THE RELATIONSHIP BETWEEN SELECTED ANTHROPOMETRIC AND ANATOMIC MEASURES AND YMCA BENCH PRESS TEST PERFORMANCE

By

LEANNE D. THORNTON

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1990

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
July, 1992

THE RELATIONSHIP BETWEEN SELECTED

ANTHROPOMETRIC AND ANATOMIC

MEASURES AND YMCA

BENCH PRESS TEST

PERFORMANCE

Thesis Approved:

Thesis Advisor

Dean of the Graduate College

ACKNOWLEDGMENTS

I wish to thank my committee members Dr. Frank Kulling, Dr. Steve Edwards, and Dr. Lori Hunt for their advice, guidance, and encouragement throughout this study. Special thanks to my committee chairman, Dr. Bert Jacobson, for believing in me and helping me work up to my potential. My sincerest gratitude goes to the entire faculty and staff in the school of HPEL at OSU for their individual roles in helping me realize my goals.

Thanks to my mom, Lida Williams, and grandma, Lois Blackford, for their financial and moral support. My sister, Laura Caddy, helped keep me going with the phone calls encouraging me to continue working. My sincerest appreciation goes to Olen and Roberta Sutton, my "in-laws", for their words of encouragement and for taking care of other important details while I focused on this work. Love to all of you!

I would like to thank my loving husband, Douglas Sutton, for his undying patience and understanding and for taking care of Tara and the dishes when I couldn't be there. Finally, I wish to express my love and gratitude to my daughter, Tara, who endured the most while mom was at school. This work is dedicated to my best friends, Doug and Tara. I love you both. Thanks for all your support.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Enhancing fitness has become a way of life for many Americans. According to the American College of Sports Medicine (ACSM, 1991), current evidence shows that regular physical activity protects against the development and progression of many chronic diseases. Physical fitness is either health-related, pertaining to qualities that protect against disease, or performance-related, pertaining to qualities that increase an individual's ability to perform certain skills (Bucher and Wuest, 1987). In the past, athletic performance was the focus of physical activity. This is changing as Americans see their health improve as a result of maintaining active lifestyles. Health-care professionals must discover the most appropriate means of determining what specific modalities, intensities, and frequencies are appropriate for each individual.

Stokes, Moore, and Moore (1988) cite five main advantages of health-related fitness: (1) cardiovascular endurance, (2) flexibility, (3) leaner body composition, (4) muscular strength, and (5) muscular endurance. Cardiovascular endurance is considered to be the single best indicator of one's physical fitness (Stokes, Moore, and Moore, 1988). However, muscular strength and endurance are

important elements in carrying out everyday activities (Nelson, 1979). The ACSM (1988) considers the primary reason for developing health-related fitness as the ability to "move efficiently in work, play, and sports performance."

In order to successfully improve muscular strength and endurance, one must participate in progressive resistance activities that include five basic principles. These principles include specificity, overload, progression, frequency, and intensity (ACSM 1988). Specificity refers to the target muscle group of the exercise. To improve a bench press score, progressive resistance activity specific to that muscle group (pectoralis major) must be accomplished. Overload refers to placing more resistance on the muscle than activities of everyday life. Progression is when resistance is increased to keep up with the strength adaptation of the muscle to the new workload or resistance. When the muscle adapts to the resistance, additional strength gains are no longer necessary. Therefore, the resistance placed on the muscle should increase, according to progress. Frequency is the number of times per week the activity is performed. Intensity refers to the amount of work it takes to improve musculoskeletal fitness.

Assessment of current fitness levels before, during, and after participation in a fitness program is important. Correspondingly, Golding, Myers, and Sinning (1989) list the reasons for assessment as follows:

* to assess current fitness levels
* to identify training needs

* to select a training regimen
* to evaluate the progress of the participant
* to evaluate the success of the program
* to motivate participants

There are several fitness test batteries used today and the fitness program guidelines set by the YMCA is one of the most widely recognized. Called the Y's Way to Physical Fitness, this fitness test battery includes the following components: (1) a medical evaluation to ascertain individual risk factors and medical clearance; (2) a physical fitness evaluation of all areas of health-related fitness including the areas of muscular strength and endurance; and (3) exercise prescription including guidelines for beginning or continuing an exercise program (Golding, Myers, and Sinning, 1989).

A recent trend toward increased participation in weight training and other resistance exercises has heightened interest in the muscular strength and endurance components of fitness testing for health-care professionals. This type of testing ranges from laboratory tests which utilize computerized technology, to field tests which use common weight room equipment. Lab tests tend to be costly to administer and time-consuming. The use of field tests of muscular strength and endurance offers a practical means of testing for the test administrator who wishes to make testing available to everyone.

Justification

The YMCA bench press test, in addition to being easy and practical, is desirable for several reasons. This test can be administered to several people at the same time, it does not take highly trained professionals, it is cost and time efficient, and equipment is widely available (Golding, Myers, and Sinning, 1989). However, little is known about the structural dimensions which may be related to bench press ability. This information could be valuable to test administrators in the prediction of success as well as reflecting structural predisposition for success (Mayhew, Ball, Ward, Hart, and Arnold, 1988).

Statement of the Problem

The purpose of this study was to determine the relationship(s) between selected anthropometric and anatomic measures and the number of YMCA bench press repetitions performed before and after participation in a 13-week weight training course. Male subjects were tested using an 80 lb. barbell and female subjects were tested using a 35 lb. barbell as required by the YMCA Bench Press Test protocol.

Hypotheses

The following hypotheses were tested at the .05 level of significance:

1. No correlation will be found between pre-test repetitions and the following pre-test measures: (1) body fat; (2)

height; (3) weight; (4) drop length; (5) shoulder circumference; (6) chest circumference; (7) upper arm circumference; (8) lower arm circumference; (9) waist circumference; (10) hip circumference; and (11) wrist circumference.

2. No correlation will be found between pre-test repetitions and the above listed pre-test measures for males.
3. No correlation will be found between pre-test repetitions and the above listed pre-test measures for females.
4. No correlation will be found between the various pre-test measures for males, females, or the combined group.
5. No correlation will be found between post-test repetitions and the post-test equivalent of the above measures for males, females or the combined group.
6. No correlation will be found between the various post-test measures for males, females, or the combined group.
7. There will be no significant change in the drop length, body fat, upper arm circumference, chest circumference, or the number of repetitions performed for any of the subjects in the combined group, male group, female group, or any of the above groups with analysis isolating those who included bench press as part of their normal workout.

Delimitations

The delimitations of this study were:

1. The study followed The Y's Way to Physical Fitness Bench

Press Test protocol .

2. The subject selection was confined to students at Oklahoma State University enrolled in sections of Leisure 1352 instructed by Leanne Thornton.

Limitations

The limitations of this study were:

1. Students followed individualized weight training programs that varied widely in intensity, frequency and progression.
2. No attempt was made to control activities outside of class.
3. The bench press was not a required exercise in the subject's individual weight training routine.
4. Measurements were not collected by the same individual for pre- and post-tests.
5. The sum of three skinfold sites was used to determine body fat as opposed to the more accurate sum of seven.

Assumptions

The following assumptions were made for this study:

1. The subjects came from an apparently healthy population.
2. The testing conditions were equal for all subjects.
3. All subjects were motivated equally for personal best performance.
4. All subjects were provided the same information and opportunity for experience in weight training throughout the semester.

Definition of Terms

Anthropometric - Measurements dealing with the size and proportion of the human body.

Anatomic Measures - Measures dealing with the structural characteristics of the human body.

