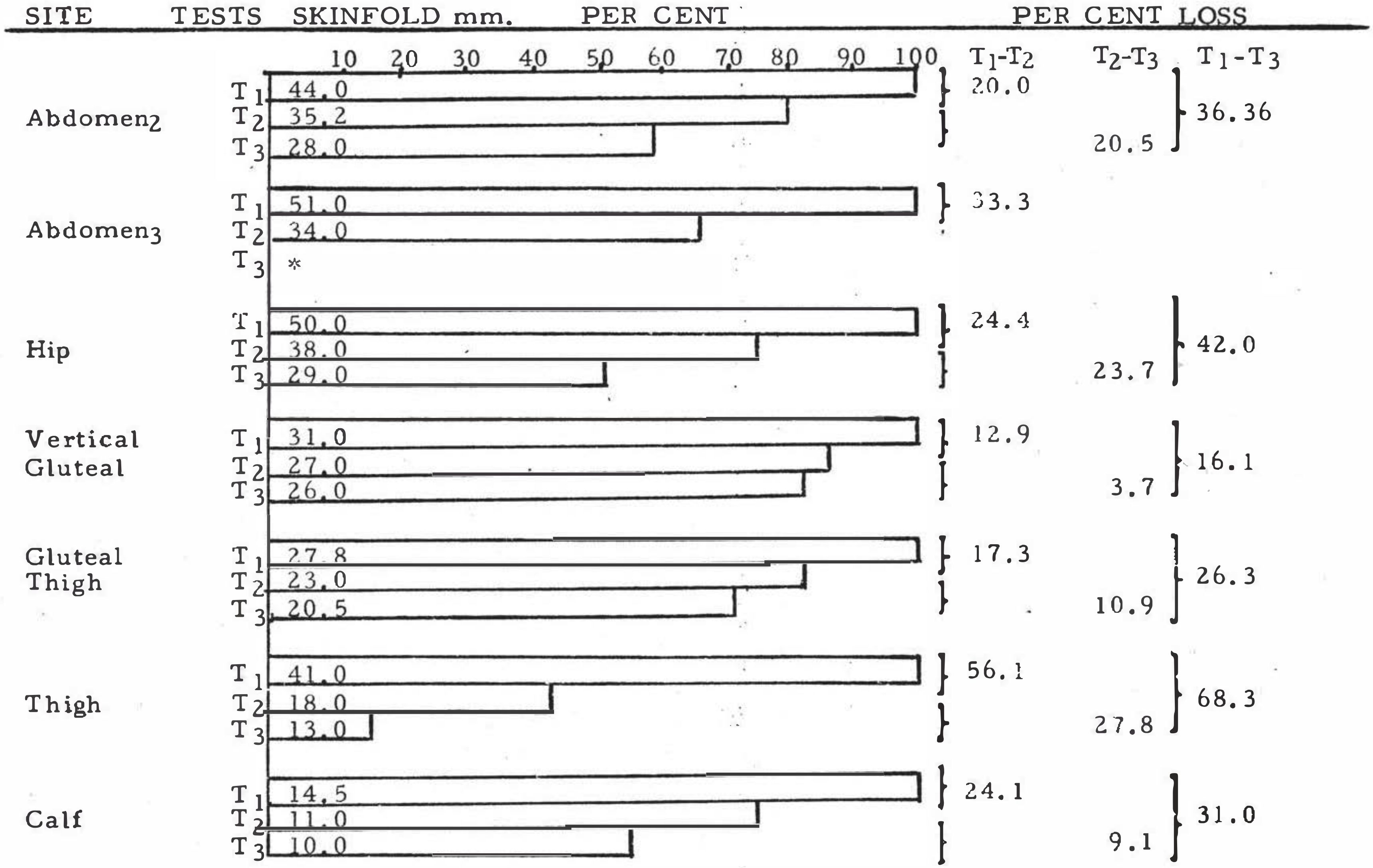


FIGURE 9 (continued)

*Data not available

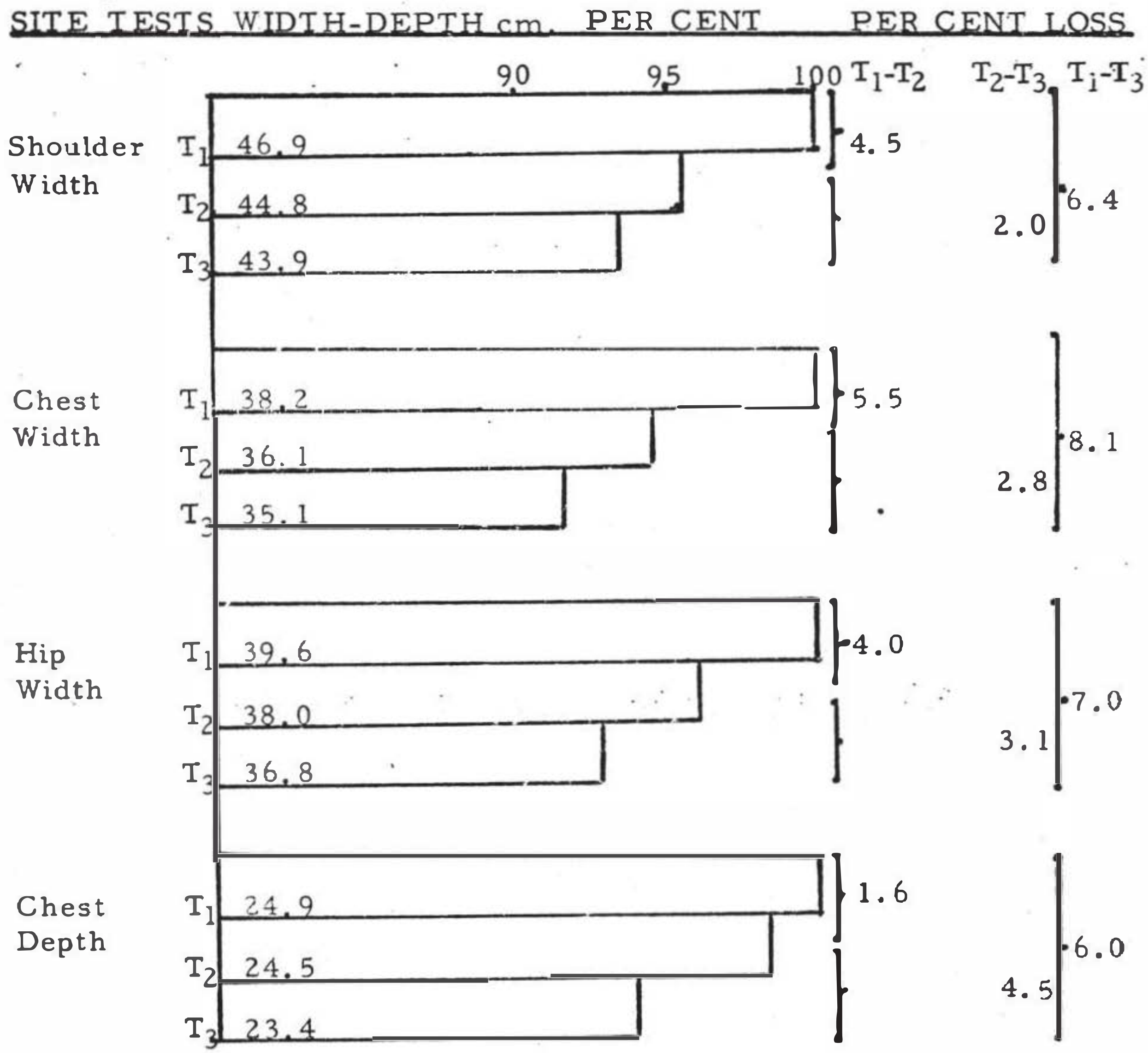


FIGURE 10

PER CENT AND PER CENT LOSS OF THREE WIDTH AND ONE DEPTH MEASUREMENT TAKEN AT $T_1$, $T_2$, AND $T_3$

Cardiorespiratory measures during treadmill running. A main objective of this investigation was to noticeably reduce the percentage of excess body weight. However, it was equally important to investigate the cardiorespiratory improvements that were found in the submaximal and maximal treadmill runs.

1. Submaximal treadmill run. The data obtained in this phase of testing encompassed blood pressure and heart rate recordings.

a. Blood pressure. As the investigation progressed the subject had a lower recovery systolic blood pressure reading and a more rapid return of both systolic and diastolic pressures to normal. This finding, portrayed in Figure 11, represents a classical effect of training.[7]

b. Heart rate. Figure 12 reveals the heart rate of J. D. at rest, during a five minute submaximal run and a ten minute recovery period. The heart muscle displayed a sharp acceleration during the initial phase of exercise followed by a linear increase which plateaued when the steady state was reached. At the conclusion of exercise there was a rapid decrease in heart rate.

In general, the heart rate was at all times noticeably lower after six weeks of training. It was interesting to observe that in the

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[7] C. Frank Consolazio, Robert E. Johnson, and Louis J. Pecora, Physiological Measurements of Metabolic Functions in Man (New York: McGray-Hill Book Company, 1963), p. 341.

