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An Analysis of the Fat Reducing Effects of Participants in Selected, Freshmen Physical Education Classes

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AN ANALYSIS OF THE FAT REDUCING EFFECTS OF
PARTICIPANTS IN SELECTED, FRESHMEN
PHYSICAL EDUCATION CLASSES

A Thesis
Presented to
the Graduate Faculty
Central Washington State College

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

by
Arthur Acuff
December, 1968

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

Freshman males at St. Martin's College are required to take two semesters of physical activities classes for two college credits. Every physical education class properly planned and constructed should have objectives that are stated at the beginning of the course. In general, one of these objectives is almost always the accomplishment of physical fitness. In some ways the measurement of physical fitness is rather vague. Can a student put on weight by adding fat on his body and can the instructor feel satisfied that he is accomplishing satisfactorily the objective of physical fitness? Some scientific studies show that accumulation of fat is a deterrent to physical fitness. This statement will be documented later in this study.

The writer had observed the addition of fat on freshmen physical education students for a period of about eight years. Observation can be deceiving so it was decided to make this study to determine if a certain physical activity did control fat gain, and to determine which activity would best control fat.

I. THE PROBLEM

Statement of the Problem

This study was composed of two problems as follows:

1. To determine if the four physical education activities classes did significantly control fat gain on college freshmen at St. Martin's College.
2. To determine which physical education activity will best control fat gain on college freshmen at St. Martin's College.

Scope of the Study

This study involved a total of 88 freshmen males at St. Martin's College during the Fall semester of the school year 1966-67. They were allowed to enroll by random in one of the four physical education activity classes. Because of overall problems of scheduling in the college, the distribution of students in the classes was not as equitable as desired. On the basis of their voluntary choice of classes, 38 students enrolled in the cross country class, 20 in the basketball class, 17 in the rolleyball class and 13 in the weight training class. Each of the four activity classes met twice each week. The class time provided was 50 minutes and the actual time of participation in the activity was 35 minutes. Five to 6 minutes of each class period was taken up by the performance of 8 basic loosening and warming up exercises. The exercises used were the jumping jacks,

trunk rotators, push-ups, berry pickers, deep knee bends, sit ups, and leg lifts. The measurements were taken of all the students the first and last week of the semester.

Importance of the Study

One of the problems that has arisen in our "Great Society," is the problem of fat gain among children and adults. The newspapers, periodicals, and books consistently carry written material advising the layman how to adequately control excess weight. There is disagreement among medical men and other health professionals as to the effect of activity on losing and controlling weight. They all agree that too many Americans are fat. There is strong evidence that overweight persons are more subject to chronic and degenerative diseases. According to the American Medical Association, one out of every four Americans is overweight.

Interest in the problem is evidenced by reactions of our government. Americans were rudely awakened to the need of physical fitness by the publication of the Kraus-Weber results and the draft rejection figures of recent years. In the last decade, Presidents Eisenhower, Kennedy and Johnson have committed their respective administrations to aid the national fitness effort. President Kennedy aptly summed up the gravity of our deteriorating standards of physical fitness in the "Presidential Message" to schools when he stated: "The

softening process of our civilization continues to carry on its persistent erosion" (34:1).

Currently, President Johnson has been carrying on the program of the late President Kennedy. He too stressed its significance when he described physical fitness as "a matter of fundamental importance to individual well-being and to the progress and security of our nation" (35:9).

Throughout the medical and health professions there is considerable confusion about obesity. Dr. Hilde Bruch, M.D., stated that the basic error in considering obesity due to overeating or inactivity, a simple condition, is that it overlooks the fact that the drives for food and activity are regulated by mechanisms which are not at all simple (6:189).

The writer feels that the scientific study of overweight is still in need of a breakthrough to determine how many people are overweight. In spite of all the studies and material written on excess fat, the opinions and statements are based on very few solid facts. Peter Wyden in his book The Overweight Society says:

The life insurance companies are considered most knowledgeable on the subject, and they do possess impressive looking statistics. These figures differ from those compiled by the Metracal people, and they are probably less accurate. At any rate, insurance experts concede that their figures were hardly more than the roughest approximations. The statistics were based on examinations of the relatively prosperous and prudent

people who buy insurance, not on a sample of the general population. They were derived from the insurance buyers' weights, heights and body frames. In recent years, researchers have found that these are unreliable indicators of overweight. According to the insurance tables, many heavy but muscle-packed athletes are undeservedly rated as overweight. Others, who are shaping up nicely according to the tables, turn out to be flabby and fat (43:15).

Obesity has become a problem to the extent that it is estimated by some authors that there are approximately fifty-two million calorie conscious people in the United States. It is hoped that this study will contribute to research that will solve the perplexing problem of overweight. It will specifically help in future planning of physical education activities at St. Martin's College.

In order to alleviate the problem it is necessary through research to find when fat deposits make the most progress on young adults, and what specific remedies will combat obesity.

Limitations of the Study

This study will be limited by the following factors:

1. Only freshman males enrolled in St. Martin's College physical education activity classes participated in the study.
2. This study was limited in time by school regulations. The students were active for 35 minutes and two days per week. Because of choice of classes, it was possible only to have boys in the same activity for one semester.
3. Due to this particular type of study it was only possible to use one type of fat measurement.

Assumptions

The following assumptions were necessary to give validity to the study:

1. The sampling is adequate to derive an accurate analysis.
2. The students would enroll in the activity by random choice.
3. The instructors of the physical education classes were qualified, objective and reliable.
4. That there was cooperation from the college administration.
5. There were uncontrollable factors of variation in diet and outside physical activity by students.
6. That differences in fat deposition at each of the four sites for members of each of the four physical education groups tend to cancel each other, thus leaving the four groups approximately equal in fat deposition at T_1 .

II. DEFINITION OF TERMS USED

The following definitions will be used regarding the terminology found in the problem and which will be referred to throughout the paper:

Fat Folds

Folds on four parts of the body that are pinched up and fat calipers are used to measure the size of the pinch.

Fat Calipers

A specially designed caliper used to measure

subcutaneous fat.

Subcutaneous Fat

Fat that is close to the surface of the body, and just under the skin.

Chest Front

One of the locations of fat measurement used in this study. On the front of the chest on the left side at the level of the Xiphoid cartilage and halfway between the mid-line and the sagittal plane tangent to the side of the chest.

Chest Back

One of the locations of fat measurement used in this study. On the back on the left side at the level of the xiphoid cartilage and over the greatest bulge of the spinae muscles.

Abdomen

One of the locations of fat measurement used in this study. On the abdomen approximately halfway between the left nipple and the umbilicus, just over the edge of the costal cartilage.

Supra-iliac

One of the locations of fat measurement used in this study. On the left side just above the ilium and in the axillary line.

Anthropometric Measurements

Selected girth measurements of major muscular areas of the body plus body weight.

Xiphoid

The xiphoid cartilage, when present, is just below the lower end of the sternum and can be palpated in most males, though it is missing in many females.

Atherogenic

Pertaining to the deposit of fat in the inner arterial walls. Hardening of the arteries.

Ischemia

A localized anemia, due chiefly to a contracted blood vessel.