Bench Press Test - A test used to assess muscular strength and endurance of the pectoralis major. The subject is in a supine position with knees bent and feet on the floor. One repetition is a complete cycle of the down position (bar touching chest) and the up position (full extension of the elbows).

Bent-Knee Sit-Ups - A measure of abdominal strength. The subject is in a supine position on the floor with knees bent at a ninety degree angle. The subject then raises the head, shoulders and back off the floor until the elbows reach the bent knees.

Body composition - The amount of lean body weight and the amount of fat weight which together equal total body weight.

Cardiovascular Endurance - The measure of the ability of the heart and lungs to deliver sufficient oxygen to the body's cells during various stages of activity.

Drop Length - The distance measured between the bottom of a wooden bar held in the "up" bench press position and the top of the chest, at the fifth intercostal space.

Dynamic - The repetition of identical movements.

Dynomometer - Equipment used to assess isometric

strength.

Endurance - The ability of the muscle to perform over time.

Field Tests - Tests used outside the laboratory setting. These tests typically use relatively inexpensive equipment, require minimal training of personnel, and may be administered to several people in a short amount of time. The nature of the equipment is such so that test sites may be moved.

Flexibility - The ability of a joint to move through a measured range of motion.

Health-Related Fitness - Those fitness components that are important to a person's health. They include cardiovascular endurance, body composition, flexibility, muscular strength, and muscular endurance.

Lab tests - Those tests typically administered in clinical or research settings. The equipment is generally state-of-the-art, expensive, and used by trained individuals. Lab testing takes longer than field testing.

Muscle Overload - Placing more resistance on the muscle than it has in everyday activity.

One-Repetition Maximum - The maximum amount of weight a subject can lift correctly one time.

Progression - After the muscle adapts to an overload resistance, increasing that resistance to improve muscle quality.

Push-up - Moving the weight of the body against gravity using elbow flexion and extension.

Repetition - The number of times a specific movement is performed.

Skill-Related Fitness - The components of fitness related to successful athletic performance. Examples of this would be agility, reaction time, balance, and coordination.

Specificity - A basic principle of weight training which refers to the improved ability to accomplish a certain task by practicing that task.

Straight-leg sit-ups - As opposed to bent-knee sit-ups, this type of exercise is performed with legs flat against the floor. This is not a recommended form of exercise because of the strain placed on the lower back.

Strength - The ability to exert force over distance.

Work - Work is the product of force and distance.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Physical activity is inversely associated with several chronic diseases as well as with premature death (Blair, Kohl, Paffenbarger, Clark, Cooper, and Gibbons, 1989). The number of people exercising is growing, thus there is an increased need for guidelines in exercise prescription and exercise testing. As fitness enthusiasts begin to understand the value of a well-rounded fitness program, it becomes necessary for physical educators and health care professionals to examine carefully techniques in fitness testing and attempt to determine the relationships between the various measures used to assess physical fitness. This type of scrutinization has occurred with many dimensions of cardiovascular fitness testing. The focus, however, needs to shift toward the factors concerning tests of muscular strength and endurance in order to keep up with current interests.

Very little is known about structural dimensions that may be associated with strength performance. Body weight is related to strength (Golding and Lindsay, 1989), but other relationships may exist. The value lies in the possibility

of prediction of strength performance. If structural dimensions are related to the ability to perform certain maneuvers then there may be a predisposition for muscular strength and endurance improvement on the bench press test (Mayhew, Ball, Ward, Hart, and Arnold, 1988).

Muscular Strength and Endurance

Muscular strength has three general forms. First, there is static or isometric strength. This is demonstrated when one applies force against an immobile object. When testing involves movement, it is termed dynamic or isotonic strength. An example of this would be the one-repetition maximum (1RM) bench press test. Finally, there is isokinetic measurement in which the speed of the movement is controlled (ACSM 1991). Cybex equipment used in laboratory testing is one example.

Muscular endurance also can be static, dynamic, or isokinetic. The difference is the number of repetitions performed. When the testing requires multiple repetitions muscular endurance is being assessed, such as the number of sit-ups performed in one minute (Golding and Lindsay, 1988).

Muscular strength and endurance are difficult to isolate and measure. Although the YMCA bench press test highly correlates with overall body strength, there does not seem to be a single isotonic test representative of total strength (Golding, Myers, and Sinning, 1989). One difficulty encountered in strength testing is determining the amount of resistance to be used. Are absolute or relative measures better? Relative strength refers to the amount lifted

divided by the body weight. Absolute strength is measured when the exact amount lifted is taken into consideration (Nelson, 1979). Muscular endurance also can be absolute or relative. Relative endurance is working with a resistance proportionate to that of the maximum strength of the specific muscle. Absolute endurance requires all subjects to use a set workload. The YMCA bench press test is an absolute measure.

Improvement of muscular strength and endurance requires the application of the following basic principles: (1) specificity, or participating in the specific activity that needs improvement; (2) overload, which is placing a workload on the muscle greater than that experienced during everyday activity; and (3) progression, which is continuing to increase the resistance as the muscle improves (ACSM 1988).

Health care professionals are obligated to modify and improve current means of fitness testing as well as formulate new testing methods as knowledge and technology expand. Historically, muscular strength and muscular endurance have been evaluated individually. Means of testing these muscle functions range from elaborate laboratory tests used primarily in clinical or research settings, to simple field tests that are less reliable but adequate for screening subjects for exercise programs (Fardy, Yanowitz, and Wilson, 1988). An early field test for assessing muscular strength was to measure grip strength using a hand dynomometer (Johnson & Nelson, 1986). However, after using this test for several years, two major deficiencies were realized. First,

it was found that grip strength did not improve as overall strength improved. The grip strength test did not reflect changes in muscular strength. In addition. hand grip proved to be a poor indicator of the body's muscular strength (Golding & Lindsay, 1989). Although grip strength still is measured, muscular strength is best evaluated by means of a 1RM weightlifting test specific to the target muscle group (ACSM, 1988).

Muscular endurance assessment has several possible forms but most often involves the dynamic ability of the muscle, or the ability of the muscle to repeat identical movements (ACSM, 1988). Early forms of endurance testing required unlimited straight-leg sit-ups. However, due to the strain on the lumbar region of the spine, the bent-knee sit-up evolved and is now in general use (Clarke & Clarke, 1987). Although motivation and specificity have been limiting factors in muscular endurance evaluations (Golding, Myers, and Sinning 1989), the sit-up test and push-up test widely are used due to ease of use and practicality of testing (ACSM, 1988). The push-up test involves moving one's body weight against gravity. Many individuals have difficulty completing a single repetition of this exercise (Baumgartner and Jackson, 1991) which limits the ability of the test to discriminate between the levels of several participants (Golding and Lindsay, 1989). The pull-up test is widely used in physical education settings. This test also requires the subject to move his or her weight against gravity. A study by Montoye and Lamphiear (1977) concluded that the pull-up test

is not a good assessment for females because of their lack of ability to exert a force equal to their body weight. For this reason, timed sit-up tests more widely are used.

A single test that involves moving a specific weight (strength) more than one repetition (endurance) is one of muscular strength and endurance. This test uses the maximum number of repetitions one can do as a score (Golding and Lindsay, 1989). The YMCA bench press test, included in the YMCA physical fitness test battery, is this type of assessment. The 1RM bench press highly and significantly is correlated with overall muscular strength (Berger, 1963). However, this test is undesirable for two specific reasons: (1) it involves a maximal effort which increases the possibility of injury; and (2) it is extremely time-consuming for individuals inexperienced with weight training (Golding and Lindsay, 1989). The YMCA bench press test is desirable because (1) it takes into account muscular endurance in addition to muscular strength; (2) the amount of weight used permits nearly everyone to perform at least one repetition; (3) testing procedures and scoring are clear and reproducible; and (4) equipment widely is available and inexpensive (Golding, Myers, and Sinning, 1989).