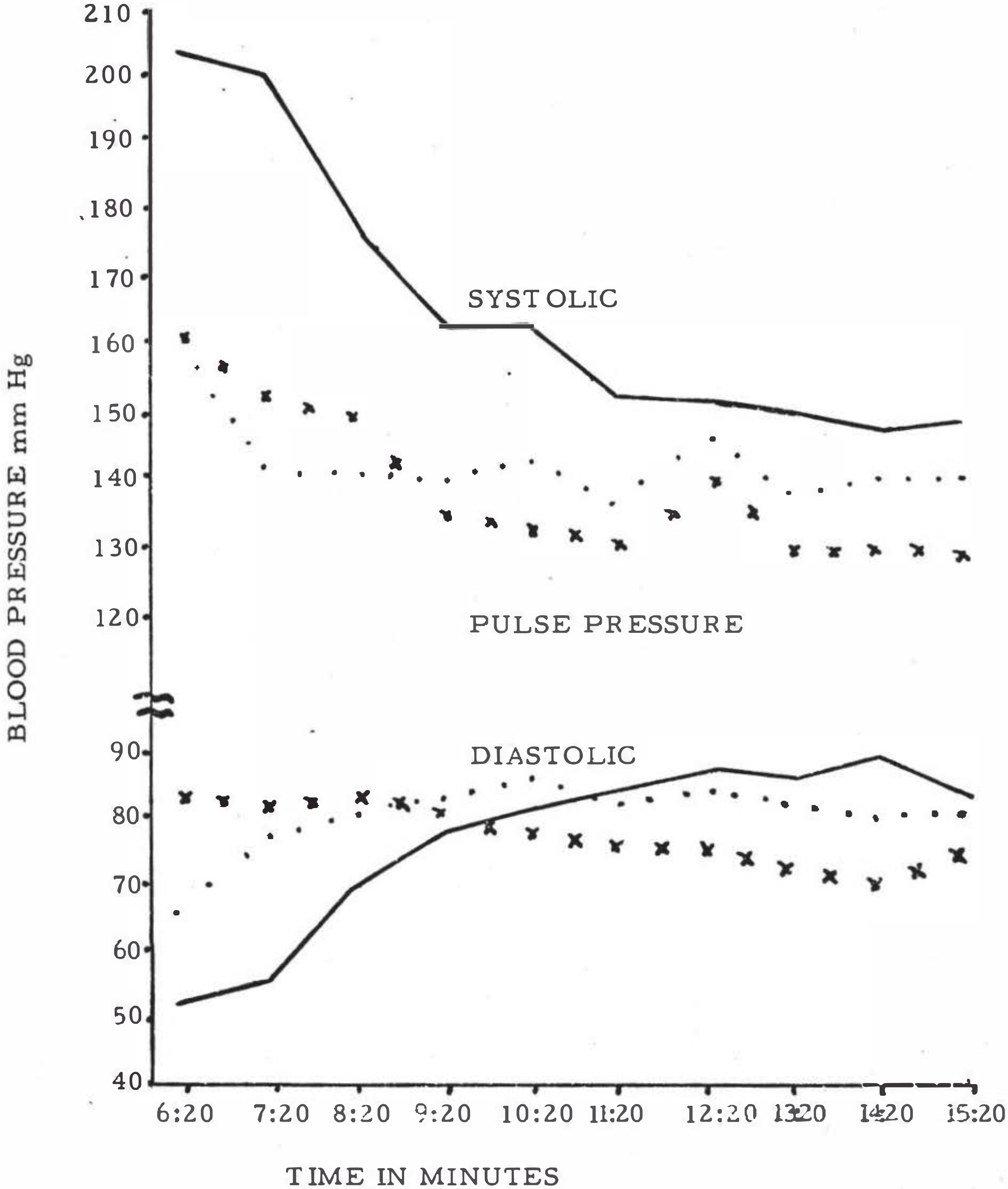


FIGURE 11

BLOOD PRESSURES IN RECOVERY FROM A SUBMAXIMAL TREADMILL RUN AT $T_1$, $T_2$, AND $T_3$

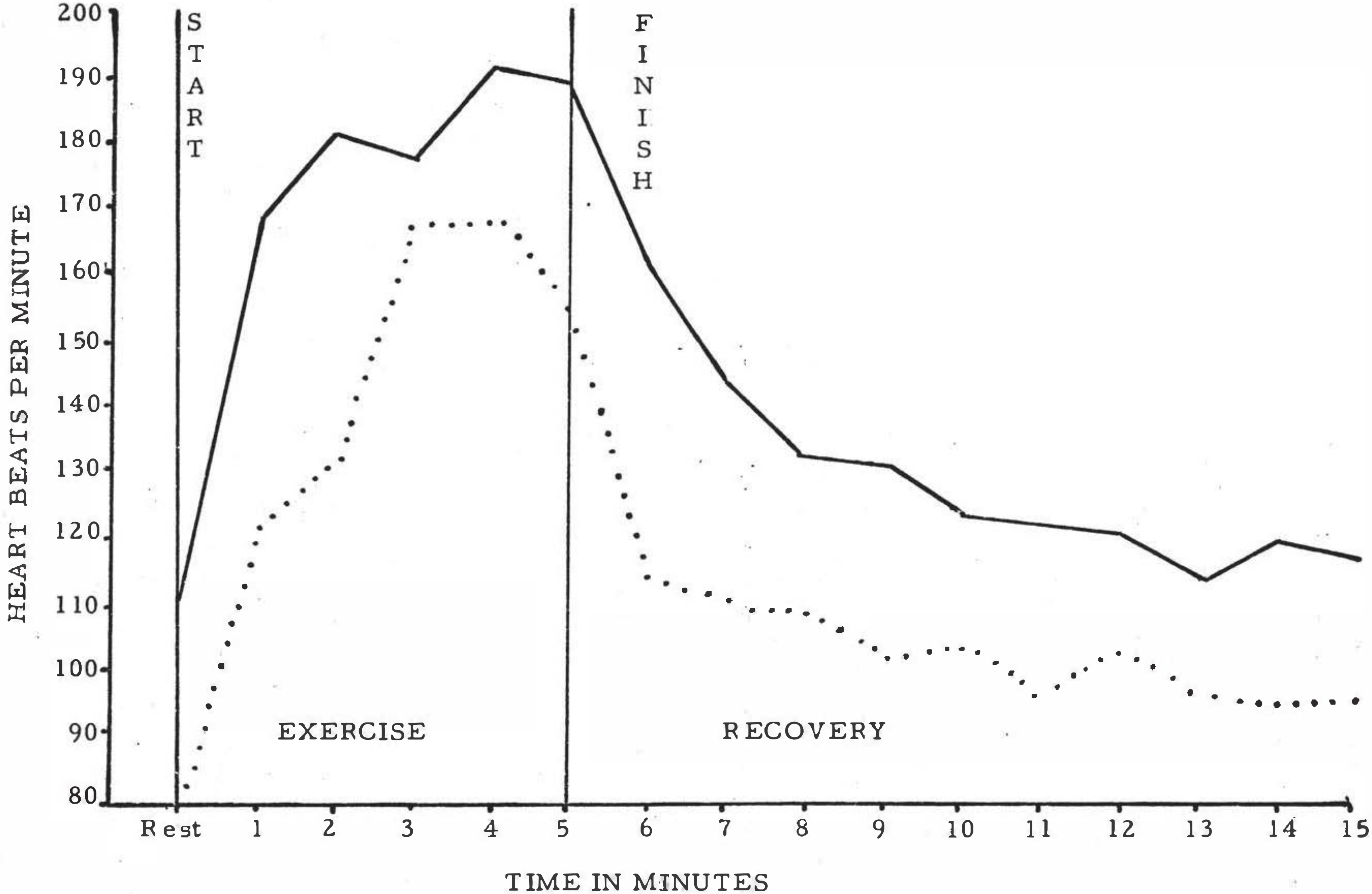


FIGURE 12

HEART RATES AT REST, DURING SUBMAXIMAL TREADMILL RUN, AND AT TEN MINUTE RECOVERY PERIOD AT $T_1$ AND $T_2$

——— $T_1$ ······ $T_2$

first minute after exercise in $T_2$ the heart rate was 14 beats per minute lower than after ten minutes of recovery in $T_1$.

The lower resting heart rates and the more rapid recovery of the heart muscle after exercise would indicate an improved cardiorespiratory fitness.

2. Maximal treadmill run. Blood pressure, heart rates, pulmonary ventilation and oxygen consumption were measurements taken during this phase of testing.

a. Blood pressure. Improved cardiorespiratory fitness was reflected in the trend of lower systolic blood pressure readings and more rapid return of blood pressure to normal in recovery from the maximal treadmill run. The most interesting aspect of this data (see Figure 13) was that J. D. exercised 16 minutes longer in $T_2$ and still had a systolic blood pressure of 39 mm Hg lower at one minute into the recovery period.

b. Heart rates. The heart rates during the maximal treadmill run and eight minute recovery period are presented in Figure 14. The $T_1$ test concluded after four minutes of running with a maximal heart rate of 200 beats per minute. However, in $T_2$, J. D. ran for 15 minutes and his heart rate was maintained at 175 beats or more per minute for 14 minutes. It was evident that in $T_2$ the training effect elicited a more conditioned heart muscle that in turn caused a steady state