Ischemic Heart Disease

Pathological conditions of the heart due to impairment of blood and oxygen supply of the myocardium, including angina pectoris, coronary thrombosis and myocardial infarction.

Glycogen

A white, mealy, amorphous polysacchoride, contained principally in the liver and hydrolized into glucose; also called animal starch.

N. E. F. A.

Non esterified fatty acids in the plasma.

Adipose Tissue

Fat tissue.

Morphological

Pertaining to the form and structure of animals considered apart from function.

Obesity

A deviation of body build characterized by excessive accumulation of fat.

Somatotype

Most useful and widely used method of relating physique to disease in general. The primary analysis is based on the anthroposcopic somatype ratings in terms of three basic components.

Endomorphy

One of the basic somatotype components. Rates softness and roundness. Soft and round abdomen dominates.

Mesomorphy

One of the basic somatotype components. Rates a combination of bone and muscle. Muscular chest development dominates.

Ectomorphy

Rates linearity and fragility. Slender, lanky, thin and fragile body dominates.

T₁

Measurements taken in the fall, at the beginning of classes and before participation in an activity.

T₂

Measurements taken in January, at the end of the scheduled classes and a semester of participation in an activity.

Photogrammetric Anthropometry

A system of measurement whereby standardized pictures of the somatotype variety are taken with the subject against a wall marked with vertical and horizontal lines.

CHAPTER II

REVIEW OF RELATED RESEARCH

I. MEASUREMENT OF FAT AND JUSTIFICATION OF THE USE OF FAT CALIPERS

Before a decision was made on the choice of a device for measuring fat in this study, it was necessary to document the reliability and validity of a variety of devices for measuring fat. The following research is an effort to determine the best device for this study.

Justification of the Use of Fat Calipers

A prominent researcher in the field of physical education has been C. H. McCloy. He conducted a number of studies to determine the physical status of human beings. For the purpose of evaluating physical status, he divided his measurements into four groups: (1) those which measure general nutritional status; (2) those which measure the amount of subcutaneous fat; (3) those which measure muscular development; and (4) those which measure respiratory condition (30:33). In another study he uses and outlines methods of measuring subcutaneous fat by use of fat calipers (29:48-53).

Thomas K. Cureton made a study of the amount of fat on champion athletes. His study was made on United States track and field athletes and swimmers. He compared the

athletes of the 1936 Olympics, with the athletes of the 1948 Olympics. His conclusion was that the 1948 athletes had less fat than those of 1936. One of the measurement devices used in this study was the fat caliper (12:51-60).

Clem Thompson of Boston University used skinfold measurements to measure fat on Boston University football players. The measurements were taken at the beginning and the end of the football season. He found that the body weight of the football players did not change significantly but significant losses occurred at three skinfold sites (41:87-93).

Thompson and two other researchers made a similar study on basketball and hockey players using skinfold measurements with very similar results (40:418, 30).

Keys and Brozek discovered a high correlation between specific gravity and skinfold measurements. Thus ready appraisal was made possible of relative and excess fatness in human subjects. The authors pointed out that for many research purposes as well as practical applications absolute accuracy is not essential, and it is not even important to know the total amount of fat in the body. It is enough, according to the authors, to know the difference in fat between two bodies or the difference in the same person at different times. As a rule, actual values of the skinfolds can be used as a criterion of fatness.

The authors established the first equations for predicting body fat on the basis of single skinfolds and of different combinations of skinfolds. The region of diminishing (and vanishing) returns in adding skinfolds beyond three or four well-selected and optimally weighed sites is rapidly reached. Thus, while generally multiple skinfold measurements are preferable, estimates derived from single skinfold measurements may reliably reflect total trends (27:245).

In 1956, T. H. Allen corroborated Keys and Brozek's conclusions and established a direct correlation between specific gravity and combined skinfold measurements taken at cheek, chin, thorax (two places), upper arm, back, abdomen, hip, thigh, and calf (1:23).

Dr. A. W. Edwards asserts that measurement of body fat by total body water or specific gravity is not suitable for general use in medicine, nor for large surveys of populations. He advocates the use of skinfold calipers then used by anthropometrists and nutritionists. Along with four other colleagues, he experimented with various designs of skinfold calipers in an attempt to standardize the calipers used for measurement of fat (13:35-36).

In a recent book by Consolazio, Johnson and Pecora, two types of calipers are discussed along with a brief outline of the correct way to use the fat calipers. Skinfold

thickness measurements are made with either the USAMRNL (1953) or the Minnesota calipers (1954). The former has circular jaw faces measuring 25 mm, and the latter has rectangular jaw faces measuring 40 mm. Both calipers were calibrated so that the spring tension gave a pressure of 10 gm/mm of jaw face surface (9:300).

A comparison of the two calipers was performed on 91 subjects in basic training at Fort Riley, Kansas in 1954. Four sites were measured on each man: abdomen, chest, arm, and back. Two types of calipers were used, the USAMRNL design and the Minnesota design.7 Each skinfold was measured twice with each caliper and the entire series of measurements was repeated after an interval of one month. A total of 2912 measurements were made. The standard deviation of a single measurement was 0.074 cm with the USAMRNL calipers and 0.069 cm with the Minnesota calipers. The difference between these values was not statistically significant, indicating that the reproducibility of measurement for the two kinds of calipers was not significantly different under the conditions of use in this study. The absolute values of the skinfold thickness measurements with the two kinds of calipers did not differ significantly. The USAMRNL calipers were judged to be more convenient to use than the Minnesota calipers (20:129).

Consolazio, Johnson, and Pecora give the following description of how skinfold measurements should be taken: All skinfold measurements are made on the right side of the body. Grasp the skinfolds between the thumb and index finger. The span of the grasp is dependent on the thickness of the skinfold. The skinfold held should include two thicknesses of skin and subcutaneous fat but not muscle or fascia. When in doubt, instruct the subject to perform an act which results in the contraction of muscle underlying the skinfold held in the grasp. Apply the calipers about 1 cm from the fingers holding the skinfold and at a depth approximately equal to the thickness of the fold. All folds are taken in the vertical plane. (9:301).

Dr. Jokl, using skinfold calipers and circumferential body measurements, found that 4 1/2 months of intensive training on adolescent girls resulted in a reduction of fat deposits and showed a significant reduction in circumferential hip measurements and skinfold measurements (25:56).

Other Fat Measuring Devices

Photography. An example of this type of measurement was a study to assess the role of exercise in reducing body weight in overweight college women and to compare the effect of two types of exercises, spot and generalized, on the physical contour of the overweight individual. The

experimental program which included a uniform diet resulted in a slight but significant reduction of weight. Planimetric measurements of selected areas and linear transverse measures, obtained from preexercise and postexercise photographs, yielded evidence of reduction in body segments where fat accumulations had been most conspicuous, regardless of the type of exercise administered. In this experiment, standardized pictures of the somatotype variety were taken before and after the exercise period with attention to major controls exercised in photogrammetric anthropometry. The result was more loss of weight in the spot than the generalized exercise program but it was not significant (37:461).

Water weighing. In 1942, Behnke published two important papers on the relationship between specific gravity and fat content of the body of healthy men.