Gender

The upper body strength of males is greater than that of females, but leg strength appears to be more similar between the two groups (Laubach, 1976). When comparing genders, investigators must take into account several differences,

including body fat, various circumferences, height, and weight. These variations make it difficult to determine whether strength and endurance differences occur because of the difference in gender, or because of the other factors.

Even less is known about muscular endurance comparisons between the two groups. A study by Clarke (1986) concluded that males are superior in strength and absolute endurance, but females possess greater relative endurance. This study employed hand-grip as the testing method. Another study by Misner, Massey, Going, Bemben, and Ball (1990) using three different muscle groups (one upper body, two lower body) found females to have greater endurance. With contradicting studies, additional research need be done with standardized testing procedures.

Gender differences must also be noted when attempting to predict performance. Men possess greater amounts of the male hormone, testosterone, which produces greater muscle hypertrophy. This affects correlations in circumferences between the sexes.

Anthropometric Measures

It was reported that a significant correlation exists between strength and body weight when results from male and female subjects were analyzed together (Golding and Lindsay, 1988). A study by Maughan, Watson, and Weir (1982) showed no correlation between these factors when the genders are analyzed separately. Although it widely is recognized that men tend to be stronger than women (Clarke, 1986), the

relationship between body weight and strength is unclear.

Mayhew, Ball, Ward, Hart, and Arnold (1991) stated that upper arm cross sectional area, percent fat, and chest circumference were the best characteristics to look at when attempting to predict bench press strength. However, the results of their study showed that highly trained individuals are more likely to be underestimated in prediction of bench press performance.

In summary, little is known about the relationship between other structural dimensions and muscular strength and endurance. These dimensions need to be examined.

CHAPTER III

METHODS

Subjects

The subjects chosen for this study were 80 Oklahoma State University students enrolled in one of three Spring Semester 1992 sections of the Beginning Weight Training course. There were 50 male and 30 female subjects. All students enrolled in each of the three sections were given the option of participating or not participating in the study. All of the students voluntarily participated in the study. The Institutional Review Board at Oklahoma State University approved administration of the various tests involved. Students were required to read and sign an Informed Consent Form (Appendix A). Data was recorded by number to insure confidentiality.

Female Subjects

The apparatus used to test female subjects included a Universal bar weighing approximately 31.5 pounds. Two 1.5 pound Hingelock collars by Strength-Tech were added for safety as well as to bring the total barbell weight to approximately 34.5 pounds. The Universal weight lifting

bench and bar were the same for pre-and post-tests. Cloth measuring tapes were used to determine circumferences and Lange skinfold calipers were used to assess body composition. A wooden bar the size of a broom handle was used to measure drop length for each individual and was the same for pre- and post- testing. Height and weight were determined using a Detecto-Medic calibrated physicians scale. The same scale was used for each individual as well as for pre- and post-testing.

Male Subjects

The apparatus used for male subjects was identical to that of the female subjects with the exception of the total barbell weight. A Universal 45 pound bar was used with the addition of one ten pound plate, one five pound plate, one two and one-half pound plate, and one Hingelock collar on each end. The Universal bar was weighed in at approximately 43 pounds. The weight of the collars brought the total barbell weight to approximately 80 pounds.

Procedures

Each student was required to read and sign an Informed Consent Form (Appendix A) prior to the commencement of the study. The form was explained to the subjects by the instructor, sufficient time was provided for the subjects to read the consent form, and subjects were required to have a classmate witness their signature.

Data from the 13-week study was collected and recorded

onto data sheets (Appendix B) by graduate assistants, graduate associates, and faculty in the school of HPEL at Oklahoma State University. An attempt was made to have the same test administrator measure each subject pre- and post-test to standardize testing procedures. In an attempt to standardize testing procedures, the course instructor explained procedures for collecting data to the appropriate test administrator.

Subject Characteristics

Name, age, and birthdate of each subject were recorded by the subject. Students names were used solely to confirm participation. Data were identified by number to insure confidentiality.

Height and weight were determined by the use of a Detecto-Medic calibrated physicians scale and recorded by the test administrator. Subjects were measured in "normal" workout attire minus their shoes.

Weight was noted to the nearest quarter pound (.1 kg). Subjects were required to stand facing the investigator with hands to their sides.

Height was noted to the nearest quarter inch (.6 cm). Subjects were required to stand facing away from the investigator with their feet flat and heels together and their arms to their sides.

Drop length was recorded by the course instructor. This length was measured by having students assume the bench press position. A wooden bar was grasped in the hands with hands

shoulder width apart. The arms were fully extended so that they were perpendicular to the supine body. Drop length was the measure of the distance between the bottom of the wooden bar and the subject's chest (fifth intercostal space).

Body Composition

Body Composition was determined by the use of Lange skinfold calipers. The sum of three sites was used. For the male subjects thigh, abdomen, and chest locations were measured. For the female subjects thigh, suprailliac, and tricep locations were measured. The total of the three measures was located on a Pollock, Schmidt, and Jackson (1980) body fat chart (Appendix C) which provided body fat percentages.

Circumferences

Circumferences were measured with a tape measure. Seven sites were measured: (1) shoulder; (2) chest; (3) upper arm; (4) lower arm; (5) waist; (6) hips; and (7) wrist. These cites were measured to the nearest one quarter inch (.6 cm) and recorded by the test administrator. Anatomic sites for circumferences were ascertained by the guidelines set by the ACSM (1988).

YMCA Bench Press Test

The YMCA Bench Press Test was administered according to the guidelines set by the YMCA (1989). Subjects assumed a supine position on the bench press bench. Their knees were

flexed with feet flat on the floor. A spotter handed the barbell to the subject who gripped the bar at shoulder width. A metronome was set for 60 beats per minute. The subject was required to lift and lower the bar in cadence. A complete up position was accomplished when the subject came to full extension at the elbow on the beat. A complete down position was accomplished when the bar was brought to the chest on the beat. One complete repetition was considered upon the successful completion of a down position plus an up position. The test was terminated when the student was no longer able to keep up with the cadence or when he/she was too exhausted to continue.

Students Absent from Class

Subjects who were not present on the day of testing were allowed to make up any test they missed except for the actual bench press test. In order to complete missed testing, subjects were required to make an appointment with the course instructor within the same week to be considered for participation in the study.

Statistical Treatment of Data

Means and standard deviations were computed for each variable in the pre- and post-test. Pre- and post-test bench press repetitions were correlated with the following variables using a Pearson Product-Moment Correlation: body fat, height, weight, drop length, shoulder circumference, chest circumference, upper arm circumference, forearm

circumference, waist circumference, hip circumference, and wrist circumference. These correlations also were computed individually for male and female groups. The t-tests were computed to compare pre- and post- test results on the following variables: lifts, drop length, body fat, and upper arm, and chest circumferences. Additional t-tests also were computed individually for male and female groups.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The purpose of this investigation was to determine possible relationships between selected anthropometric and anatomic measures and the number of YMCA bench press repetitions college students could perform before and after participation in an Oklahoma State University beginning weight training course.