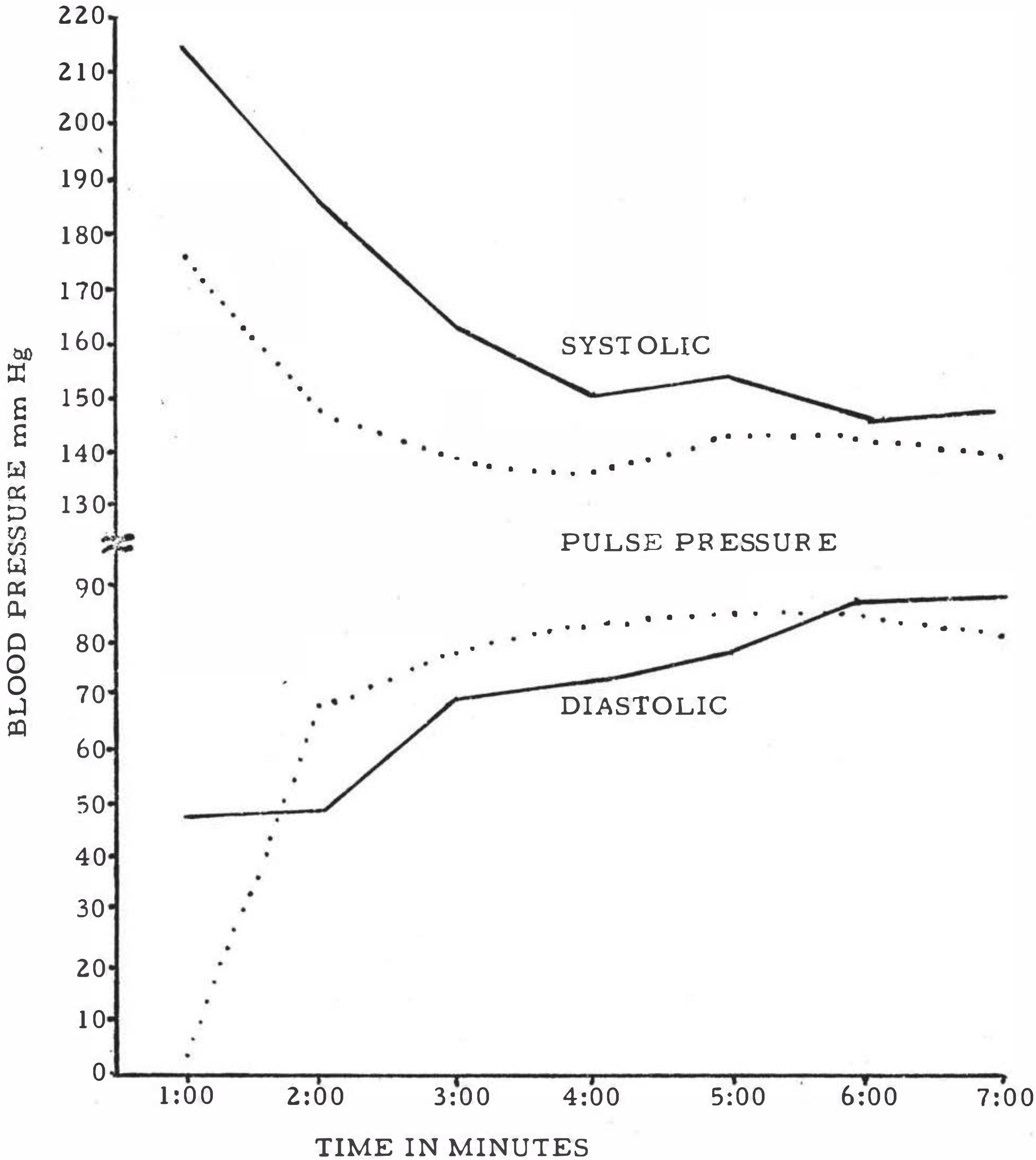


FIGURE 13

BLOOD PRESSURES IN RECOVERY FROM A MAXIMAL TREADMILL RUN AT $T_1$ AND $T_2$

——— $T_1$ ...... $T_2$

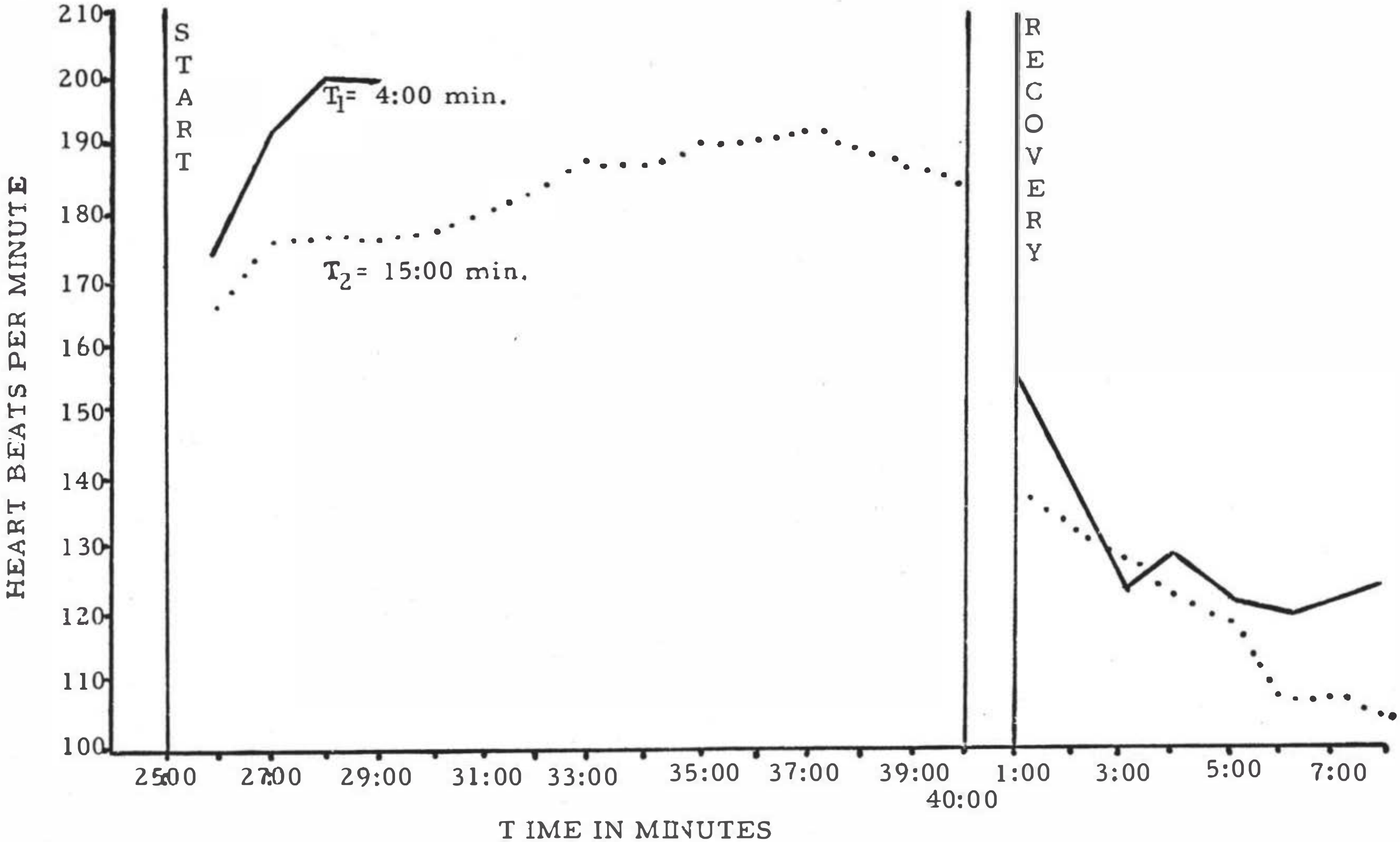


FIGURE 14

HEART RATES DURING A MAXIMAL TREADMILL RUN AND EIGHT MINUTE RECOVERY PERIOD AT $T_1$ AND $T_2$

——— $T_1$ . . . . . . $T_2$

response to what at one time was a maximal work load. This phenomena has been observed by Sheppard and others.[8]

Even though the tests differed and J. D. ran almost four times longer at the same rate and grade, his $T_2$ recovery heart rate was lower and more near normal than $T_1$.

c. Maximal pulmonary ventilation. Data for this parameter was obtained from measurements recorded during $T_1$ and $T_3$. The steady state response to the work load in $T_2$ was not considered a representative measurement and therefore was not included in the discussion of maximal pulmonary ventilation. J. D. ventilated 91.16 liters per minute at $T_1$ and 106.08 liters per minute at $T_3$. The 16.4 per cent increase during ten weeks of training indicated an improvement in this phase of cardiorespiratory fitness.

d. Maximal oxygen uptake. $T_1$ and $T_3$ measurements were reported. It was concluded that the $T_2$ reading did not represent a maximal oxygen uptake (steady state as previously mentioned).

There was 84.5 per cent increase in oxygen uptake with a $T_1$ reading of 32.91 (ml/kg/min) and a $T_3$ reading of 60.70 (ml/kg/min).

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[8]R. J. Sheppard, "Physiological Determinants of Cardiorespiratory Fitness," Journal of Sports Medicine and Physical Fitness, VII (September, 1967), p. 123.

The increase in maximal oxygen uptake concurs with other investigations.[9, 10, 11] J. D. had a marked improvement in aerobic efficiency as a result of training.

Blood Pressures Throughout the Training Program

There were noticeable fluctuations in the blood pressure readings recorded throughout the training program (see Figure 15). This would indicate that J. D. was not completely relaxed from his activity immediately before the blood pressure measurement. However, it was evident that as the subject improved his physical condition there was a decrease in the systolic blood pressure reading.

Heart Rates Throughout the Training Program

Figure 16 displays 15 second pre- and post-exercise heart rates that were recorded throughout the training program. The training effect can be observed in the lower pre-exercise heart rate recordings

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[9] Thomas K. Cureton, "Improvements in Oxygen Intake Capacity Resulting from Sports and Exercise Training Programs: A Review," American Corrective Therapy Journal, XXIII (September-October, 1969), pp. 144-147.

[10] Born Ekblom, Per-Olof Astrand, Bengt Saltin, Jasper Stenberg, and Brittmari Wallstrom, "Effect of Training on Circulatory Response to Exercise," Journal of Applied Physiology, XXIV (April, 1963), p. 51[illegible].

[11] Elsworth Buskirk and Henry Taylor, "Maximal Oxygen Intake and Its Relation to Body Composition, with Special Reference to Chronic Physical Activity and Obesity," Journal of Applied Physiology, XI (January - November, 1957), p. 72.