In accordance with Archimedes' principle, body volume can be determined by hydrostatic weighing whereby "equivalent volume" is ascertained as the difference between weight in air and weight in water. Corporeal density serves as an index of the amount of excess adipose tissue. The weight in water is determined by suspending a subject below the surface of the water on a line leading to a spring scale graduated in ounces. A weighted lead belt maintains a negative buoyancy for all types of persons. Special methods

have to be employed to measure vital capacity and residual air.

The average weight in water of a group of 28 men whose mean weight was 148.7 pounds and whose specific gravity was low (1.056) amounted to 9.4 pounds. The corresponding values for high specific gravity of 38 whose mean weight was 176 pounds were 1.081 and 11.1. The difference in weight in air between the two groups was 27.3 pounds.

On the assumption based on the foregoing figures that a loss of 27.3 pounds of body weight in air is associated with a gain of weight in water of 1.7 pounds (11.1 - 9.4), the conclusion was drawn that if men in the low specific gravity group had lost this amount, their specific body weight would have risen from an initial value of 1.056 to 1.081; that is, for every pound of weight lost, the weight of the body in water would have increased 0.062 pounds. The specific gravity of the reduced tissues was calculated as 0.94. This value is in accord with the specific gravity of adipose tissue.

Thus, the difference between the specific gravity of the two groups was attributed to a variation in adipose tissue. In explanation it should be pointed out that the body may be viewed as comprising calcium salts representing 50 per cent of the weight of bone, essential or irreducible

lipoid substance, excess adipose tissue and all other tissues of the body embracing chiefly muscle, organs, brain, skin and blood. The specific gravity of the mineral substance of bone is of the order of 3.0, adipose tissue 0.94 and all other tissue 1.060.

In contrast to bone, the amount of excess fat is subject to wide variations and a value of 30 per cent of the total body weight is not unreasonable for obese persons. For example, if a lean man weighing 140 pounds accumulates 60 pounds of adipose tissue, the specific gravity of the body will be lowered from 1.082 to 1.035. Since the density of the mass of tissue exclusive of bone and fat may be considered constant for healthy men, the amount of fat appears to be the main factor determining specific gravity.

Behnke and co-workers drew attention to the fact that diet and exercise exert a major effect upon specific gravity. A man placed on a restricted diet and engaging in systematic exercise lost 19.5 pounds over a period of 7 months. His net weight in water increased from 10.8 pounds to 12.1 pounds although the corresponding weight in air decreased from 202.5 pounds to 183.0 pounds. Thus for every pound of weight lost in air, the weight in water increased 0.067 pound ($1.3 \div 19.5$). The specific gravity of the reduced tissue is, therefore, computed to be 0.937

(1.000 ÷ 1.067). Again, this value is in accord with the specific gravity of neutral fat (2:495).

X-ray. S. M. Garn compared the use of pinch calipers and x-ray measurements of skin plus (16:124-179). From this research it was found that there are three best methods of determining outside or surface fat. These are the use of x-ray, the fat caliper and the use of specific gravity or water weighing. From these studies it was determined that there was no significant difference in the methods, and the fat caliper was the most convenient and economical.

Stereophotogrammetry. According to the authors of this article, this system of measurement is a 3-D method of measuring superior to calipers and tape measures. Scientists at the University of Illinois and others around the country, are beginning to use the technique to measure and understand physiological differences among people. Briefly, the technique is to make a contour map of the hills and valleys of the human body. Civil engineers use it to map terrain--of obtaining an accurate measurement of the physique. Drawing of the map begins with three-dimensional photographs which must be taken with a special camera. A frame in which a person stands is carved out to accommodate various heights and arm lengths. It also serves as ground zero--the engineering equivalent of sea level. The grid

marks, thrown on the person by slide projector, help mark the differences in the various body levels. The 3-D pictures are then inserted into a complex machine known as a plotter. The machine's operator, by tracing a built-in marker over the various levels as he sees them on the photograph, simultaneously maneuvers a mechanical pencil which draws the contour lines (19:57-60).

II. PHYSICAL TRAINING AND FAT CONTROL

Physical Training and Obesity

In 1941, Cluver, de Jongh, and Jokl communicated the results of a four month's physical exercise experiment in which anthropometric measurements of previously untrained lean and obese recruits of a South African police academy were compared. The physical training caused lean trainees to gain and obese trainees to lose weight. Chest circumferences and bulk of muscles of the extremities increased in both groups; abdominal circumferences increased in the lean but decreased in the obese men. In other words, the nature of the morphological effects of physical training was largely determined by the amount of excess body fat. Secondly, this study was concerned with the effect of exercise regimes of different intensity. Anthropometric adjustments during training were distinctly greater in a group of men whose activity schedule was longer and more

strenuous. From these observations the hypothesis was derived that the effects of physical training upon physique are modified by the amount of excess body fat and by the intensity of the exercise regime (25:41).

In a study reported by Mary Louise Johnson, two groups of high school girls, 28 obese subjects and 28 non-obese individuals of similar height, age, and grade, were compared in regard to physical maturation, food intake, and activity.

The obese girls showed advance development, earlier deceleration of growth in height and earlier menarche. Both groups were relatively inactive, but the obese girls were significantly more so.

When caloric intakes and activity indices were compared for each group, to determine the salient energy factors in the development and maintenance of obesity, it appeared that on a statistical basis, inactivity was much more important than "overeating." In fact, the caloric intake of the obese group was significantly lower than that of the nonobese group, with the relatively greater energy balance being consequently supplied by inactivity (22:37-43).

A. J. Stunkard and colleagues used a mechanical device (pedometer) to count the number of steps taken by obese and nonobese men and women. This was done to assess individual attitudes toward physical activity. The authors

applied a questionnaire and sentence completion test. When these tests were evaluated they found that the obese subjects walked significantly less than nonobese subjects (39:935-940).

Dr. Hilde Bruch in summarizing the results of her studies over more than twenty years came to the following conclusions: Fat children are physically less active than lean children and that inactivity is the chief cause of obesity. The lack of exercise expresses a disturbance in these children's total approach to life, a real lack of enjoyment of physical activity due to a deep-seated mistrust about being able to master any athletic skills. Fat boys and girls save energy in every movement even though they actually use more energy than lean children if they move, because they carry heavier body mass. Their inhibition of activity represents a more fundamental disturbance than overeating (6:220).

Dr. Jokl of the University of Kentucky had this to say about obesity:

Physical activity is the most significant etiological factor in obesity. Obese subjects lose excess fat if they exercise. A sustained regime of intensive physical training may completely change physique and character. In adolescence obesity is frequently accompanied by marked delay in puberty and exercise exerts a remedial influence also upon developmental retardation. Under the influence of exercise all structural, behavioral, metabolic and functional characteristics of fat children undergo decisive changes. Extent and effectiveness of morphological maladjustments to training of obese individuals depend upon intensity of physical activity (25:50).

Weight Control

Kenneth H. Cooper, M.D., a Major in the United States Air Force, did a research study about the human body's need for exercise and the appropriate kind and duration. Dr. Cooper's research made a significant contribution by correlating oxygen consumption and pulse rate with various types of exercise and the vigor and duration of each.

According to Dr. Cooper's research the best exercises are running, swimming, cycling, walking, stationary running, handball, basketball and squash, in that order. Isometrics, weight lifting and most calisthenics do not even make the list. This study could possibly correlate with energy used and weight loss (10:56).