The following abbreviations and corresponding units of measure are used in the various tables of this chapter:

AGE = age in years

BF = percent body fat

HT = height in centimeters

WT = weight in kilograms

DR = drop length in centimeters

REPS = number of repetitions performed

SC = shoulder circumference in centimeters

CC = chest circumference in centimeters

UC = upper arm circumference in centimeters

FC = forearm circumference in centimeters

WC = waist circumference in centimeters

HC = hip circumference in centimeters

RC = wrist circumference in centimeters

X = post-test measure

St. Dev. = standard deviation

Max = maximum value

Min = minimum value

Comb. = combined group

Eighty Oklahoma State University students participated in a 13-week long study to determine the relationship between selected anthropometric and anatomic measures. Subject characteristics were: (1) mean $\pm$ St. Dev. age = 20.67 $\pm$ 3.09 years; (2) mean $\pm$ St. Dev. weight = 72.32 $\pm$ 14.02 kgs; (3) mean $\pm$ St. Dev. height = 171.37 $\pm$ 8.94 cm; (4) mean $\pm$ St. Dev. body fat = 15.94 $\pm$ 6.76 percent. There were 50 male subjects and 30 female subjects. All subject characteristics including the seven circumference sites for the combined group are shown in Table I. Tables II and III represent data for the male and female groups, respectively. Pre-and post-test means, standard deviations, and maximum and minimum scores are included in these tables.

Results

Pearson Product-Moment correlations were computed at the .05 level of significance comparing the following characteristics to bench press repetitions (pre- and post-): body fat, height, weight, drop length, shoulder circumference, upper arm circumference, forearm circumference, waist circumference, hip circumference, and wrist circumference. These correlations were further broken

TABLE I

SUBJECT CHARACTERISTICS
(Combined Group)

Variable	Pre Mean	Post Mean	Pre St. Dev.	Post St. Dev.
AGE (yrs)	20.67	20.89	3.09	3.04
BF (%)	15.94	15.91	6.76	6.74
HT (cm)	171.37	171.86	8.94	9.17
WT (kg)	72.32	73.07	14.02	13.94
DR (cm)	48.16	47.88	3.99	4.57
REPS (number)	25.41	29.45	10.55	10.99
SC (cm)	110.67	113.11	9.68	10.13
CC (cm)	94.67	96.93	.91	8.71
UC (cm)	29.11	29.41	3.61	3.68
FC (cm)	26.95	27.23	2.79	2.95
WC (cm)	81.71	82.07	10.34	9.98
HC (cm)	87.88	88.27	8.46	7.49
RC (cm)	17.09	17.27	1.63	1.61

TABLE I (con't)

Variable	Pre Max	Post Max	Pre Min	Post Min
AGE (yrs)	39.00	39.00	17.00	18.00
BF (%)	32.20	30.10	4.20	3.20
HT (cm)	191.77	191.77	147.96	146.05
WT (kg)	113.75	114.55	39.55	50.45
DR (cm)	62.23	61.60	41.28	36.83
REPS (number)	75.00	80.00	7.00	8.00
SC (cm)	136.65	141.73	89.66	90.93
CC (cm)	119.38	122.68	75.69	81.28
UC (cm)	38.10	37.59	20.32	22.86
FC (cm)	33.02	33.78	20.32	22.35
WC (cm)	109.22	113.03	63.50	61.72
HC (cm)	111.25	109.98	71.12	99.12
RC (cm)	20.32	21.08	13.46	13.97

TABLE II

SUBJECT CHARACTERISTICS
(Male Group)

Variable	Pre Mean	Post Mean	Pre St. Dev.	Post St. Dev.
AGE (yrs)	20.92	21.22	3.40	3.52
BF (%)	12.68	12.95	5.44	6.15
HT (cm)	176.17	176.66	6.43	6.38
WT (kg)	79.51	79.94	11.24	11.86
DR (cm)	49.45	49.71	3.94	4.11
REPS (number)	26.64	30.16	9.62	9.88
SC (cm)	116.38	118.95	6.78	6.63
CC (cm)	97.74	100.58	7.59	8.05
UC (cm)	30.89	31.45	2.87	2.77
FC (cm)	28.63	29.03	1.76	1.88
WC (cm)	86.51	86.46	8.71	8.81
HC (cm)	89.51	89.92	8.33	9.74
RC (cm)	17.98	18.08	1.27	1.30

TABLE II (con't)

Variable	Pre Max	Post Max	Pre Min	Post Min
AGE (yrs)	39.00	39.00	18.00	18.00
BF (%)	25.30	26.70	4.20	3.20
HT (cm)	191.77	191.77	164.47	166.37
WT (kg)	113.75	114.55	29.43	29.77
DR (cm)	62.23	61.60	41.91	41.28
REPS (number)	75.00	80.00	12.00	18.00
SC (cm)	136.65	141.73	104.14	106.68
CC (cm)	119.38	122.68	86.36	86.36
UC (cm)	38.10	37.59	25.40	26.67
FC (cm)	33.02	33.78	25.40	26.67
WC (cm)	109.22	113.03	71.12	72.39
HC (cm)	111.25	109.98	73.15	77.47
RC (cm)	20.32	21.08	15.24	15.24

TABLE III

SUBJECT CHARACTERISTICS
(Female Group)

Variable	Pre Mean	Post Mean	Pre St. Dev.	Post St. Dev.
AGE (yrs)	20.24	20.31	2.47	1.87
BF (%)	21.33	21.05	5.11	4.20
HT (cm)	163.37	163.53	6.50	7.06
WT (kg)	60.35	61.18	9.21	8.06
DR (cm)	46.02	44.68	3.07	3.45
REPS (number)	23.19	28.23	11.94	12.81
SC (cm)	101.12	103.02	5.18	6.53
CC (cm)	89.59	90.58	6.35	5.69
UC (cm)	26.16	25.91	2.69	2.14
FC (cm)	24.18	24.08	1.79	1.30
WC (cm)	73.74	74.42	7.52	6.81
HC (cm)	85.14	85.45	8.13	7.67
RC (cm)	15.57	15.82	.84	.91

TABLE III (con't)

Variable	Pre Max	Post Max	Pre Min	Post Min
AGE (yrs)	28.00	25.00	17.00	18.00
BF (%)	32.20	30.10	13.60	12.50
HT (cm)	175.26	175.26	147.96	146.05
WT (kg)	78.64	80.45	39.55	26.14
DR (cm)	53.98	54.61	41.28	36.83
REPS (number)	51.00	65.00	7.00	8.00
SC (cm)	109.22	119.38	89.66	90.93
CC (cm)	104.14	103.63	75.69	81.28
UC (cm)	31.75	30.48	20.30	22.86
FC (cm)	27.94	26.67	20.32	22.35
WC (cm)	87.63	88.90	63.50	61.72
HC (cm)	104.90	101.09	71.12	77.47
RC (cm)	17.78	17.78	13.46	13.97

down individually for male and female groups. Also computed were t-tests between pre- and post- tests for the following variables: body fat, repetitions, drop length, chest and upper-arm circumferences. These tests were computed for the combined group, the combined group of students who used the bench press in their regular workout, the male group, the group of male subjects who used the bench press in their regular workout, the female group, and the group of female subjects who used the bench press in their regular workout.

Pre- and Post-tests

Significant correlations ($p < .05$) for the combined group were found between pre-test repetitions and the following variables: weight, shoulder circumference, chest circumference, upper arm circumference, forearm circumference, and wrist circumference. Scores for this group showed no correlations at the .05 level of significance between pre-test repetitions and the following variables: body fat, height, drop length, waist circumference, and hip circumference. Post-test results showed similar correlations in the same categories (Table IV).

The t-tests for the combined group showed a significant change from pre- to post-test for the number of repetitions performed and chest circumference (Table V). The combined group that included the bench press in an average workout showed the same changes as those who did not, signifying no difference between those subjects who did and did not include the bench press as part of their workout (Table VI).