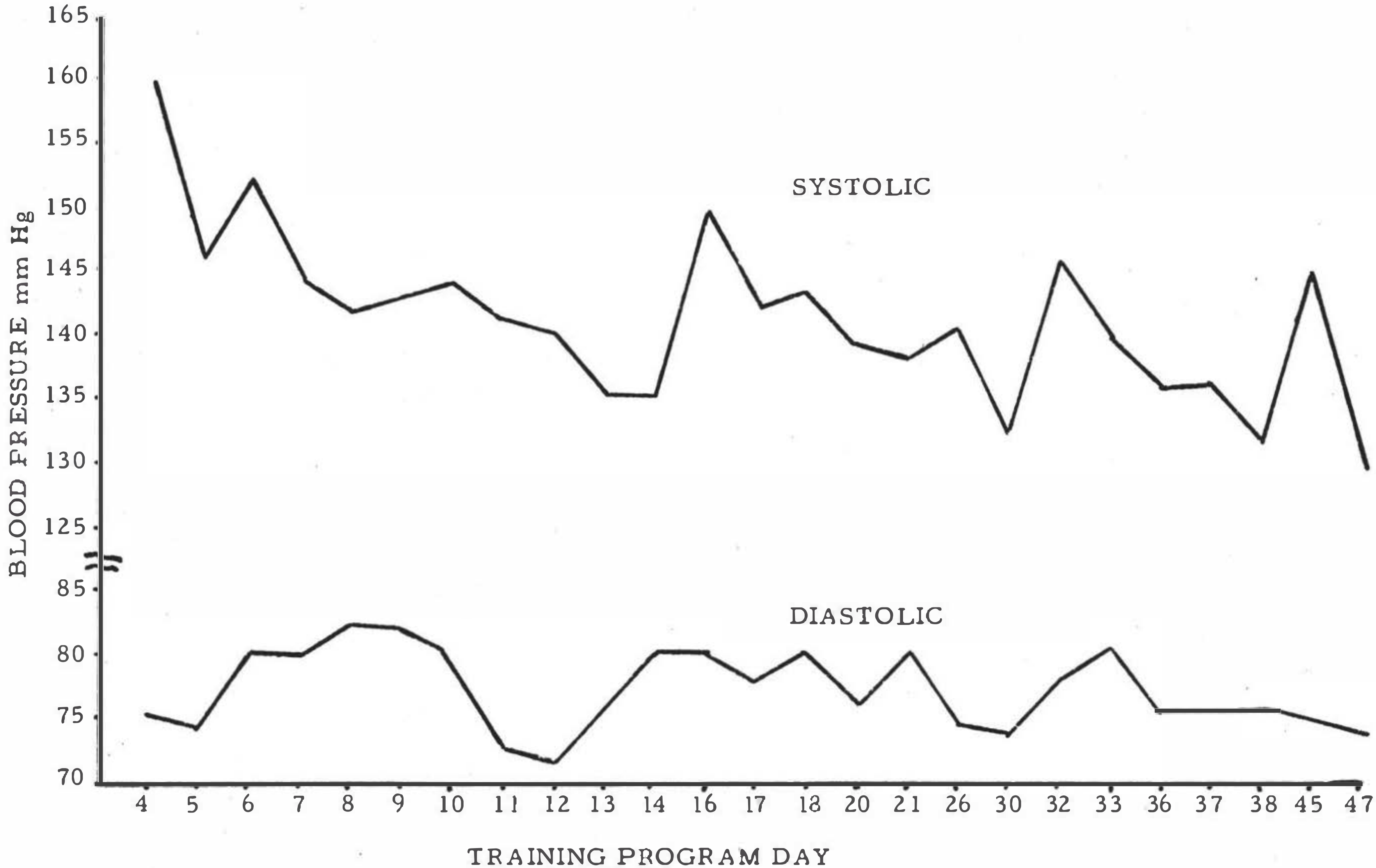


FIGURE 15

BLOOD PRESSURES TAKEN THROUGHOUT THE TRAINING PROGRAM

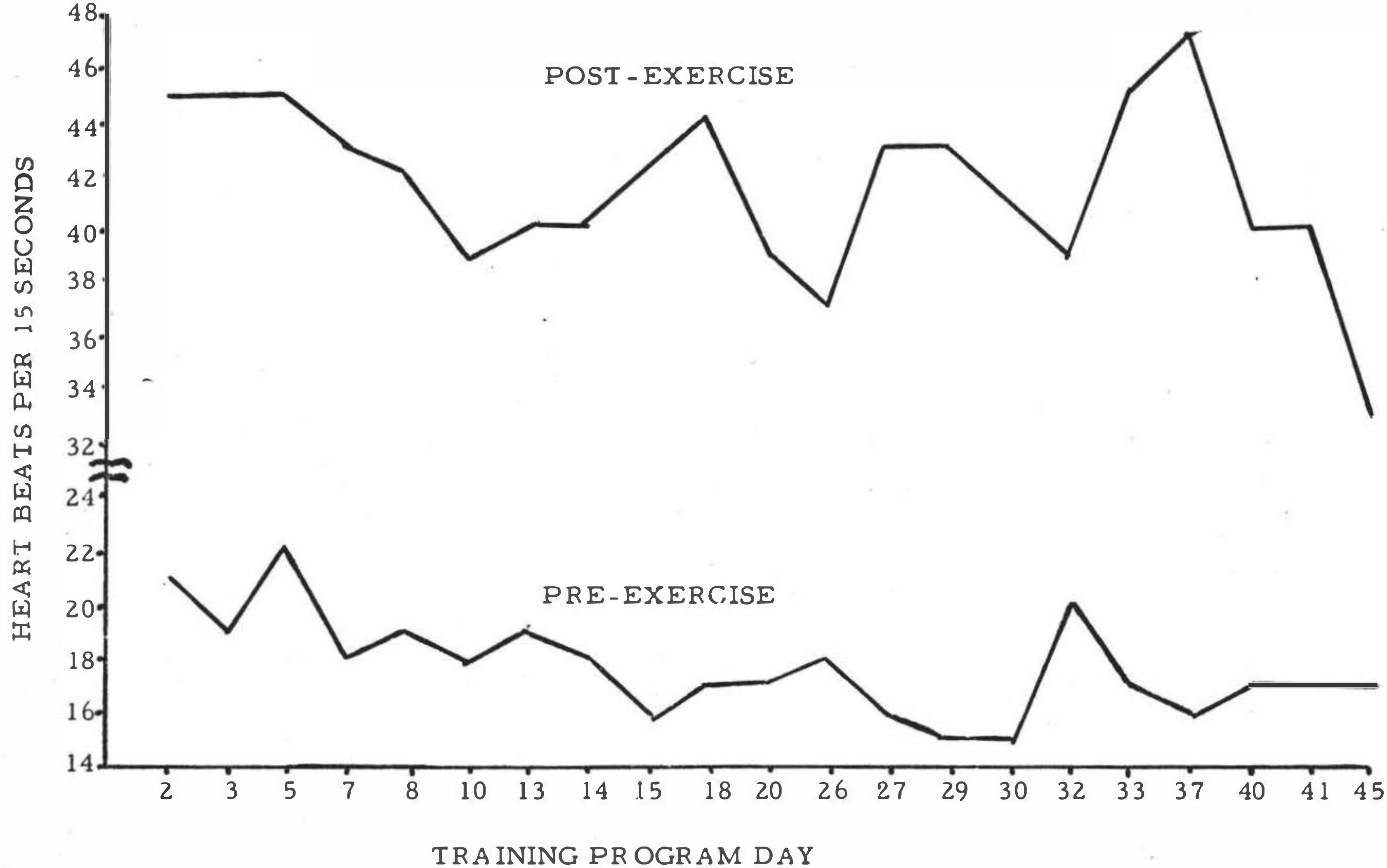


FIGURE 16

HEART RATES TAKEN THROUGHOUT
THE TRAINING PROGRAM

obtained in the latter phases of training and in the lower post-exercise heart rates recorded throughout training even though the intensity and the duration of the workout increased. J. D. also showed the ability to send heart rates quite high during certain intense workouts.

In this study the subject averaged a training phase post-exercise heart rate of approximately 166 beats per minute which was above the recommendations for improved endurance.[12, 13, 14]

Performance Runs During the Training Program

J. D. had a 19.3 per cent reduction in the time required to run two miles (Figure 17) and a 14.8 per cent improvement in the distance walked and/or run in one half hour (Figure 18). Discuseions with the subject revealed that he was more highly motivated to perform well on the two mile event than the one half hour event.

It appears that a relationship between improved distance running performance and improved maximal oxygen uptake ability ie quite

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[12]Irvin E. Faria, "Cardiovascular Response to Exercise as Influenced by Training of Various Intensities," Research Quarterly, XLI (March, 1970), pp. 44-50.

[13]Brian J. Sharkey and John P. Hollemen, "Cardiorespiratory Adaptations to Training at Specific Intensities," Research Quarterly, XXXVIII (December, 1967), pp. 698-704.

[14]Kenneth H. Cooper, Aerobics (New York: M. Evans and Company, 1968), p. 23.