In a summary of one of his research projects, Dr. Jean Mayer of Harvard University made this statement:

In spite of popular belief, the performance of exercise is not automatically followed by an increase in food intake. This increase only takes place if the individual was fairly active to start with. If he was sedentary, he can step up his activity without such increase in appetite. Conversely, if activity is decreased below a certain point (the exact point depends on the individual), appetite does not decrease correspondingly; in fact, it may increase somewhat. The result, of course, is accumulation of fat.

Finally the cost of moving the body is proportional to body weight. It follows that energy cost of a given exercise is greater for an overweight person than a normal weight individual. Conversely, a physically active person will tend to have a more stable weight than an inactive person. Thus regular exercise has an essential role in weight control (31:301-310).

It is worthy of note that recent findings reveal that reducing the weight of obese animals through exercise has a much more lasting effect than reduction through curtailment of food (24:314).

A pamphlet published by the American Medical Association emphasized the benefits of daily exercise in the control of weight, as compared to diet and other methods. It states that exercise in the long run is the best method of weight control for most people. The authors state that the key to effective weight control is balance between energy input (food eaten) and energy output (exercise taken) (23:1-2).

R. W. Kireillis made a study of the results of physical training on adiposity at the University of Illinois. He found that intensified physical training did reduce adiposity (28:1).

La Von Johnson made a study of eighth grade boys and girls enrolled in David Douglas Public Schools, Portland, Oregon in the 1965-66 school year. He compared the effects of five-day-a-week physical education classes as opposed to two-and three-day-a-week physical education classes on physical fitness, activity skill, subcutaneous tissue, and physical growth. The hypothesis that the triceps skinfold measurement of subcutaneous adipose tissue would be less for the five-day subjects than for the two-and-three-day

subjects was accepted. Another hypothesis stating that the five-day subjects would have greater body density than the two-and three-day subjects was also accepted (21:2).

III. NUTRITION, AND MISCELLANEOUS OBESITY STUDIES

Nutrition

Except for pathological and psychological reasons, weight loss and gain is very much a matter of food intake and energy expenditure. The man with a daily caloric expenditure of 2500 calories will slowly lose weight if he eats less than 2500 calories per day, and will gain weight if he eats more than 2500 calories per day. Because a pound of body weight is the equivalent of about 4500 calories, changes in daily caloric intake or caloric expenditure do not result in rapid weight fluctuations. Significant changes in food intake and additional energy expenditure will result in significant weight fluctuations in most cases.

Basically exercise is not expensive calorically. A world champion athlete working maximally can, at the very most, burn 1800 calories per hour and even this figure is an academic one. The average man cannot burn much more than about 800 calories per hour even if he is working extremely hard. A ten to fifteen minute exercise program

normally costs 140-200 calories. Comparing this to the caloric value of a slice of bread (75) or a piece of pie (250), it can be seen that very little food is the equivalent of considerable exercise (18:6).

Taylor in his studies of the relationship between mechanical efficiency and diet found that the mechanical efficiency of work is higher when subjects have been fed on a high carbohydrate diet for some days as compared to the same subjects existing on a high fat diet. This therefore could reduce efficiency of people on a starvation diet and living on stored fat (40:123-161).

In comparing the diets of the Olympic athletes to that of the average American, Dr. Jokl points out that the reason why the athletes can consume 4500 calories daily and not gain in adipose tissue or atherogenicity is because it is nullified by intensive athletic training. The average American consumes 3000 calories a day and is more susceptible to atherogenicity and fat gain because of inactivity. He suggests a diet of 2300 calories which would be made up of 69 per cent carbohydrates, 16 per cent proteins, 11 per cent unsaturated fats and 4 per cent saturated fats (25:6-7).

The fuel of muscle. Carbohydrates have been considered as "prime fuel" of muscle. Studies of N. E. F. A. have recently shown that unlike other lipid components this fraction is relatively little affected by a fatty meal.

N. E. F. A. has a rate of turnover about 40 times greater than that of glucose. Since a molecule of N. E. F. A. provides on oxidation more than 3 times as much energy as a molecule of glucose, N. E. F. A. could easily supply the necessary fuel for muscular exercise.

The opinion is now rapidly gaining ground that the major portion of the dietary carbohydrate is converted immediately to fat in the adipose tissues. During muscular exercise it is mobilized directly as N. E. F. A. which is carried to the working muscles. During transit in the blood N. E. F. A. is loosely bound to serum-albumin. Thus, fat rather than carbohydrate now seems to be the "prime fuel" of muscle. The present view is that carbohydrate is the one fuel immediately available in muscle, and its breakdown to lactic acid provides the energy for any burst of activity. But this mechanism is probably responsible for no more than a small fraction of the energy utilized in long-continued muscular work. The heart muscle can extract from the blood enough fat to account for 70 per cent of the oxygen uptake. Plasma from the veins of exercising muscles contains significantly less N. E. F. A. than that from the veins of resting muscles. There can no longer be any doubt that the non-esterified fatty acids are directly utilized as fuel during muscular exercise (25:18-21).

Body water and fat. "Lean tissue" comprises 73 per cent of body water. Two-thirds of these 73 per cent are intracellular. The remainder is extracellular. The body, however, consists also of the skeleton and of fat deposits. Water content of extracellular fluid and skeleton are virtually constant. However, fat deposits contain relatively little water (20-30 per cent), so that obese individuals have a relatively smaller water content than lean persons. Variations of fat are the main source of variations in total body water among individuals (27:802).

Miscellaneous Fat Studies

In comparisons between obese and nonobese rural girls (aged 10 through 16) made on family-structure variables, intelligence and achievement scores, measures of physical activity, and sex role identification, research failed to support Dr. Bruch's psychogenic theory of obesity. The high correspondence in overweight between parents and children suggested the alternate hypothesis that either constitutional factors or family eating habits were more centrally involved in child obesity (7:288-94).

What causes obesity? According to Dr. Bruch, all cases of obesity overeat in relation to their energy expenditure. There is no longer the search for one single measurement that would tell the complete story; instead

efforts should be directed toward a more complete picture of how disturbances in carbohydrate metabolism, in glandular function, in growth processes, and other regulatory mechanisms combine to produce the complex syndrome of obesity.

Dr. Bruch brings out that in the case of fat children and fat adults a basal metabolism test will invariably report a "low" metabolic rate. This does not necessarily denote hypothyroidism. She thinks there should be more intensified study into the fat metabolism of the body, and that fat accumulation is caused by multiple causes and that each individual may have a different problem or problems (6:415).

Helen Canning and Jean Mayer made a study to determine the possible effect obesity has on college acceptance. The study showed significantly less obesity among college females of the Ivy league as compared to the high school females in the study. The females of high school had twice as many girls obese as the college females. Of the college males studied, 18 per cent were obese as compared to 13.7 per cent for high school males. They concluded that obese applicants are discriminated against even though discriminators may be unconscious of it. This could be by unconscious discrimination by high school teachers in recommending and by college admissions officers (8:1172).

The Statistical Bulletin of the Metropolitan Life Insurance Company states that insured men are getting heavier age for age, height for height, continuing a trend noted in earlier studies. Average weights of new male policyholders increased between two world wars. The largest increases were among the younger and taller of both sexes (32:47).