TABLE IV

CORRELATION COEFFICIENTS
BETWEEN BENCH PRESS
REPETITIONS
BY SELECTED
VARIABLES

Variable	Pre Comb Reps	Post Comb Reps	Pre Male Reps	Post Male Reps	Pre Female Reps	Post Female Reps
BF	-.09	-.07	.02	-.02	.02	-.02
HT	.17	.13	.31*	.29	-.23	-.14
WT	.32**	.29*	.38**	.34*	.16	.28
DR	-.08	-.10	-.06	-.12	-.34	-.28
SC	.35**	.37**	.38**	.41**	.32	.56**
CC	.37**	.27*	.40**	.30*	.25	.26*
UC	.41**	.34**	.38**	.38*	.48*	.51**
FC	.39**	.30*	.53**	.35*	.30	.56**
WC	.22	.21	.11	.11	.24	.35
HC	.08	.12	.00	.09	.13	.11
RC	.36**	.32**	.43**	.33*	.25	.47**

* significant at .05 level ** significant at .01 level

TABLE V

t-TESTS FOR PAIRED SAMPLES
(Combined Group)

Variable	N	Mean ± St. Dev.	t-value	df	Probability
Pre-Lifts		25.32 reps ±10.80			
	69		-6.74	68	.000 *
Post-Lifts		29.59 reps ±11.11			
Pre-BF		15.59 % ± 6.52			
	70		-1.52	69	.132
Post-BF		16.00 % ± 6.80			
Pre-Drop		48.23 cm ± 4.01			
	71		1.25	70	.000 *
Post-Drop		47.88 cm ± 4.57			
Pre-Chest		95.12 cm ± 8.15			
	71		-4.34	70	.000 *
Post-Chest		96.93 cm ± 8.71			
Pre-Uparm		29.18 cm ± 3.56			
	71		-1.19	70	.238
Post-Uparm		29.41 cm ± 3.68			

* significant at .05 level

TABLE VI

t-TESTS FOR PAIRED SAMPLES
(Combined Group w/ bench press)

Variable	N	Mean ± St. Dev.	t-value	df	Probability
Pre-Lifts		25.63 reps ±10.37			
	49		-6.42	48	.000 *
Post-Lifts		30.31 reps ± 9.31			
Pre-BF		15.40 % ± 7.01			
	50		-1.28	49	.207
Post-BF		16.00 % ± 7.13			
Pre-Drop		48.51 cm ± 3.94			
	51		1.93	50	.059
Post-Drop		47.85 cm ± 4.70			
Pre-Chest		95.61 cm ± 8.05			
	51		-3.77	50	.000 *
Post-Chest		97.54 cm ± 8.99			
Pre-Uparm		29.59 cm ± 3.58			
	51		-1.20	50	.237
Post-Uparm		29.82 cm ± 3.58			

* significant at .05 level

Male Subjects

For male subjects at the pre-test, there were no significant correlations between any of the following variables when compared to repetitions: body fat, drop length, and waist and hip circumferences. The post-test results showed a slight change from the pre-test results with no correlation between post-test repetitions and the above listed variables plus height (Table IV).

The t-tests for the male group showed a significant change pre- to post- for the number of repetitions performed and chest circumference (Table VII). The analysis for the group of males that included bench press in an average workout showed similar significant changes. Again, no difference was shown in those subjects who did or did not include the bench press in their routine (Table VIII).

Female Subjects

The female group had dissimilar results. Pre-test correlations showed no relationship for any variable with repetitions except upper arm circumference. Post-test results showed relationships with repetitions in the categories of upperarm, forearm, shoulder, and wrist circumference (Table IV).

The t-tests also were dissimilar for the female groups showing significant changes from pre- to post- in the total number of repetitions performed and drop length (Tables IX, X). No real difference was found between the total female

TABLE VII

t-TESTS FOR PAIRED SAMPLES
(Male Group)

Variable	N	Mean ± St. Dev.	t-value	df	Probability
Pre-Lifts		26.71 reps ± 9.79			
	45		-5.89	44	.000 *
Post-Lifts		30.16 reps ± 9.88			
Pre-BF		12.64 % ± 5.64			
	44		-1.15	43	.258
Post-BF		13.02 % ± 6.02			
Pre-Drop		49.56 cm ± 3.84			
	45		- .49	44	.626
Post-Drop		49.71 cm ± 4.11			
Pre-Chest		98.20 cm ± 7.77			
	45		-4.22	44	.000 *
Post-Chest		100.58 cm ± 8.05			
Pre-Uparm		30.89 cm ± 3.84			
	45		-2.35	44	.023
Post-Uparm		31.45 cm ± 2.77			

* significant at .05 level

TABLE VIII

t-TESTS FOR PAIRED SAMPLES
(Male Group w/ bench press)

Variable	N	Mean ± St. Dev.	t-value	df	Probability
Pre-Lifts		27.29 reps ±10.57			
	35		-5.33	34	.000 *
Post-Lifts		30.66 reps ±10.37			
Pre-BF		12.00 % ± 5.52			
	34		-1.48	33	.148
Post-BF		12.53 % ± 6.19			
Pre-Drop		49.66 cm ± 3.86			
	35		- .05	34	.001
Post-Drop		49.68 cm ± 4.24			
Pre-Chest		98.02 cm ± 7.77			
	35		-3.72	34	.001 *
Post-Chest		100.56 cm ± 8.48			
Pre-Uparm		31.04 cm ± 3.07			
	35		-1.64	34	.110
Post-Uparm		31.47 cm ± 2.87			

* significant at .05 level

TABLE IX

t-TESTS FOR PAIRED SAMPLES
(Female Group)

Variable	N	Mean ± St. Dev.	t-value	df	Probability
Pre-Lifts		22.71 reps ±12.26			
	24		-4.09	23	.000 *
Post-Lifts		28.54 reps ±13.30			
Pre-BF		20.59 % ± 4.62			
	26		- .99	25	.333
Post-BF		21.05 % ± 4.20			
Pre-Drop		45.97 cm ± 3.25			
	26		2.24	25	.034 *
Post-Drop		44.68 cm ± 3.45			
Pre-Chest		89.84 cm ± 5.77			
	26		-1.49	25	.150
Post-Chest		90.58 cm ± 5.69			
Pre-Uparm		26.26 cm ± 2.49			
	26		1.36	25	.187
Post-Uparm		25.91 cm ± 2.13			

* significant at .05 level

TABLE X

t-TESTS FOR PAIRED SAMPLES
(Female Group w/ bench press)

Variable	N	Mean ± St. Dev.	t-value	df	Probability
Pre-Lifts		21.50 reps ± 8.91			
	14		-4.52	13	.001 *
Post-Lifts		29.43 reps ± 6.14			
Pre-BF		21.38 % ± 5.45			
	16		- .22	15	.828
Post-BF		21.52 % ± 4.83			
Pre-Drop		46.05 cm ± 2.87			
	16		3.63	15	.002 *
Post-Drop		43.89 cm ± 2.92			
Pre-Chest		90.32 cm ± 5.97			
	16		-1.09	15	.292
Post-Chest		90.91 cm ± 6.17			
Pre-Uparm		26.39 cm ± 2.39			
	16		.53	15	.602
Post-Uparm		26.24 cm ± 2.01			

* significant at .05 level

group and the female group who included bench press as part of a normal workout.

Discussion

Waist and hip circumference did not correlate with the number of repetitions performed. This is not surprising because bench press uses the pectoral muscles in the upper trunk region where waist and hip fall in the lower trunk region. Also, it was found that body fat did not correlate with the number of repetitions performed. Higher body fat percentage would not mean that muscle tissue is minimal, it would mean that the percentage of fat tissue is comparatively higher. In the combined group, weight correlated with the number of repetitions performed. Muscle tissue weighs more than fat tissue (Jackson and Pollock, 1985), and for this reason increased weight could correlate with the ability to perform more repetitions. Weight also correlated with the number of repetitions performed for the male group.