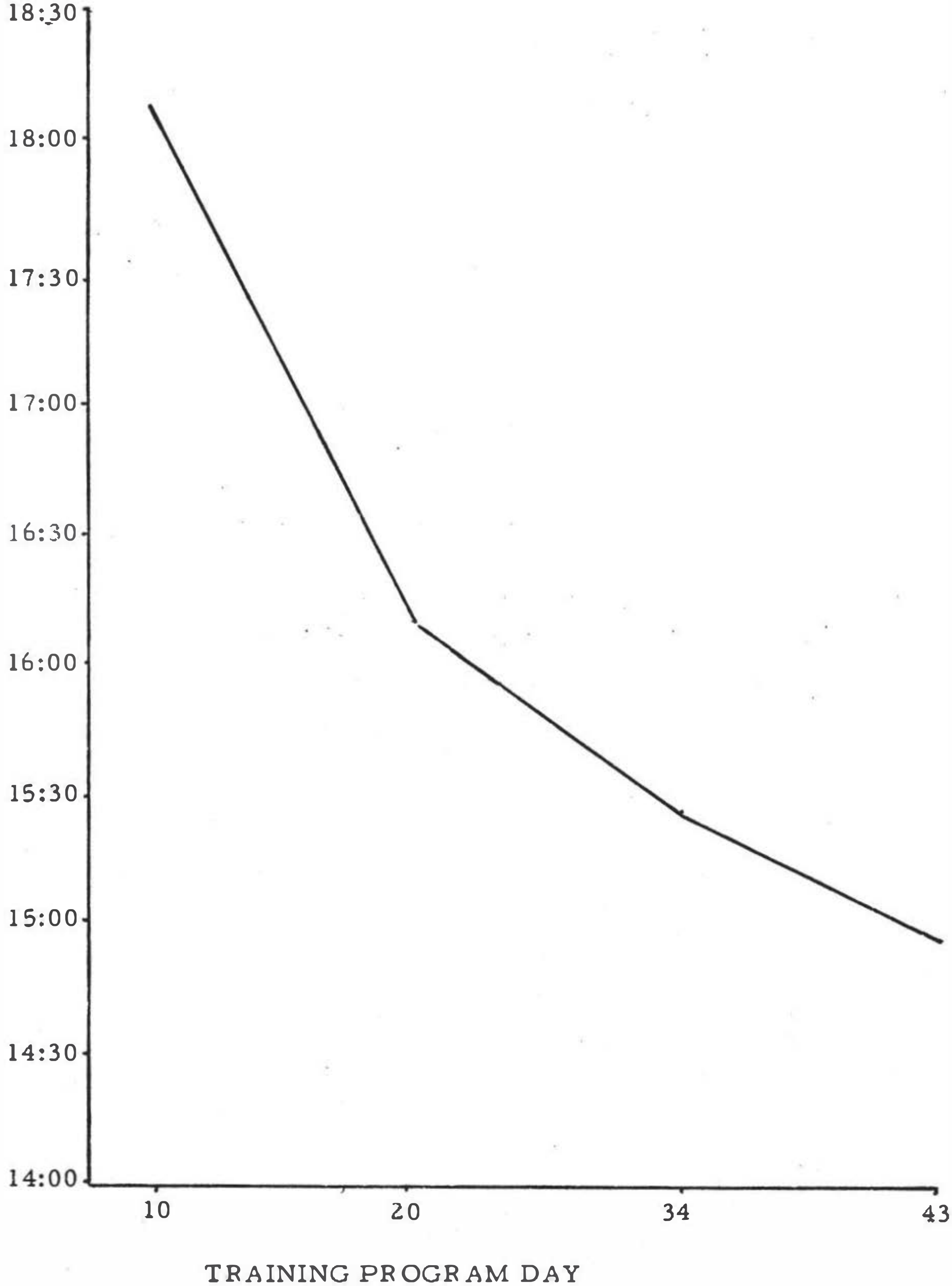


FIGURE 17

TIME REQUIRED TO RUN TWO MILES ON
FOUR TRAINING PROGRAM DAYS

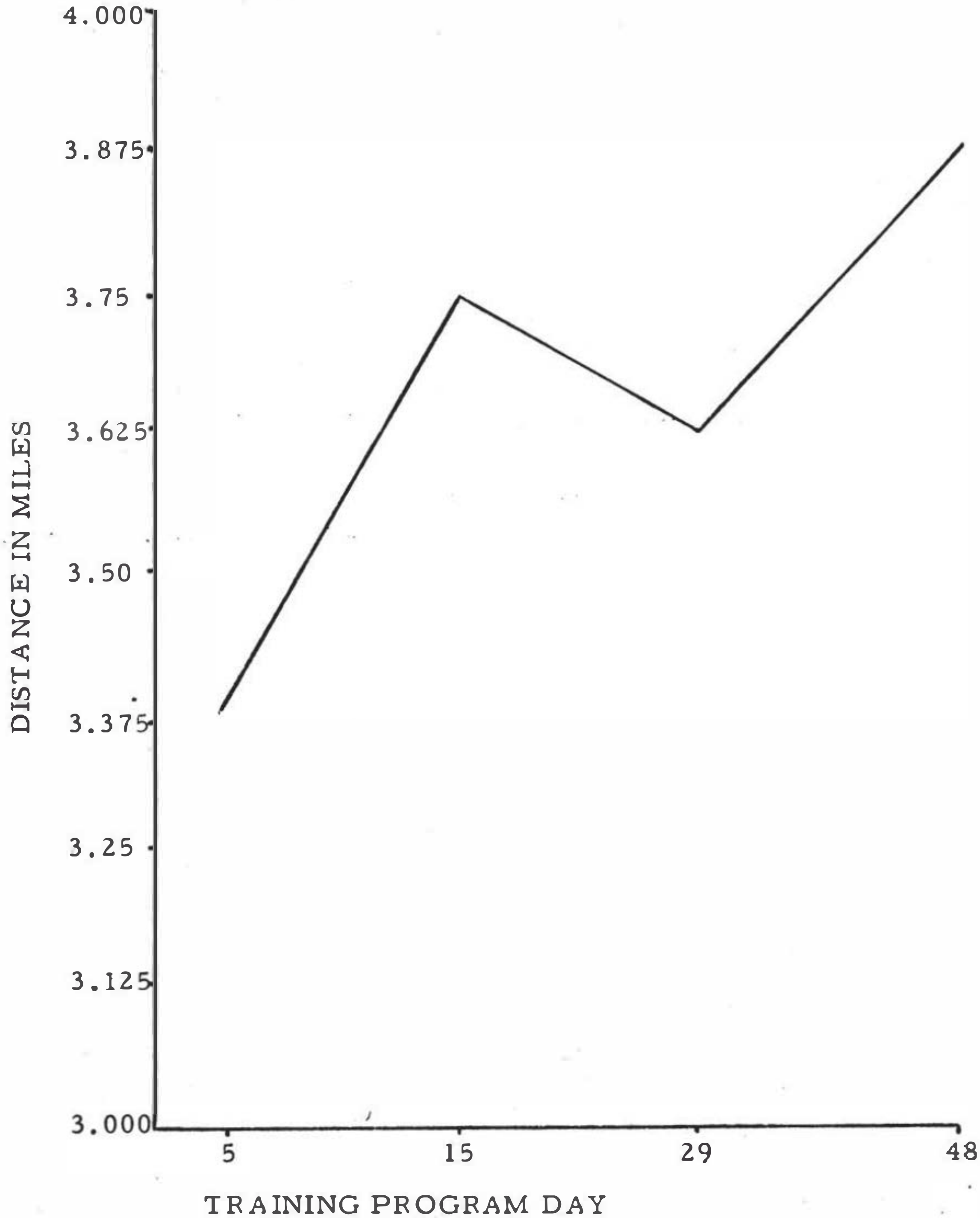


FIGURE 18

DISTANCE WALKED AND/OR RUN IN ONE-HALF HOUR ON FOUR TRAINING PROGRAM DAYS

noticeable. Other studies support this finding.[15, 16, 17, 18]

## Daily Food Consumption

Caloric intake values for each Wednesday throughout the training program are revealed in Figure 19.[19] The investigator believed that caloric measurements obtained during the middle of the week would most likely be representative of the five day school week and least effected by the increase of food intake during the weekend.

It was evident that J. D. voluntarily reduced his food intake, especially during the initial weeks of the study. The mean caloric intake for the first through the sixth Wednesday was 1,623, compared to 1,927 for the seventh through the eleventh Wednesday. Appendix F describes the type of food and the number of servings during meals and snacks.

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[15] Costill, *loc. cit.*

[16] T. L. Doolittle and Roland Bigbee, "The Twelve-Minute Run-Walk: A Test of Cardiorespiratory Fitness of Adolescent Boys," *Research Quarterly*, XXXIX (October, 1968), p. 491.

[17] Paul M. Ribisl and William A. Kachadurian, "Maximum Oxygen Uptake Predicted in Young and Middle Age Males," *Journal of Sports Medicine and Physical Fitness*, IX (March, 1969), p. 21.

[18] Jack H. Wilmore, "Maximal Oxygen Intake and Its Relationship to Endurance Capacity on a Bicycle Ergometer," *Research Quarterly*, XXXX (March, 1969), p. 208.

[19] Anna de Planter Bowles, Charles E. Church, and Helen N. Church, *Food Values of Portions Commonly Used* (Philadelphia: J. B. Lippincott Company, 1966).

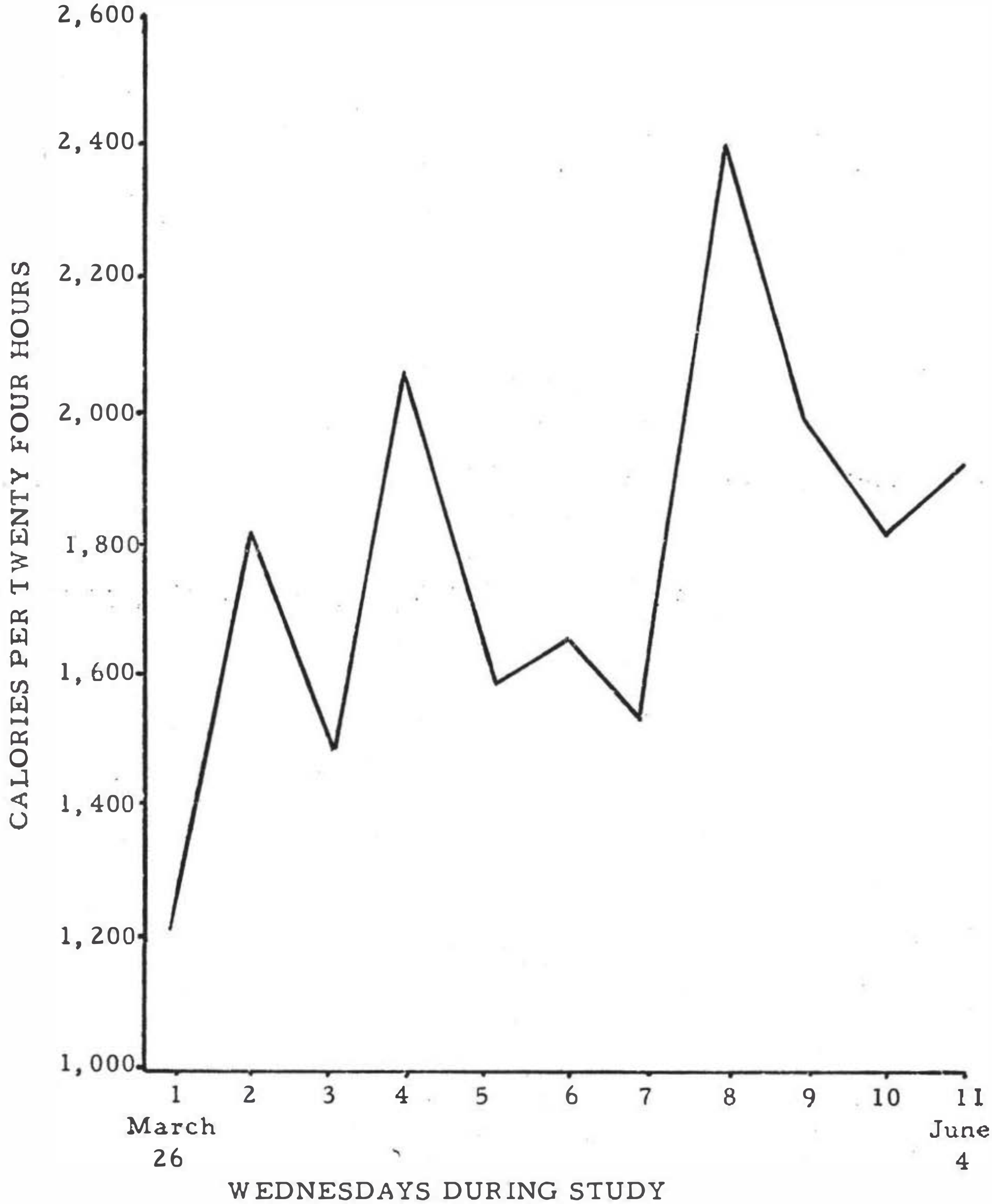


FIGURE 19

CALORIC INTAKE ON THE WEDNESDAYS DURING THE STUDY

According to Per-Olof Astrand,[20] a moderately active male 25 years old with a body weight of 70 kg would be expected to use 2,900 calories per day. It is evident that J. D. was highly motivated for he consumed less than an expected average and at the same time he became more physically active. However, in this case, an unhealthy situation developed when he consistently failed to consume balanced meals at breakfast and lunch. The investigator believed that if this eating pattern combined with the training program were allowed to continue there would be a deterioration in physical performance and health. Consultations with the subject concerning balanced nutrition quickly eliminated the problem.