Who are the obese? Do obese subjects differ from nonobese in morphological features other than differences in amount of fatty tissue? This study was made to help determine the genetic and constitutional factors in obesity. The subjects were adolescent girls. The researchers used skinfold measurements with large skinfold calipers, and somatotype photographs were taken. The skinfold measurements taken were over the triceps and below the scapula. A minimum of 20 millimeters for either was considered diagnostic of obesity for this study.

The authors Seltzer and Mayer concluded that obesity does occur in all varieties of physical types. There was greater frequency in some physical types than others. Obese adolescent girls seem to be more endomorphic, somewhat more mesomorphic and less ectomorphic than nonobese of the same age. The tendency toward obesity is more prevalent in endomorphs. There are some mesomorphs that are obese but the ectomorphic are rarely obese (38:677).

In the Obesity-Diabetes Clinic of the American Medical Association, Dr. Fineberg states that the experience in this clinic suggests that the onset of prolonged salt and water retention during weight reduction may be the greatest single cause of failure in treatment of obesity (15:862).

Solving the problem of overweight. Theodore Berland reports on what cosmetic surgery can do to solve the problem of excess fat. When diet and exercise fail to accomplish it, excess fat on upper arms, buttocks, and abdomen can be removed and the skin tightened and lifted. The operation takes from two to five hours and requires from several days to two weeks of hospitalization (3:42-47).

As discussed in his book, Peter Wyden investigates the facts and follies of girth control. Mr. Wyden concludes after his extensive investigation, that the best experts should pause in their study of fragments of the problem, discuss all of its elements at the summit level and then issue a progress report to demolish unnecessary public uncertainties. He suggests the report should, at a minimum, answer the following questions:

1. How solid is the evidence that excessive calorie intake substantially shortens life?
2. How solid is the evidence that lack of exercise substantially shortens life?
3. Which diet aids are helpful and which are useless or worse?

4. What should consumers do about fats?
5. Who are the people who should not diet at all?
6. What can mothers do to help prevent obesity of their children from birth?
7. What is the most urgent diet-and-exercise research needed and how should it be organized (43:311).

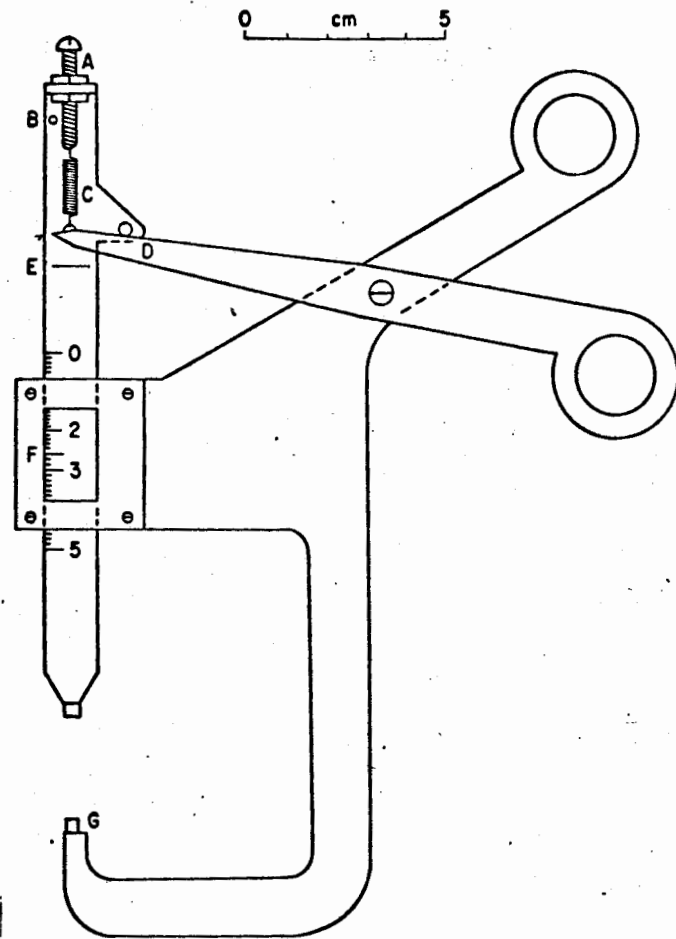


Diagram of USAMRNL calipers for measuring skinfold thickness. [Best (1953)].

FIGURE 1

USAMRNL CALIPER

CHAPTER III

METHODS AND PROCEDURES

This chapter consists of: (1) a description of measurements, apparatus used and procedure for their administration; (2) a description of the test for validity of equipment, and the test-retests for the reliability of the researcher and his use of equipment; (3) the methods employed in conducting the physical education program; and (4) the methods employed in analyzing the test information.

I. DESCRIPTION AND PROCEDURE IN TESTING

All measurements were administered at the beginning and the end of the Fall semester, 1965. The apparatus used were USAMRNL type skinfold Calipers, and Health O'Meter scales made by Continental Scales Company of Chicago, Illinois. The skinfold measurements were taken at four places on the body. The four places on the body were chest front, chest back or scapular, abdomen and the supra-iliac. These body locations are as recommended by McCloy (27:48-49). The weights were taken while the subjects were in the nude. Page 34 depicts the type of USAMRNL caliper which was used.

Skinfold measurements were taken on the right side of the body, grasping the skinfolds between the thumb and index finger. All folds were taken in the vertical plane

about 1 cm from the fingers. Measurements were taken in the morning hours from one to three hours after breakfast by the same observer. All measurements were taken by the same observer as rapidly as possible. These methods were as prescribed by Consolazio, Johnson, and Pecora (9:300-302).

II. OBJECTIVITY AND RELIABILITY TESTS

Objectivity Test

In order to test the validity of the apparatus used and the ability of the researcher to use the apparatus properly, it was necessary to obtain the assistance of two other professional men. Mr. Lewis Christiansen, physical education instructor of Ellensburg Junior High School, Ellensburg, Washington, provided the subjects and setting for the test for objectivity. The subjects were eighth and ninth grade male students of Ellensburg Junior High School, Ellensburg, Washington. Dr. Robert Irving of Central Washington State College, Ellensburg, Washington, assisted in the testing by measurement of all the Junior High Students so as to have a measurement to compare with that of the writer.

There were twenty subjects in the chosen physical education class and to measure the subjects for the objectivity test, they were divided into groups of 11 and 9. Dr. Irving and the writer alternately measured the two

groups and compared the results after all 20 subjects had been measured in four locations by both men. The results were correlations of: chest front .826, chest back .907, abdomen .859, and supra-iliac .865.

Reliability Test

The test for reliability was made possible through the cooperation of Mr. Jim Willis, physical education instructor at St. Martin's High School, Olympia, Washington. The measurements for the tests were made on successive days early in September of 1966. The subjects were 20 ninth grade male students in a regular physical education class attending St. Martin's High School. The measurements were taken at 2:30 p.m.

The 20 subjects were lined up and measured by the author as quickly as possible. They were measured on two succeeding days with the following results on four locations: A correlation of .989 for the chest front measurement; a correlation of .964 for the abdominal measurement; a correlation of .941 for the chest back measurement; and a correlation of .974 for the supra-iliac measurement.