The only correlation found for the female pre-test group comparing repetitions with all other variables was upper arm circumference. This correlation was found in every group. Body weight did not correlate as it did with male subjects. The reason for this could be that women are stronger in their lower body (Misner, Massey, Going, Bemben, & Ball, 1990). Due to the location of muscle tissue density, those women having more muscle tissue and therefore higher weight would not necessarily have strong upper bodies.

The combined group t-tests and male group t-tests showed

significant pre- to post-test changes in the areas of repetitions performed and chest circumference. However, the female group showed significant change in the areas of repetitions performed and drop-length. This may be explained by the differences in the female anatomy. Arm length for the female group probably did not change, but breast tissue placement may have. During the pre-test, pectoralis muscle tissue was not developed, therefore it was not able to support the breast tissue well. After training, muscle tissue may had developed to hold the breast tissue more erect causing a change in drop length but not chest circumference. No real difference was shown between those who did and did not include the bench press as part of their workout routine.

Although drop length did in fact change in the female group, it did not correlate with bench press success. Therefore, a shorter drop length did not enhance bench press performance in the female.

Other correlations were found between the various measures when analyzed. Height correlated with drop length. This seemed to be a somewhat obvious discovery, since tall subjects would be more likely to have longer arms. Weight correlated highly with all of the circumferences. Again, a simple explanation would be that larger people have larger girth measurements. Many of the circumferences correlated to one another. Shoulder circumference correlated with chest, upper arm, forearm, waist and wrist circumferences. Chest circumference correlated with upper arm, forearm, waist and hip circumferences. Upper arm circumference correlated with

forearm, waist, hip, and wrist circumferences. Forearm circumference correlated with waist, hip, and wrist circumferences. This, too, seemed quite obvious. Subjects tended to have consistently large or small circumferences. It would be unusual to have an individual with a large upper arm and a small forearm. The most interesting correlation found was lifts to upper arm circumference. This is the type of correlation that could have predictive value in the future. No negative correlations consistently were found for any of the variables.

Correlations that did not exist were as follows: body fat did not correlate with repetitions; repetitions did not correlate with waist and hip circumferences; drop length did not correlate with hip circumference or lifts. The most noteworthy of the correlations that did not exist was drop length to lifts, which was the main focus of this study.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The following is a summary of the study, the findings derived from the data analysis, conclusions, and recommendations for further study.

Summary

The purpose of this study was to determine possible relationships between the number of bench press repetitions performed and various anthropometric and anatomic measures.

A total of 80 subjects, 50 male and 30 female, were used in this study. The YMCA bench press test was administered to the subjects prior to and upon completion of a 13-week weight training course. Frequency distributions, Pearson product-Momeny correlations, and t-tests were performed to determine any relationships.

Findings

The following findings were determined from the data analysis:

Hypothesis 1: No correlation was be found between pre-test lifts and the following pre-test measures: (1) body fat;

(2) height; (3) weight; (4) drop length; (5) shoulder circumference; (6) chest circumference; (7) upper arm circumference; (8) lower arm circumference; (9) waist circumference; (10) hip circumference; and (11) wrist circumference. Hypothesis 1 was rejected. There were correlations between pre-test lifts and some of the above listed pre-test measures.

Hypothesis 2: No correlation was found between pre-test lifts and the above listed pre-test measures for males. Hypothesis 2 was rejected. There were correlations in the male group between pre-test lifts and some of the above listed pre-test measures.

Hypothesis 3: No correlation was found between pre-test lifts and the above listed pre-test measures for females. Hypothesis 3 was rejected. There were correlations in the female group between pre-test lifts and the above listed pre-test measures.

Hypothesis 4: No correlation was found between the various pre-test measures for males, females, or the combined group. Hypothesis 4 was rejected. There were correlations between the various measures.

Hypothesis 5: No correlation was found between post-test lifts and the post-test equivalent of the above measures for males, females, or the combined group. Hypothesis 5 was rejected. There were correlations between post-test lifts and the various post-test measures.

Hypothesis 6: No correlation was found between the various post-test measures for males, females, or the combined

group. Hypothesis 6 was rejected becuase correlations were found.

7. There was no significant change in the drop length, body fat, upper arm circumferencechest circumference, or the number of repetitions performed for any of the subjects from pre-test to post-test. Hypothesis 7 was rejected. There were significant changes from pre- to post-test in some of the above listed categories.

Conclusions

The lack of correlation between the number of lifts performed and drop length suggested that the YMCA bench press test was adequate for individuals with varying drop lengths, as found in the study. However, other anthropometric and anatomic measures correlated with the number of lifts performed. Although these correlations were different for males and females, they may be helpful in predicting the success of an individual in the YMCA bench press test.

Recommendations

In retrospect, the author would like to make the following recommendations to future investigators:

1. In a field test, seven sites instead of three should be used when measuring skinfolds.
2. Subjects should be given a specific workout routine to follow that includes the bench press.
3. The study should be replicated using subjects in a similar age group to reduce variability.

4. The study should be replicated focusing on the relationship between upper arm circumference and the number of lifts performed.

BIBLIOGRAPHY

American College of Sports Medicine. (1988). Resource manual for guidelines for exercise testing and prescription. Philadelphia: Lea & Febiger.

American College of Sports Medicine. (1990). Position stand on the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. Medicine and Science in Sports and Exercise, 22, 265-274.

American College of Sports Medicine. (1991). Guidelines for exercise testing and prescription (4th ed.). Philadelphia: Lea & Febiger.

Baumgartner, T., & Jackson, A. (1991). Measurement for evaluation in physical education and exercise science (4th ed.). DuBuque, IA: Wm C. Brown Publishers.

Berger, R. (1963). Classification of students on the basis of strength. Research Quarterly, 34, 514-515.

Blair, S., Kohl, H., Paffenbarger, R., Clark, D., Cooper, K., & Gibbons, L. (1989). Physical fitness and all-cause mortality: A prospective study of healthy men and women. Journal of the American Medical Association, 262, 2395-2401.

Bucher, C., & Wuest, D. (1987). Foundations of physical education and sport (10th ed.). St. Louis: Times Mirror/ Mosby College Publishing.

Clarke, D. (1986). Sex differences in strength and fatigability. Research Quarterly. 57. 144-149.

Clarke, H., & Clarke, D. (1987). Application of measurment to physical education (6th ed.). Englewood Cliffs, NJ: Prentice-Hall, Inc.

Fardy, Yanowitz, & Wilson. (1988). Cardiac rehabilitation, adult fitness, and exercise testing (2nd ed.). Philadelphia: Lea & Febiger.

Golding, L. (1989). Revisions get Y's way to physical fitness into shape. Perspective, 15, 50-53.

Golding, L., & Lindsay, A. (1989). Y's way revised: Testing strength and muscular endurance. Perspective, 30-35.

Golding, L., Myers, C., & Sinning, W. (1989). Y's way to physical fitness (3rd ed.). Champaign, IL: Human Kinetics Publishers, Inc.

Heyward, V., Johannes-Ellis, S., & Romer, J. (1986). Gender differences in strength. Research Quarterly, 57, 154-159.

Johnson, B., & Nelson, J. (1986). Practical measurements for evaluation in physical education (4th ed.). Edina, MN: Burgess Publishing Company.

Laubach, L. (1976). Comparative muscular strength of men and women: a review of the literature. Aviation, Space, and Environmental Medicine, 47, 534-542.

Maughan, R., Watson, J., & Weir, J. (1983). Strength and cross-sectional area of human skeletal muscle. (1983). Journal of Physiology, 37-39.