## II. SUMMARY

The data obtained from a teenage male subject indicates that there was a decrease in body weight and an increased level of cardiorespiratory fitness during a ten week training program. In order to review the findings of this study, the following summary statements are presented:

1. The subject lost 12.64 kilograms or 13 per cent of his original body weight. As the investigation progressed there were losses in all

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[20] Per-Olof Astrand and Kaare Rodahl, Textbook of Work Physiology (New York: McGraw-Hill Book Company, 1970), p. 447.

the anthropometric measurements recorded. The most noticeable losses were in the abdomen, thigh, chest and upper arm.

2. Physiological adaptations during resting conditions were evident as determined by lower systolic blood pressures, heart rates, and basal oxygen uptake measurements.

3. An increased tolerance to submaximal and maximal treadmill runs was demonstrated through lower exercise heart rates during the submaximal run and increased running time, pulmonary ventilation, and oxygen uptake during the maximal treadmill run.

4. The subject experienced a more rapid recovery after exercise as evidenced by lower recovery heart rates and systolic blood pressure recordings.

# CHAPTER V

# SUMMARY

## I. SUMMARY

A case study was the vehicle used to investigate the effects of a ten week progressive jogging and running program on selected metabolic, anthropometric, cardiorespiratory, and performance measurements.

The subject was 17.7 years old. Initially he weighed 97.64 kilograms and was 175 centimeters tall. He was moderately active before the investigation and he maintained a high level of motivation throughout the 59 formal and informal training sessions held between March 31, 1969 and June 9, 1969.

Initial aerobic work was performed via an interval method of training. The subject was gradually conditioned until he could perform continuous submaximal runs up to 8 miles in length without rest intervals.

Three evaluative tools were used to observe the response of the subject to the training program. They included the following: (1) Initial, intermediate, and final laboratory testing; (2) Blood pressures and heart rates recorded throughout the training program; and (3) Performance runs during the training program. In addition, daily caloric intakes

were recorded.

The initial, intermediate, and final laboratory tests consisted of four parts: (1) Basal metabolic rate; (2) Resting heart rate and blood pressure; (3) Anthropometric measurements; and (4) Cardiorespiratory measures during a submaximal and maximal treadmill run.

Pre- and post-exercise heart rates and pre-exercise blood pressures were recorded at approximately 50 per cent of the training sessions. On four occasions the subject was timed at two miles, while on four other days he walked and/or ran as far as possible in 30 minutes.

## II. CONCLUSIONS

Based on the findings of this investigation the following conclusion appears warranted. The jogging and running program as performed in this study decreased the body weight and improved the cardiorespiratory fitness of a teenage male subject, as determined by:

1. A noticeable loss in body weight and losses in all the anthropometric measurements recorded.

2. Lower systolic blood pressures, heart rates, and oxygen uptake measurements during resting conditions.

3. Lower heart rates during submaximal work.

4. Increased running time, pulmonary ventilation, and oxygen uptake during maximal work.

5. Lower recovery heart rates and systolic blood pressure recordings.

6. A more rapid return to normal of systolic-diastolic blood pressures and heart rate measurements during recovery.

## III. OBSERVATIONS

While it was difficult to assess any psychological influences as the result of the anthropometric and physiological changes, it is important to note that the subject has continued with a daily running program. At this writing, approximately 18 months after the completion of the study, the subject is continuing with a daily running program and has maintained and lowered his post-training body weight.

## IV. RECOMMENDATIONS

On the information found in the study the following recommendations were made.

1. A pilot study should be designed to validate the procedures used in obtaining skinfold measurements.

2. The body density of obese subjects should be determined by underwater weighing.

3. Similar studies of this nature should be conducted using obese subjects. The investigations should be related to improving the level of physical fitness of the subjects.