III. PHYSICAL EDUCATION CLASS PROCEDURES

The physical education program was conducted for one semester with classes meeting for 50 minutes two times

per week. The actual working time was approximately 35 minutes per class period in each activity. The activities chosen for this study were cross country, basketball, volleyball and weight training. The absences were held to a minimum due to the fact that regular attendance was necessary to obtaining a passing grade.

Warm-up Exercises

During the 35 minutes of activity time, approximately the first 5 minutes were spent on limbering and warming up exercises. The same exercises were given each class period. They were as follows:

Jumping jacks. These exercises are also known as the side-straddle hops. Subjects start the exercise with hands down to the side and feet together. At the count of one, hands and arms are extended and swung sideways and up until hands meet above the head. Simultaneously the subject hops and the feet are spread sideways about 20 inches. At the count of two, subject returns to the starting position.

Trunk rotators. Starting position for this exercise is with hands on hips and it is done in four counts. At the count of one, the subject bends forward and sideways to the left; at the count of two the body is straight forward; count of three forward and to the right; and at the

count of four, returns to the starting position. This is repeated starting from the right side.

Push-ups. Starting position is with subject lying on floor face down with hands braced on floor at the sides. On the first count the subject, keeping a straight body and on the toes, presses body upward. On the second count, the subject returns to the starting position.

Berry pickers. Starting position is with feet spread about 16 inches and hands on hips. At the count of one, the subject bends and touches the floor in front of body about 6 to 8 inches; at the count of two, the subject touches the floor between the feet; on the third count the subject touches the floor about 6 inches through the legs and to the rear of the body; and at the count of four, the subject returns to the starting position.

Deep knee bends. Starting position is with hands on hips, feet together at a 45 degree angle, and in an upright position. On the first count the subject bends to deep squat position while staying on toes and keeping the back straight. On the second count he returns to the starting position.

Sit-ups. Starting position is with subject lying on back with hands extended above head and body fully

extended. At the count of one, subject raises upper portion of body, touches toes with hands, and at the count of two returns to starting position.

Leg lifts. Starting position is with subject lying on back, hands and arms down to the sides of the body. At the first count the feet are lifted to about 6 inches off the floor with feet together; at the second count the feet are spread laterally as far as comfortable, holding at about 6 inches off the floor; at the count of three the feet are brought back together; and at the count of four the subject returns to the starting position.

Procedures of Physical Education Activities

The following activities are described as to daily routine. It was necessary to keep the classes moving and on time for all activities in order to accomplish the plan for each class. No extra incentives or spirited instruction was given to any of the classes. The purposes of measurements taken was not explained until the end of the semester.

Cross country. There were 43 freshmen male students enrolled in this class at the beginning of the semester. At the end of the semester 38 had survived, due to regular dropouts from school. The physical education instructor was the author of this paper. Every class was started with

warm-up exercises. A goal of being able to jog 3 miles at the end of the semester was set for the purpose of aiding the instructor in assigning grades. After the exercises were given the rest of the period was spent in running. The instructor gave instructions as to conditioning and care of any injury that might occur. Nearly all of the students walked or ran alternately the first two weeks. When the weather was inclement all running was done inside the gymnasium. This was only necessary in 5 class periods. By the end of the semester only 1 of the 38 subjects was unable to jog at least 3 miles.

Basketball. There were 25 freshmen male students enrolled in the basketball class at the beginning of the semester. Three of these students dropped out of school and 2 failed to show up for the final measurements used in the study. There were 20 students that participated in the class and were used for purposes of this study. The instructor for this class was Mr. Jerry Vermillion, a regular member of the physical education staff of St. Martin's College.

The procedure for this class was to spend 10 minutes in instruction and practice of skills and to scrimmage approximately the last 15 minutes of class. The latter part of the semester the routine was only slightly changed. It started with the warm-up exercises, followed by using

basketball skills and scrimmage. Part of the grade was on the basis of performance of skills. This is the usual type of incentive for this class.

Volleyball. There were 18 male freshmen students enrolled in the volleyball class at the beginning of the semester. One of the students dropped out of the class shortly after the start of the semester. There were 17 students that finished the class and participated in the study until the end of the semester. The instructor for this class was the author of this paper.

The procedure for the volleyball class was to do warm-up exercises, spend approximately 10 minutes on instruction and practice of skills and then play a volleyball game. As the class became more proficient in the skills of volleyball, more time was spent in playing the game.

Weight training. There were 14 male freshmen students enrolled in the weight training class at the beginning of the semester. One of the students dropped the class, leaving 13 students who were participating in the study at the end of the semester.

The procedure for the weight training class was to do the regular warm-up and limbering up exercises and then proceed with the weights. The first 10 minutes of each class

were spent in a sort of warm-up using bar bells. Bar bells and the bench for pressing were the only equipment items used. In the 10 minute warm-up with the whole class using bar bells, the class would do heel raises, 2 arm curls, 2 arm standing presses, deep knee bends, and straight legged dead lifts. Following this, a routine type of graduated circuit training was set up using weights from 10 pounds and up, to a maximum of 100 pounds. In this circuit was also used the bench press. The subjects were encouraged to build up their endurance as well as strength during this time.

IV. METHODS OF DATA ANALYSIS

In order to test statistically the significance of change in fat measurements and weight as a result of participation in specific college physical education classes, the T_1 measurements of the beginning of the semester were compared with the T_2 tests at the end of the semester. The data were analyzed according to the \underline{t} ratio test for the significance of the difference between means of correlated groups. The groups are designated as correlated because the T_1 scores of each group were compared to the group's own T_2 scores. Therefore, the \underline{t} ratio formula included the correlation between tests as shown by Garrett:

$$SE_D = \frac{\sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2 - 2r_{12}\sigma_{M_1}\sigma_{M_2}}}{\quad} \quad (17:226-228).$$

CHAPTER IV

ANALYSIS OF THE DATA

Two analyses were made of the data in this study. The first purpose of this study was to determine the amount and significance of change in fat measurements and body weight as a result of a specific physical education activity class, and to determine the extent to which two days of this type of physical activity will control fat gain. Secondly, it was the purpose of this study to determine the amount and significance of change in fat measurements and body weight as a result of specific physical education classes and so indicate how the four activities rank in their ability to control fat gain.

The beginning of the semester, T1 scores of the four activity groups were compared to the T2 scores in order to test the statistical significance of any change in fat measurements or weight.

Because this study is concerned with positive changes in measurements due to activity, the one tailed statistical test of the null hypothesis was applied as demonstrated by Garrett (17:226-228).

I. AMOUNT AND SIGNIFICANCE OF CHANGE IN MEASUREMENTS
AS A RESULT OF SPECIFIC ACTIVITIES

Cross Country (N = 36)

Chest front. The pre-activity test mean score for the chest front measurement of the 38 subjects was 13.60 millimeters. The post-activity test mean score of the same group was 13.57 millimeters. The correlation between the initial test and final test was .798. The difference between the mean scores was a loss of .03. This gave a t ratio of 0.176 which was not statistically significant.