Mayhew, J., Ball, T., Ward, T., Hart, C., & Arnold, M. (1991). Relationships of structural dimensions to bench press strength in college males. Journal of Sports Medicine and Physical Fitness, 31, 135-141.

Misner, J., Massey, B., Going, B., Bemben, M., & Ball, T. (1990). Sex differences in static strength and fatigability in three different muscle groups. Research Quarterly, 61, 238-242.

Montoye, H., & Lamphiear, D. (1977). Grip and arm strength in males and females, age 10 to 69. The Research Quarterly, 48, 190-120.

Nelson, J. (1979). Measurement of physical performance: Resource guide with laboratory experiments. Minneapolis: Burgess Publishing Company.

Petrofsky, J., Burse, R., & Lind, A. (1975). Comparison of physiological responses of women and men to isometric exercise. Journal of Applied Physiology, 38. 863-868.

Stokes, R., Moore, A., & Moore, C. (1988). Fitness: The new wave (2nd ed.). Winston-Salem, NC: Hunter Textbooks, Inc.

Wilmore, J. (1974). Alterations in strength, body composition and anthropometric measurements consequent to a 10-week weight training program. Medicine and Science in Sports, 6, 133-138.

APPENDIXES

APPENDIX A

INFORMED CONSENT

OKLAHOMA STATE UNIVERSITY
SCHOOL OF HPEL
INFORMED CONSENT FORM

PURPOSE. The purpose of this study is to determine the relationship between certain body measures and muscle strength and endurance as measured by a bench press test. This study involves research carried out under the supervision of Dr. Frank A. Kulling, Asst. Prof. HPEL, and Ms. Leanne Thornton, LEIS 1352 instructor and HPEL Graduate Student.

EXPLANATION AND PURPOSE OF TEST. Each subject will have the following measures recorded: (1) height and weight using calibrated scales and height bar; (2) body composition using a skinfold caliper and body pinches at the chest, abdomen, and thigh for males and suprailliac, thigh, and tricep for females; (3) body circumference measures using measuring tape at the shoulder, chest, waist, hip, upper arm, forearm, and wrist.

Each subject will complete a YMCA bench Press Test by performing the maximum number of bench press repetitions possible with a barbell and weights. Males will use an 80 lb. barbell while females will use a 35 lb. barbell.

Each measure and test will be collected/completed twice: once at the beginning of the semester and again at the end of the semester.

POSSIBLE RISKS. All of the procedures and tests mentioned have been performed on students involved in weightlifting. The risks of these procedures and tests are no greater than those normally encountered in LEIS 1352. The YMCA bench Press Test may cause temporary, local muscle fatigue but so will the other weightlifting exercises in LEIS 1352. Additionally, the bench press will be a part of your weightlifting regimen in LEIS 1352.

Measures will be taken and tests administered by competent, trained HPEL graduate students. All tests and procedures will be accomplished in normal LEIS 1352 workout clothing. Measures and testing will not require you to remove clothing other than shoes for height and weight.

BENEFITS OF TESTING. Data secured from these measures and tests will be beneficial in the following ways: (1) it will help establish and understanding of the relationship between body measures and muscle strength and endurance as measured by a bench press test; (2) it will help HPEL Graduate Students collect data for research, creative components, and thesis; and (3) it will provide pre- and post- test information about changes in your strength, endurance, and body measures as a result of your participation in LEIS 1352.

CONFIDENTIALITY OF RECORDS. Information used by researchers will be coded by number and gender (male, female); therefore your name will not be used in published papers, theses, dissertations, or journal articles. All information will be treated as privileged and confidential at all times.

CONSENT/AFFIRMATION/WAIVER. I hereby authorize Dr. Frank A. Kulling, Ms. Leanne Thornton and such HPEL graduate students as may be chosen by them, to administer and collect data relative to the measures and tests previously mentioned. I additionally provide my consent for the investigators to analyze, interpret, present, and publish findings from this data with the understanding that all records will be kept confidential and my name will not be associated with the research data.

I acknowledge my participation in this study is voluntary. Additionally, I understand that I have not waived any of my legal rights or released this institution from liability for negligence.

I further understand I may refuse to participate or I may revoke my consent and withdraw from this study at any time without penalty or prejudice. My treatment, relations, and evaluation (including grades) with my instructor and HPEL faculty and staff will not be affected in any way if I refuse to participate or if I initially participate and withdraw later.

If I have any questions or need to report anything adverse about my participation in or the effects of this study, I may contact Dr. Kulling at 744-6753 (work) or 372-4266 (home) or Ms. Leanne Thornton at 744-9356 (work) or 624-9947 (home). If I have any questions about my rights as a research subject, I may take them to the office of university research services, Oklahoma State University, at 001 Life Sciences East at 744-9991. I also affirm I am at least 18 years of age.

_____(signed)_____(date)

_____(witness)_____(date)

APPENDIX B

DATA COLLECTION SHEET

DATA SHEET
YMCA BENCH PRESS TEST

NAME_____ DATE_____

AGE_____ BIRTHDATE_____

CLASS 1 2 3

HEIGHT_____(in) WEIGHT_____(kg)

DROP LENGTH_____(in)

SKINFOLDS (mm):

men		women	
abdomen	_____	suprailliac	_____
chest	_____	tricep	_____
thigh	_____	thigh	_____
total	_____	total	_____

% body fat_____

CIRCUMFERENCES (in):

shoulder_____

chest_____

upper arm_____

forearm_____

waist_____

hips_____

wrist_____

YMCA Bench Press Test # of repetitions_____

APPENDIX C

BODY FAT SHEETS

TABLE 4: Part I
Percentage of Body Fat - Women
(Sum of Triceps, Iliac, and Thigh Skinfolds)