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# APPENDIX

APPENDIX A

PICTURES TAKEN OF THE SUBJECT AT TWELVE, THIRTEEN, FIFTEEN, AND SEVENTEEN YEARS OF AGE

TWELVE YEARS OLD

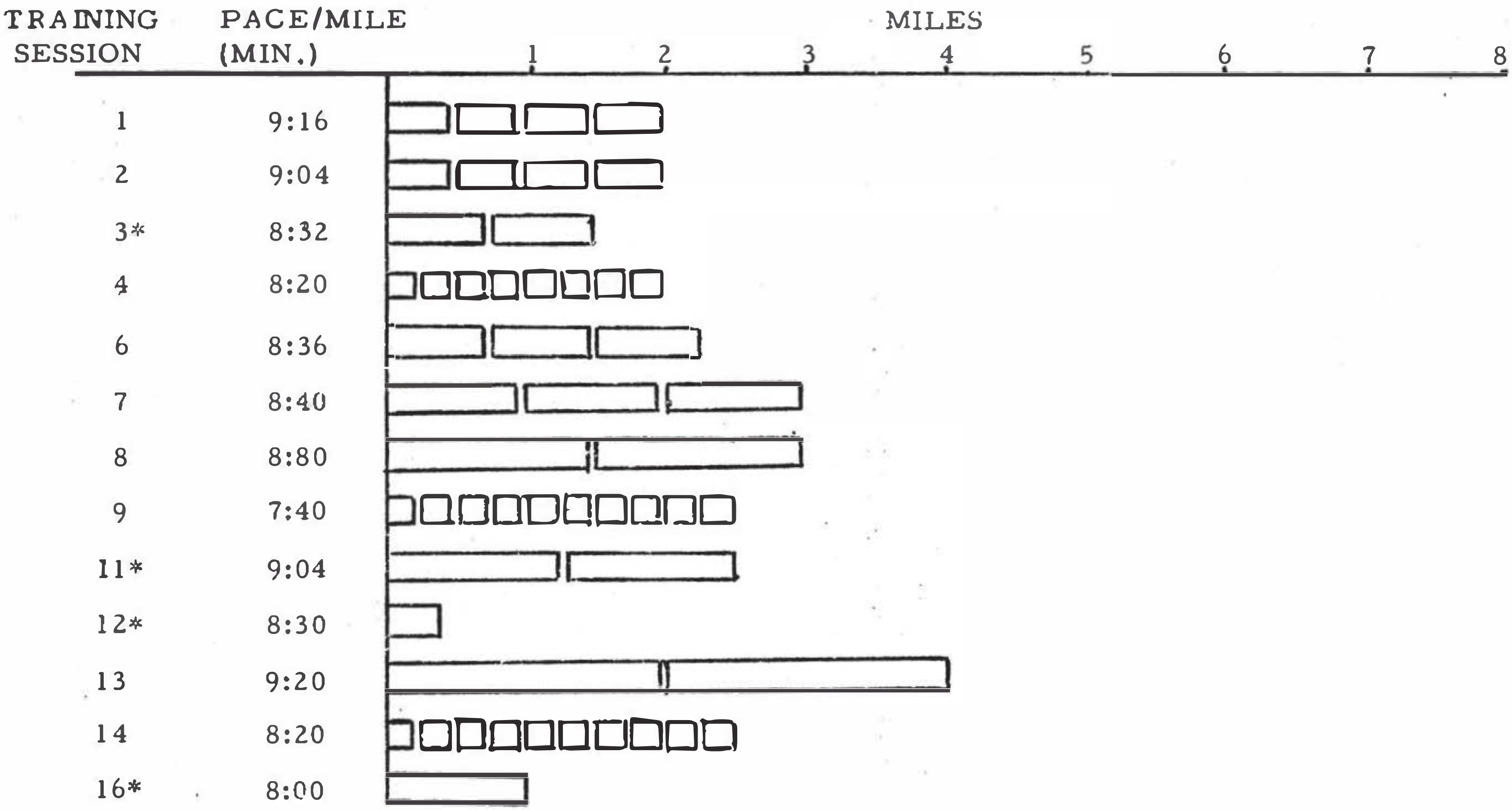
THIRTEEN YEARS OLD

FIFTEEN YEARS OLD

SEVENTEEN YEARS OLD

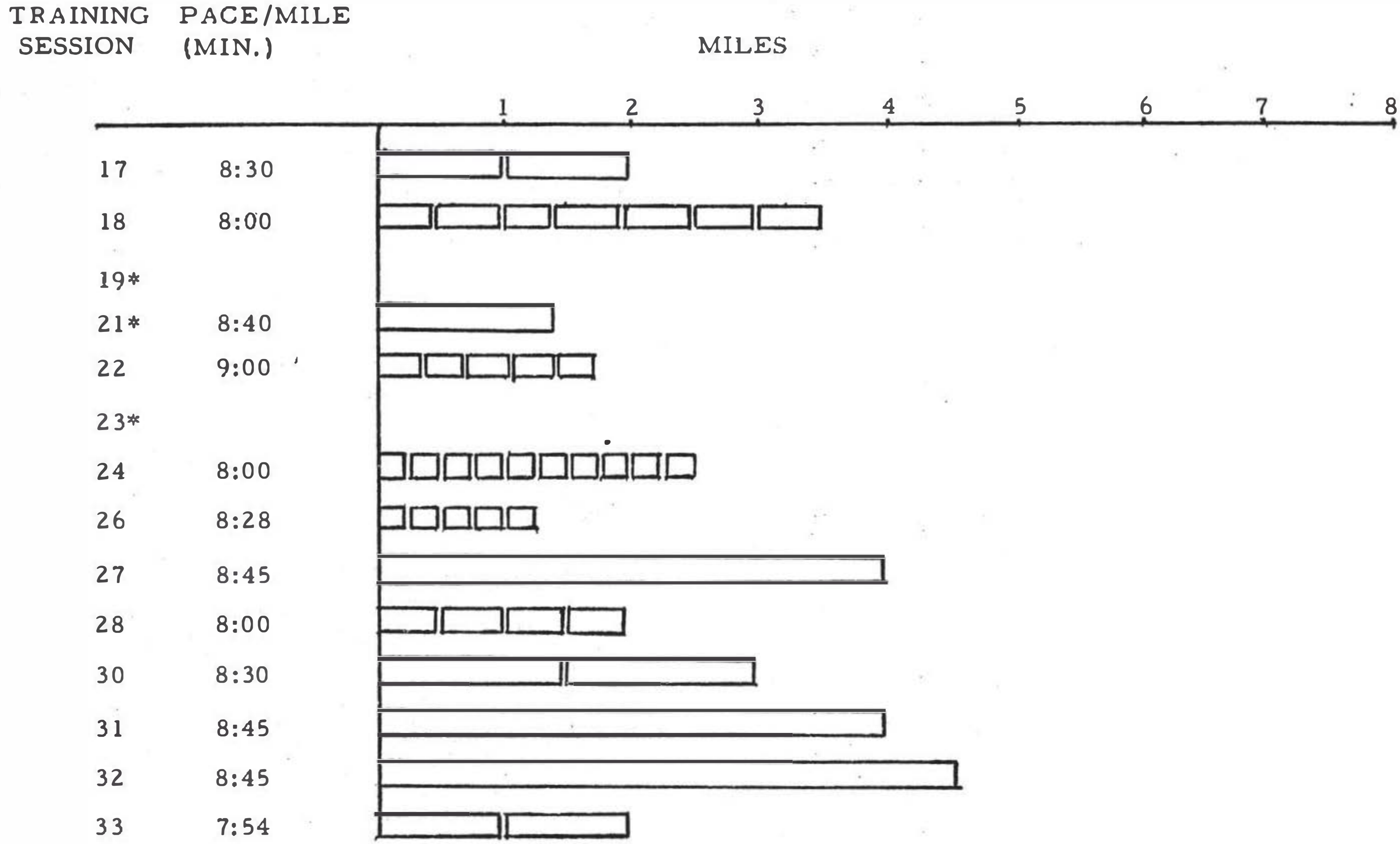
## APPENDIX B

### DISTANCE, NUMBER OF REPETITIONS, AND AVERAGE PACE PER MILE OF EACH TRAINING SESSION RUN



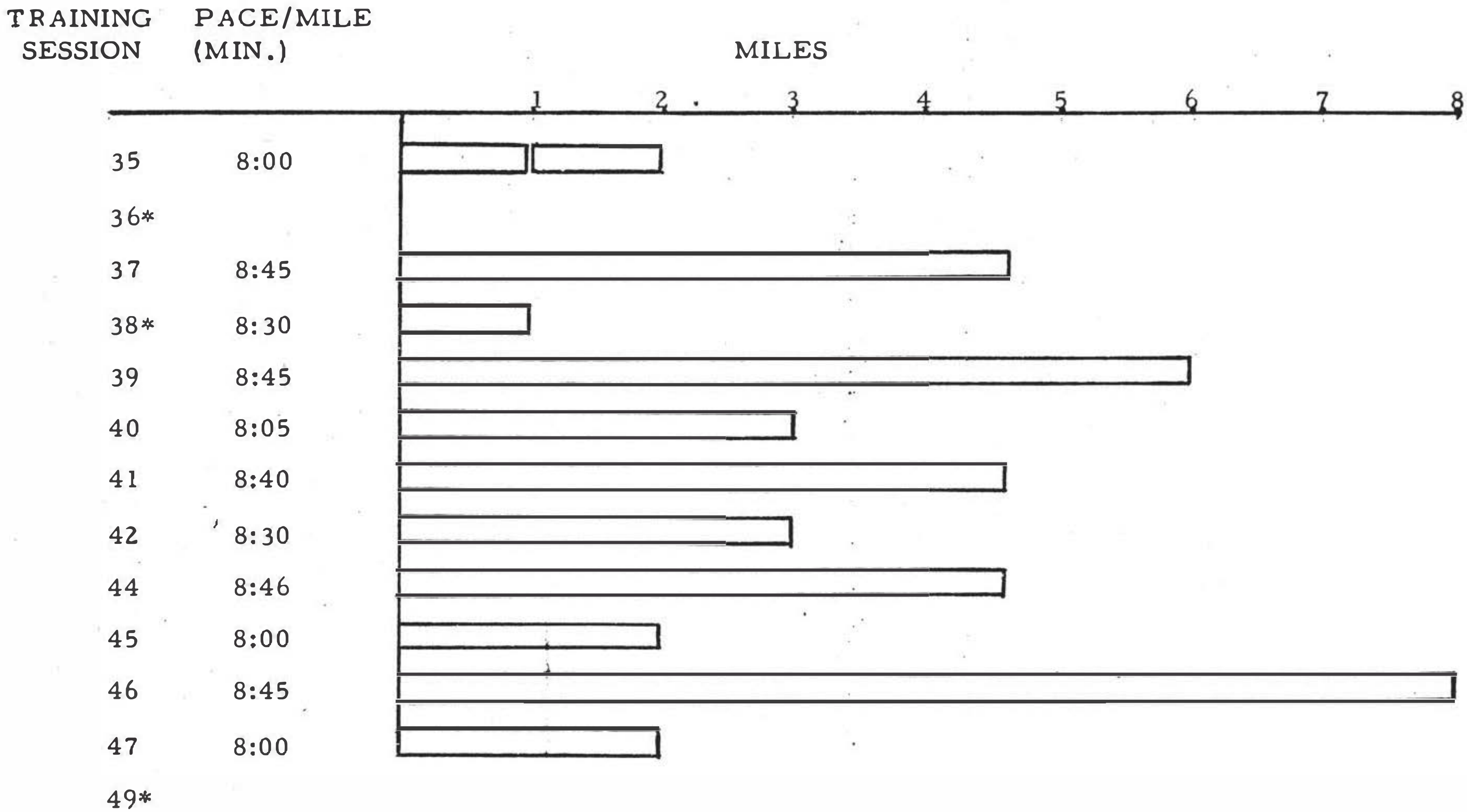

*Modification in the training program

APPENDIX B (continued)




*Modification in the training program

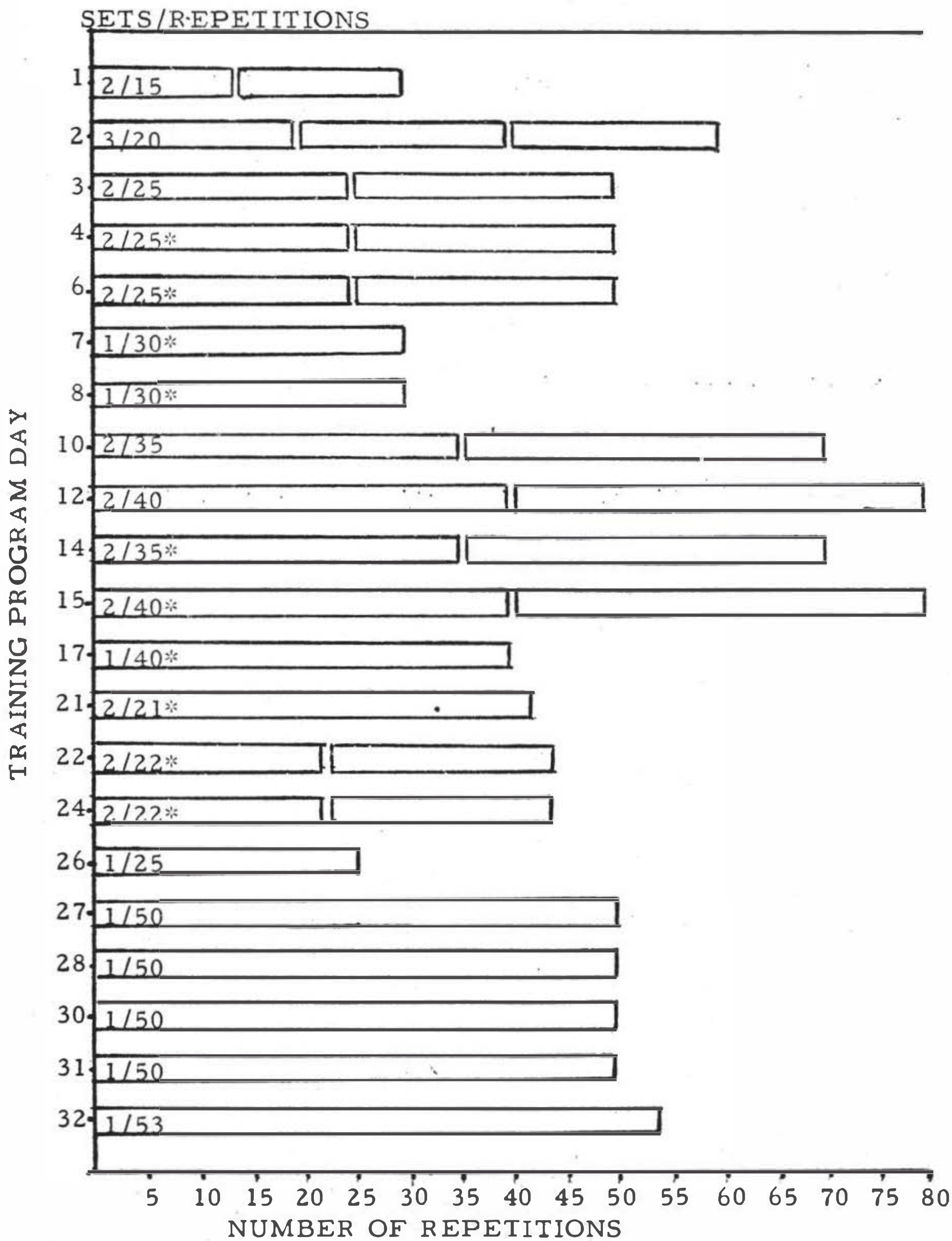
APPENDIX B (continued)