Chest back. The pre-activity test mean score for the chest back measurement of 38 subjects was 15.52 millimeters. The post-activity test mean score of the same group was 15.21 millimeters. The correlation between the initial test and final test was .851. The difference between the mean scores was a loss of .31. This gave a t ratio of .457 which was not statistically significant.

Abdomen. The pre-activity test mean score for the abdomen measurement of 38 subjects was 18.78 millimeters. The post-activity test mean score of the same group was 17.47 millimeters. The correlation between the initial test and final test was .808. The difference between the

mean scores was a loss of 1.31. This gave a t ratio of 1.84 which was statistically significant.

Supra-iliac. The pre-activity test mean score for the supra-iliac measurement of 38 subjects was 21.00 millimeters. The post-activity test mean score of the same group was 22.94 millimeters. The correlation between the mean scores was .750. The difference between the mean scores was a 1.94 millimeter gain. This resulted in a t ratio of 2.19 which was statistically significant above the .05 level of confidence for 36 degrees of freedom.

Body weight. The pre-activity test mean score for the body weight measurement of 38 subjects was 157 pounds. The post-activity test mean score of the same group was 160.18 pounds. The correlation between the initial test and final test was .977. The difference between the mean scores showed a gain of 3.18 pounds. This gave a t ratio of 3.87 which was statistically significant above the .05 level of confidence for 36 degrees of freedom.

Basketball (N = 18)

Chest front. The pre-activity test mean score for the chest front measurement of 20 subjects was 12.85 millimeters. The post-activity test mean score of the same group was 12.35 millimeters. The correlation between the

initial test and final test was .912. The difference between the mean scores was a loss of .50 millimeters. This gave a t ratio of .927 which was not statistically significant.

Chest back. The pre-activity test mean score for the chest back measurement of 20 subjects was 14.20 millimeters. The post-activity test mean score of the same group was 12.90 millimeters. The correlation between the initial test and final test was .858. The difference between the mean scores was a loss of 1.30. This produced a t ratio of 2.77 which was statistically significant beyond the .05 level of confidence for 18 degrees of freedom.

Abdomen. The pre-activity test mean score for the abdomen measurement of 20 subjects was 16.65 millimeters. The post-activity test mean score of the same group was 15.85 millimeters. The correlation between the initial test and final test was .853. The difference between the mean scores was a loss of .80 millimeters. This produced a t ratio of .862 which was not statistically significant.

Supra-iliac. The pre-activity test mean score for the supra-iliac measurement of 20 subjects was 16.65 millimeters. The post-activity test mean score of the same group was 18.70 millimeters. The correlation between the initial

test and final test was .912. The difference between the mean scores was a gain of 2.05 millimeters. This resulted in a t ratio of 2.48 which was statistically significant beyond the .05 level of confidence for 18 degrees of freedom.

Body weight. The pre-activity test mean score for the body weight measurement of 20 subjects was 159.45 pounds. The post-activity test mean score of the same group was 164.10 pounds. The correlation between the initial test and final test was .969. The difference between the mean scores was a gain of 4.65 pounds. This resulted in a t ratio of 3.12 which was statistically significant beyond the .05 level of confidence for 18 degrees of freedom.

Volleyball (N = 15)

Chest front. The pre-activity test mean score for the chest front measurement of 17 subjects was 12.88 millimeters. The post-activity test mean score of the same group was 11.94 millimeters. The correlation between the initial test and final test was .714. The difference between the mean scores was a loss of .94 millimeters. This gave a t ratio of 1.14 which was not statistically significant.

Chest back. The pre-activity test mean score for the chest back measurement of 17 subjects was 13.88 millimeters.

The post-activity test mean score of the same group was 13.35 millimeters. The correlation between the initial test and final test was .865. The difference between the mean scores was a loss of .53 millimeters. This gave a t ratio of .84 which was not statistically significant.

Abdomen. The pre-activity test mean score for the abdomen measurement of 17 subjects was 16.35 millimeters. The post-activity test mean score of the same group was 16.35 millimeters. The correlation between the initial test and the final test was .852. The difference between the mean scores was .00 millimeters. This gave a t ratio of .00 which was not statistically significant.

Supra-iliac. The pre-activity test mean score for the supra-iliac measurement of 17 subjects was 18.41 millimeters. The post-activity test mean score of the same group was 18.58 millimeters. The correlation between the initial test and final test was .835. The difference between the mean scores was a gain of .17 millimeters. This resulted in a t ratio of 1.39 which was not statistically significant.

Body weight. The pre-activity test mean score for the body weight measurement of 17 subjects was 156 pounds. The post-activity test mean score of the same group was 160 pounds. The correlation between the initial test and

final test was .927. The difference between the mean scores was a gain of 4 pounds. This resulted in a t ratio of 2.06 which was statistically significant.

Weight Training (N = 11)

Chest front. The pre-activity test mean score for the chest front measurement of 13 subjects was 12.38 millimeters. The post-activity test mean score of the same group was 12.53 millimeters. The correlation between the initial test and final test was .855. The difference between the mean scores was a gain of .15 millimeters. This resulted in a t ratio of .241 which was not statistically significant.

Chest back. The pre-activity test mean score of the chest back measurement of 13 subjects was 16.07 millimeters. The post-activity test mean score of the same group was 15.00 millimeters. The correlation between the initial test and final test was .836. The difference between the mean scores was a loss of 1.07 millimeters. This gave a t ratio of 1.35 which was not statistically significant.

Abdomen. The pre-activity test mean score for the abdomen measurement of 13 subjects was 15.30 millimeters. The post-activity test mean score of the same group was 16.00 millimeters. The correlation between the initial test and the final test was .926. The difference between the

mean scores was .70 millimeters gain. This gave a t ratio of 1.37 which was not statistically significant.

Supra-iliac. The pre-activity test mean score for the supra-iliac measurement of 13 subjects was 17.00 millimeters. The post-activity test mean score of the same group was 18.46 millimeters. The correlation between the initial test and final test was .512. The difference between the mean scores was a gain of 1.46 millimeters. This resulted in a t ratio of 1.15 which was not statistically significant.

Body weight. The pre-activity test mean score for the body weight measurement of 13 subjects was 154.61 pounds. The post-activity test mean score of the same group was 159.69 pounds. The correlation between the initial test and the final test was .990. The difference between the mean scores was a gain of 5.08 pounds. This resulted in a t ratio of 4.93 which was statistically significant beyond the .05 level of confidence for 11 degrees of freedom.

The figures in Table I summarize the preceding facts about changes in fat and weight measurements due to a specific activity.