Sum of Skinfolds (mm)	Age to the Last Year								
	Under 22	23 to 27	28 to 32	33 to 37	38 to 42	43 to 47	48 to 52	53 to 57	Over 58
23-25	9.7	9.9	10.2	10.4	10.7	10.9	11.2	11.4	11.7
26-28	11.0	11.2	11.5	11.7	12.0	12.3	12.5	12.7	13.0
29-31	12.3	12.5	12.8	13.0	13.3	13.5	13.8	14.0	14.3
32-34	13.6	13.8	14.0	14.3	14.5	14.8	15.0	15.3	15.5
35-37	14.8	15.0	15.3	15.5	15.8	16.0	16.3	16.5	16.8
38-40	16.0	16.3	16.5	16.7	17.0	17.2	17.5	17.7	18.0
41-43	17.2	17.4	17.7	17.9	18.2	18.4	18.7	18.9	19.2
44-46	18.3	18.6	18.8	19.1	19.3	19.6	19.8	20.1	20.3
47-49	19.5	19.7	20.0	20.2	20.5	20.7	21.0	21.2	21.5
50-52	20.6	20.8	21.1	21.3	21.6	21.8	22.1	22.3	22.6
53-55	21.7	21.9	22.1	22.4	22.6	22.9	23.1	23.4	23.6
56-58	22.7	23.0	23.2	23.4	23.7	23.9	24.2	24.4	24.7
59-61	23.7	24.0	24.2	24.5	24.7	25.0	25.2	25.5	25.7
62-64	24.7	25.0	25.2	25.5	35.7	26.0	26.7	26.4	26.7
65-67	25.7	25.9	26.2	26.4	26.7	26.9	27.2	27.4	27.7
68-70	26.6	26.9	27.1	27.4	27.6	27.9	28.1	28.4	28.6
71-73	27.5	27.8	28.0	28.3	28.5	28.8	28.0	29.3	29.5
74-76	28.4	28.7	28.9	29.2	29.4	29.7	29.9	30.2	30.4
77-79	29.3	29.5	29.8	30.0	30.3	30.5	30.8	31.0	31.3
80-82	30.1	30.4	30.6	30.9	31.1	31.4	31.6	31.9	32.1
83-85	30.9	31.2	31.4	31.7	31.9	32.2	32.4	32.7	32.9
86-88	31.7	32.0	32.2	32.5	32.7	32.9	33.2	33.4	33.7
89-91	32.5	32.7	33.0	33.2	33.5	33.7	33.9	34.2	34.4
92-94	33.2	33.4	33.7	33.9	34.2	34.4	34.7	34.9	35.2
95-97	33.9	34.1	34.4	34.6	34.9	35.1	35.4	35.6	35.9
98-100	34.6	34.8	35.1	35.3	35.5	35.8	36.0	36.3	36.5
101-103	35.3	35.4	35.7	35.9	36.2	36.4	36.7	36.9	37.2
104-106	35.8	36.1	36.3	36.6	36.8	37.1	37.3	37.5	37.8
107-109	36.4	36.7	36.9	37.1	37.4	37.6	37.9	38.1	38.4
110-112	37.0	37.2	37.5	37.7	38.0	38.2	38.5	38.7	38.9
113-115	37.5	37.8	38.0	38.2	38.5	38.7	39.0	39.2	39.5
116-118	38.0	38.3	38.5	38.8	39.0	39.3	39.5	39.7	40.0
119-121	38.5	38.7	39.0	39.2	39.5	39.7	40.0	40.2	40.5
122-124	39.0	39.2	39.4	39.7	39.9	40.2	40.4	40.7	40.9
125-127	39.4	39.6	39.9	40.1	40.4	40.6	40.9	41.1	41.4
128-130	39.8	40.0	40.3	40.5	40.8	41.0	41.3	41.5	41.8

Source: Pollock, M.L., Schmidt, D.H., and Jackson, A.S.: Measurement of Cardiorespiratory Fitness and Body Composition in the Clinical Setting, *Comprehensive Therapy*, Vol. 6, No. 9, pp. 12-27, 1980.

TABLE 4: Part II
Percentage of Body Fat - Men
(Sum of Chest, Abdominal and Thigh Skinfolds)

Sum of Skinfolds (mm)	Age to the Last Year								
	Under 22	23 to 27	28 to 32	33 to 37	38 to 42	43 to 47	48 to 52	53 to 57	Over 58
8-10	1.3	1.8	2.3	2.9	3.4	3.9	4.5	5.0	5.5
11-13	2.2	2.8	3.3	3.9	4 4	4.9	5.5	6.0	6.5
14-16	3.2	3.8	4.3	4.8	5.4	5.9	6 4	7.0	7.5
17-19	4.2	4.7	5.3	5.8	6.3	6.9	7.4	8.0	8.5
20-22	5.1	5.7	6.2	6.8	7.3	7.9	8.4	8.9	9.5
23-25	6.1	6.6	7.2	7.7	8.3	8.8	9.4	9.9	10.5
26-28	7.0	7.6	8.1	8.7	9.2	9.8	10.3	10.9	11.4
29-31	8.0	8.5	9.1	9.6	10.2	10.7	11.3	11.8	12.4
32-34	8.9	9.4	10.0	10.5	11.1	11.6	12.2	12.8	13.3
35-37	9.8	10.4	10.9	11.5	12.0	12.6	13.1	13.7	14.3
38-40	10.7	11.3	11.8	12.4	12.9	13.5	14.1	14.6	15.2
41-43	11.6	12.2	12.7	13.3	13.8	14.4	15.0	15.5	16.1
44-46	12.5	13.1	13.6	14.2	14.7	15.3	15.9	16.4	17.0
47-49	13.4	13.9	14.5	15.1	15.6	16.2	16.8	17.3	17.9
50-52	14.3	14.8	15.4	15.9	16.5	17.1	17.6	18.2	18.8
53-55	15.1	15.7	16.2	16.8	17.4	17.9	18.5	18.1	19.7
56-58	16.0	16.5	17.1	17.7	18.2	18.8	19.4	20.0	20.5
59-61	16.9	17.4	17.9	18.5	19.1	19.7	20.2	20.8	21.4
62-64	17.6	18.2	18.8	19.4	19.9	20.5	21.1	21.7	22.2
65-67	18.5	19.0	19.6	20.2	20.8	21.3	21.9	22.5	23.1
68-70	19.3	19.9	20.4	21.0	21.6	22.2	22.7	23.3	23.9
71-73	20.1	20.7	21.2	21.8	22.4	23.0	23.6	24.1	24.7
74-76	20.9	21.5	22.0	22.6	23.2	23.8	24.4	25.0	25.5
77-79	21.7	22.2	22.8	23.4	24.0	24.6	25.2	25.8	26.3
80-82	22.4	23.0	23.6	24.2	24.8	25.4	25.9	26.5	27.1
83-85	23.2	23.8	24.4	25.0	25.5	26.1	26.7	27.3	27.9
86-88	24.0	24.5	25.1	25.7	26.3	26.9	27.5	28.1	28.7
89-91	24.7	25.3	25.9	25.5	27.1	27.6	28.2	28.8	29.4
92-94	25.4	26.0	26.6	27.2	27.8	28.4	29.0	29.6	30.2
92-97	26.1	16.7	27.3	27.9	28.5	29.1	29.7	30.3	30.9
98-100	26.9	27.4	28.0	28.6	29.2	29.8	30.4	31.0	31.6
101-103	27.5	28.1	28.7	29.3	29.9	30.5	31.1	31.7	32.3
104-106	28.2	28.8	29.4	30.0	30.6	31.2	31.8	32.4	33.0
107-109	28.9	29.5	30.1	30.7	31.3	31.9	32.5	33.1	33.7
110-112	29.6	30.2	30.8	31.4	32.0	32.6	33.2	33.8	34.4
113-115	30.2	30.8	31.4	32.0	32.6	33.2	33.8	34.5	35.1
116-118	30.9	31.5	32.1	32.7	33.3	33.9	34.5	35.1	35.7
119-121	31.5	32.1	32.7	33.3	33.9	34.5	35.1	35.7	36.4
122-124	32.1	32.7	33.3	33.9	34.5	35.1	35.8	36.4	37.0
125-127	32.7	33.3	33.9	34.5	35.1	35.8	36.4	37.0	37.6

VITA

Leanne Denise Thornton

Candidate for the Degree of

Master of Science

Thesis: THE RELATIONSHIP BETWEEN SELECTED ANTHROPOMETRIC AND YMCA BENCH PRESS TEST PERFORMANCE

Major Field: Health, Physical Education and Leisure

Biographical:

Personal Data: Born in Hammond, Indiana, December 8, 1966, the daughter of Lida Sue Williams.

Education: Graduated from Boone Grove High School, Boone Grove, Indiana, in May, 1985; received Bachelor of Science Degree in Health, Physical Education and Leisure from Oklahoma State University, December, 1990; completed requirements for the Master of Science Degree at Oklahoma State University in July, 1992.

Professional Experience: Volunteered as lab assistant at Oklahoma State University Health and Fitness Center 1988-1989; Interned at the National Institute for Fitness and Sport, summer 1990; Presently working as Graduate Assistant at Oklahoma State University teaching Weight Training, Physical Fitness, and First Aid; teach non-credit Standard First Aid courses for the Payne County Red Cross.

Certifications: Certified Standard First Aid Instructor, American Red Cross, 1990; Certified Exercise Test Technologist, American College of Sports Medicine, 1991.