*Modification in the training program

## APPENDIX C

## SIT-UPS PERFORMED THROUGHOUT THE TRAINING PROGRAM

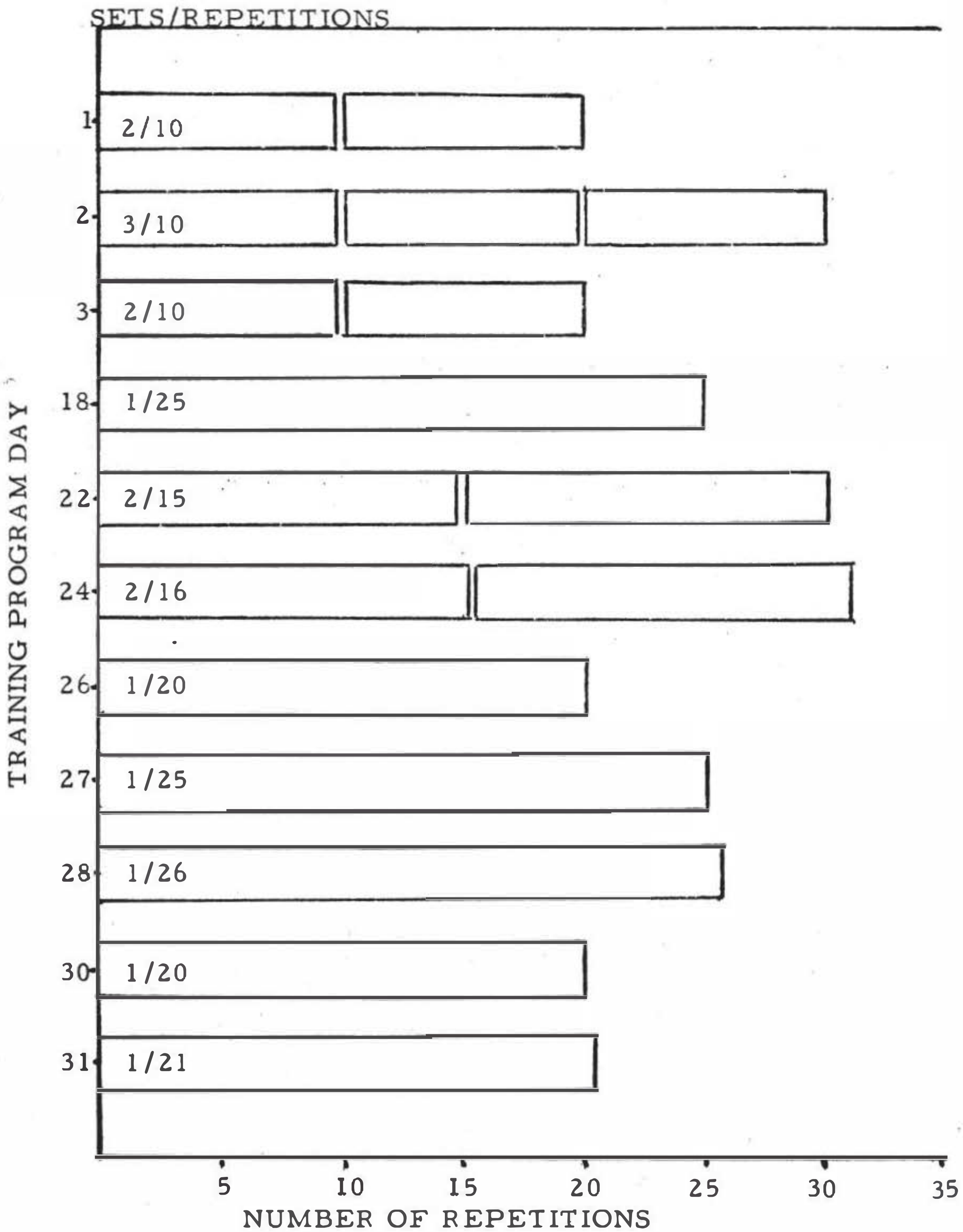



*Sit-ups performed on an incline

APPENDIX D

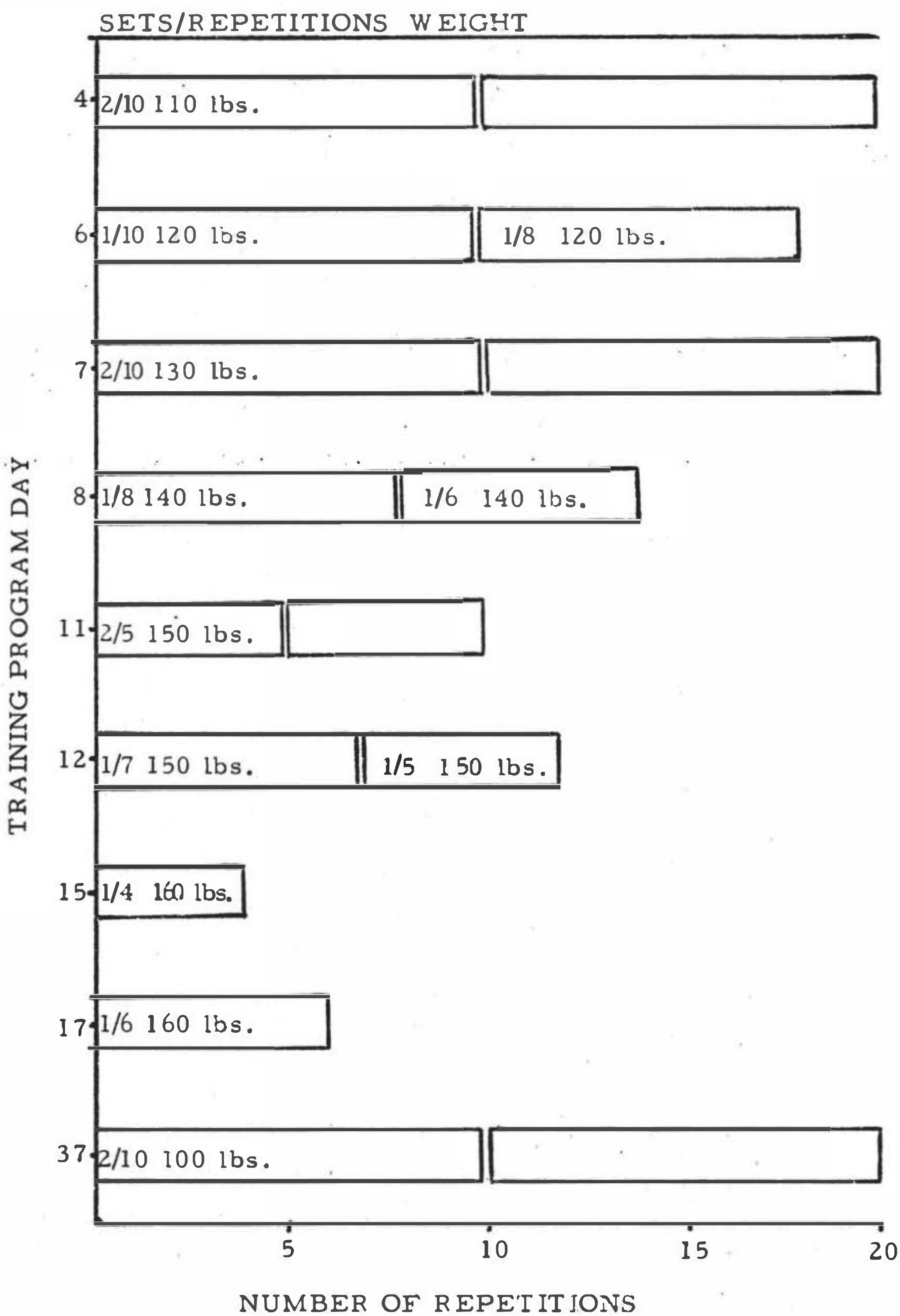
PUSH-UPS PERFORMED THROUGHOUT

THE TRAINING PROGRAM



## APPENDIX E

BENCH PRESSES PERFORMED THROUGHOUT THR TRAINING PROGRAM



## APPENDIX F

## TYPE OF FOOD AND NUMBER OF SERVINGS DURING MEALS AND SNACKS ON THE WEDNESDAYS THROUGHOUT THE INVESTIGATION

| DATE | BREAKFAST | LUNCH | DINNER | SNACKS |
|---|---|---|---|---|
| 3/26 | 1 hamburger/ 1 serving pudding/ 1 8-oz. glass milk | 1 bag pop-corn | 2 servings rice/ 1 serving sir-loin steak/ 2 servings peas/ 3 low calorie pear halves | None |
| 4/2 | 1 8-oz. glass milk/ 1 pancake with syrup | 1 bag pop-corn | 4 pieces chicken/ 2 servings rice/ 2 servings cabbage/ 1 serving jello | 1 can Like |
| 4/9 | 1 small bowl dry cereal/ 1 poached egg on English muffin/ 1 8-oz. glass milk | 2 apples | 2 slices round steak/ 2 small boiled potatoes/ 2 servings green beans/ chocolate bar | 1 Diet Pepsi/ 1 apple |
| 4/16 | 1 small bowl dry cereal/ 1 3gg/ 1 slice ham/ 1 8-oz. glass apple juice | 1 piece pie/ 1 small piece chocolate cake/ 1 glass milk/ 2 slices bread/ 1 ser-ving peas | 2 servings spa-ghetti/ 1 meat ball/ 1 large salad (tossed) | 2-oz. glass punch |
| 4/23 | 1 bowl dry cere-al/ 1 piece cherry pie | 1 bag pop-corn/ 1 glass milk | 2 bowls noodle beef soup/ 1 meat loaf sand-wich/ 1 serving jello | 1 Diet Pepsi |
| 4/30 | 2 slices bacon/ 2 poached eggs/ 1 English muf-fin/ 1 grapefruit | 1 chicken breast/ 1 serving mashed pota-toes & gravy/ 1 serving applesauce/ 1 glass milk | 2 slices turkey/ 1 serving mashed potatoes & gravy/ 1 fruit tart | None |
| 5/7 | 1 egg/ 2 slices bacon/ 1 slice toast/ 1 glass orange juice | 1 hamburger/ 1 glass milk | 2 chicken breasts/ 2 servings cole slaw/ 1 serving French fries/ 1 glass Kool Aid | 1 can Diet Pepsi |

APPENDIX F (continued)

| DATE | BREAKFAST | LUNCH | DINNER | SNACKS |
|---|---|---|---|---|
| 5/14 | 1 glass orange juice/ 1 glass milk/ 1 egg/ 2 slices bacon/ 1 piece toast | 1 serving noodles and beef/ 1 serving potatoes/ 1 glass milk/ 1 piece bread/ 1 serving tossed salad | 2 cheeseburgers/ 1 ice cream cone/ 1 turnover/ 1 7 Up | 2 glasses iced tea |
| 5/21 | 2 pieces bacon/ 1 egg/ 1 glass milk/ 1 glass orange juice/ 1 English m ffin | 1 corn dog/ 1 serving beets/ 1 serving corn/ 1 slice bread/ 1 glass milk | 1 serving meat loaf/ 1 serving cole slaw/ 1 serving corn/ 1 glass iced tea/ 1 ice cream cone | 1 glass iced tea |
| 5/28 | 1 serving flap-jacks/ 1 glass grape juice/ 1 cup coffee | 1 ham sandwich | 2 pork chops/ 1 serving rice/ 2 servings cabbage/ 1 glass iced tea | None |
| 6/4 | None | 2 ham sandwiches/ 1 serving cornies/ 1 glass milk | 2 hamburgers/ 1 serving peas/ 1 serving potatoes/ 1 serving strawberry shortcake | 1 coke/ 1 hamburger |

# VITA

The writer was born in Dayton, Ohio on July 31, 1942. He attended Howard County Junior College and Delaware State College. In 1968 he graduated with a Bachelor of Science in Physical Education.

During the school year 1968-69 the writer was a graduate assistant in the Department of Men's Physical Education. He persued a course of study leading to a Masters of Science in Physical Education.

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