TABLE I

FAT LOSS ON ST. MARTIN'S COLLEGE
PHYSICAL EDUCATION STUDENTS

SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS OF CORRELATED GROUPS

	M1	r	M2	M1-M2	Diff.	t	
(N=38)							
<u>Cross Country</u>							
Chest front	13.60	.798	13.57	.03	.17	0.176	(d)
Chest back	15.52	.851	15.21	.31	.652	.457	(d)
Abdomen	18.78	.808	17.47	1.31	.710	1.84	(b)
Supra-iliac	21.00	.750	22.94	1.94	.883	2.19	(a)
Body weight	157.00	.977	160.18	3.18	.82	3.87	(a)
(N=20)							
<u>Basketball</u>							
Chest front	12.85	.912	12.35	.50	.539	.927	(d)
Chest back	14.20	.858	12.90	1.30	.469	2.77	(b)
Abdomen	16.65	.853	15.85	.80	.927	.862	(d)
Supra-iliac	16.65	.912	18.70	2.05	.825	2.48	(a)
Body weight	159.45	.969	164.10	4.65	1.49	3.12	(a)
(N=17)							
<u>Volleyball</u>							
Chest front	12.88	.714	11.94	.94	.82	1.14	(d)
Chest back	13.88	.865	13.35	.53	.63	.84	(d)
Abdomen	16.35	.852	16.35	.00	1.015	.000	(e)
Supra-iliac	18.41	.835	18.58	.17	1.22	.139	(c)
Body weight	156.00	.927	160.00	4.00	1.94	2.06	(a)
(N=13)							
<u>Weight Training</u>							
Chest front	12.38	.855	12.53	.15	.62	.241	(c)
Chest back	16.07	.836	15.00	1.07	.79	1.35	(d)
Abdomen	15.30	.926	16.00	.70	.509	1.37	(c)
Supra-iliac	17.00	.512	18.46	1.46	1.26	1.15	(c)
Body weight	154.61	.990	159.69	5.08	1.03	4.93	(a)

(a) Significant Gain -----6
 (b) Significant Loss -----2
 (c) Not Significant Gain -----5

(d) Not Significant Loss ----8
 (e) No Change -----1

II. INTERPRETATION OF THE DATA

A subjective comparison of these data indicates that in every activity there seemed to be evidence that these activities caused a variance in the subject's body between test 1 and test 2.

Chest Front

The measurement on the chest front showed a loss of fat on three of the four activities, cross country, basketball, and volleyball. They were not close to being statistically significant. In weight training there was a slight gain which was not close to being statistically significant. It is possible that in this area the activities would control fat to some extent, but that such control could only be attributed to chance.

Chest Back

The data on the chest back measurement indicates that in cross country, volleyball, and weight training there was a loss of fat but it was not significant. In the basketball activity class there was a significant loss of fat in this area. This could be interpreted to mean that all four of these activities cause a loss of fat on the upper back or at least help to maintain the status quo, but that only in basketball could the loss be attributed to anything but chance.

Abdomen

Fat gain on the abdomen was held to a minimum in these activities, with some fat loss showing up in cross country, basketball, and volleyball. However, there were not any significant losses on the abdomen. The weight training activity class showed a gain in fat dimensions on the abdomen, but they were not significant.

Supra-iliac

The supra-iliac measurements indicated that the type of activity chosen for these classes, and/or the time spent in class did not adequately control fat in the supra-iliac area. In cross country and basketball the data shows a significant gain in fat measurements for those subjects. In volleyball and weight training a slight gain was shown, but it was not significant.

Body Weight

There were significant gains in body weight in cross country, basketball and weight training. Subjects in the weight training class gained the most weight. This was more or less expected. Volleyball was the one activity that showed a gain that was not significant. However, it was close to being significant.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY OF PURPOSES

The problems of inactivity and appetite are causing more people to worry and fret than any other physical handicap now existing in the United States. Even the poor in this country are able to get fat. Because of the fact that we have a surplus of money, surplus of food, and our jobs need less physical exertion, we need to find methods of coping with the problem of excess weight and/or fat. This study was undertaken with the hope that it will discover where, and how we can cope with the problem. This writer initiated this study because he thought he noticed a time and a place where over-weight gets its start on young college adults. We need to know how effective programs in college physical education are in controlling fat gain.

Briefly, the purposes of this study were to: (1) determine if the four college physical education activities classes did significantly control fat gain on college freshmen; (2) to determine which physical education activity will best control fat gain on college freshmen.

Procedures

All tests were administered twice in one semester,

one at the beginning and one at the end. The students randomly enrolled in one of four physical education activity classes. At the end there were 88 freshmen males enrolled in the four classes. There were 38 students enrolled in the cross country class, 20 in the basketball class, 17 in the volleyball class and 13 in the weight training class. The classes met twice a week for 50 minutes, with 35 minutes actually allotted for activity. An effort was made to conserve all of the 35 minutes for activity. Measurements on each student were taken at four places with fat calipers and they were weighed by standard scales.

Analyses of data were made by testing the significance of changes in fat measurements and of changes in their body weight by means of the t test for significance of difference between means of correlated groups. It was necessary to determine the correlation between the groups because the initial test scores of the semester were compared to the final test scores of the semester. Because it was the concern of this study to reflect positive changes in body measurements from specific activities, all tests of statistical significance were considered as one-tailed.

II. CONCLUSIONS

Significance of Change in Fat Measurements

The mean change in overall body measurements with

fat calipers was not statistically significant in most instances. On five of the body measurements taken there was a gain in fat measurements, but they were not statistically significant. The two measurements that showed a statistically significant gain were on the supra-iliac area in the activities of cross country and basketball. The supra-iliac measurement in cross country gave a t ratio gain of 2.19 which was significant at the .05 level of confidence. The supra-iliac measurement in basketball gave a t ratio gain of 2.48 which was significant at the .05 level of confidence. The only measurement to show a significant loss was the chest back measurement in the basketball activity. This measurement gave a t ratio loss of 2.77 which was statistically significant at the .05 level of confidence. The mean change showed a loss in 8 of the other measurements, but they were not statistically significant. One measurement on the abdomen in the volleyball class showed no change in either direction.

From the evidence of this study the writer deems it appropriate to conclude that in at least one-half of the areas of measurement the selected activities did not sufficiently control fat gain. The two measurements that indicated significant gain were in the supra-iliac area where it is difficult to remove weight once it is acquired. There is evidence that the activities are and can be an aid to

students in relation to controlling fat gain. If only those areas where fat calipers are used were considered, it would show six measurements with a gain in fat and nine measurements with a loss of fat. There is evidence to conclude that we could use more time and more intensified work in the selected activity classes to properly control fat gain.

Activity Rank Order in Controlling Fat Gain

Statistically, showing the rank order of these selected activities was not a clear, definite, and concise decision. The activities are ranked on the basis of this writer's interpretation of the data presented. For this study it was concluded that volleyball with 2 losses that were not significant, 2 gains that were not significant and one measurement with no change, best controlled fat gain. The second ranked activity is basketball with 2 losses that were not significant, 1 significant loss, 2 significant gains. The third ranked activity was cross country with 2 measurements with significant gains and 3 losses which were not significant. The fourth ranked activity was weight training, which had 1 loss that was not significant, 3 gains that were not significant, and 1 gain which was significant.

From this study it was then concluded the activities ranked in this order: (1) volleyball, (2) basketball, (3) cross country, and (4) weight training.

III. RECOMMENDATIONS

Based on the results of statistical compilations and data presented in preceding chapters, the investigator recommends the following:

1. College service activity classes should be required five days a week to adequately control fat gain.
2. College health classes should stress the problem of fat gain on American adults.
3. Physical educators should have a working knowledge of nutrition.
4. Physical education personnel should publicly proclaim the benefits of regular exercise in combatting obesity.
5. Physical education classes should specifically state the objectives of each individual class.
6. More opportunities should be given the college student to adequately control fat gain by voluntary activity.

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