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Title: Modification of the YMCA Bench Press Test With A Body Weight Variable

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Purpose: The purpose of the study was to determine whether performance on the YMCA's Bench Press Test would be significantly altered by the inclusion of a factor which determined the workload in relation to each individual's body weight.

Methods of Research: Ninety-six male subjects, 18 to 26 years of age, were randomly selected for the study. Each subject performed both the YMCA's Bench Press Test (BPT) which sets workload at 80 pounds for all males and a modification of the BPT (MOD BPT) which determines workload in relation to each individual's body weight. The tests were scored in accordance with the number of repetitions successfully completed. A

t-test was used to determine a whether a difference existed between the BPT and the MOD BPT at the .05 level of significance. Percentages were calculated to determine the numbers and percentages of subjects whose fitness rating on the BPT changed as a result of the weight variable being added in the MOD BPT. A multiple regression was run to determine the efficiency of BPT scores and body weight as predictors of performance on the BPT.

Conclusions: There was a significant difference between performance on the BPT and performance on the MOD BPT. The majority of the subjects did change fitness categories as a result of the addition of the body weight variable. Both BPT scores and body weight were determined to be very significant as predictors of performance on the MOD BPT.

It was concluded that when testing upper body muscular endurance, the test would provide more information pertinent to each individual's muscular endurance needs if the workload used was determine relative to each individual's body weight. Thus, the MOD BPT, a relative test, is a more efficient test of upper body muscular endurance than the BPT, an absolute test. The time and effort required to implement this change would be minimal and well worth the effort.

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MODIFICATION OF THE YMCA BENCH PRESS
TEST WITH A BODY WEIGHT VARIABLE

A Thesis

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Chapter 1

Introduction

Physical fitness is difficult to define, but most authorities agree that many individual aspects which comprise physical fitness can be classified as either health related or performance related. The performance related aspects, such as power and speed, are important in the performance of specific motor tasks, but are not usually critical to one's general health and overall well-being. The health related aspects are critical both to one's health and to performance of certain sports. These aspects, identified as cardiovascular fitness, body composition, hamstring flexibility, and muscular endurance, are directly related to the incidence and severity of hypokinetic disease such as coronary heart disease, obesity, hypertention, and low back pain. Adequate levels of the health related aspects reduce the severity of hypokinetic disease.

The fact that twenty years ago 24% of American adults participated in some form of regular physical activity, as compared to 59% today, indicates that people have become increasingly aware of their fitness needs (Corbin, 1983). Unfortunately, these figures are somewhat misleading when one realizes that each passing year finds the American lifestyle less active, especially in regard to work. Futhermore, increased awareness alone has not and connot solve problems. People must learn how to exercise properly and then perform the exercise on a regular basis.

The first step in properly designing an exercise program is to identify each individual's specific fitness needs. Identification of needs is done through testing. The two general categories of testing procedures are direct and indirect.

The direct method entails the collection of data with finely tuned and highly sophisticated instruments. The precise amount of work performed can be accurately measured by scientifically calibrated equipment. Direct measurement is used as a criterion measure because it provides the most accurate means of assessment known.

While direct methods of evaluating fitness provide the most accurate measurements, they are impractical for general use. The equipment required to take direct measurements is expensive, requires constant maintenance, and often demands extensive knowledge to operate. Direct measurement is time consuming and is generally reserved for laboratory situations. Therefore, somewhat less precise but more practical indirect measures have been designed for use in non-laboratory situations.

The indirect method of testing fitness is commonly known as field testing. Field testing is used in educational settings and fitness programs where equipment, expense, expertise, and time limitations make direct testing impractical. While field testing may not ensure the precise scientific measurements provided by direct testing, field tests are usually validated using direct tests as criterion models. The validity of a field test is based on how well its measures correlate to the measures of the direct method of measurement. Equipment necessary for field testing is relatively inexpensive, highly mobile, readily accessible for a wide variety of situations and facilities, and can be easily adapted to test large numbers of people in a short period of time.

Body composition, cardiovascular endurance, flexibility, and muscular strength have long been recognized as necessary for maintenance of bodily health (Astrand, 1977). Each aspect may be evaluated through either direct or indirect methods. Only recently, however, has muscular endurance been included as a component of health related fitness. The health related fitness needs of an individual are highly personalized. However, every individual should possess a level of muscular endurance significant enough to enable them to do the following:

(1) Meet his/her occupational needs and requirements of normal daily activities.

(2) Meet the needs required to cope with emergency situations.

(3) Have adequate reserves of muscular endurance to participate in recreational activities at the conclusion of an average day (Corbin, 1983).

To date, no direct method for testing muscular endurance is available for fitness evaluation because no criterion measure has been developed. Since no criterion exist on which to validate tests of muscular endurance, tests, which by logic seem to test muscular endurance, have been developed and are commonly used.

Because there is no direct method or criterion available for the measurement of muscular endurance, it is not possible to establish validity for the tests used. However, reliability of such tests can and should be determined. It is imperative that each person be required to perform the test in precisely the same manner and under similar conditions. Properly administered tests of muscular endurance can provide valuable information to an individual regarding this aspect of fitness.

"Muscular endurance may be either dynamic or static in nature and concerns the ability of a muscle to repeat identical movements or pressures, or to maintain a certain degree of tension over a period of time" (Johnson, 1974, p. 112). Tests designed to measure dynamic and static pressures generally require expensive equipment such as tensiometers, ergographs, dynamometers, and spring scales. For this reason, the majority of the tests used to assess muscular endurance are those which are scored in terms of the number of repetitions a person can perform using a selected workload. The selected workload can be either absolute or relative. An absolute workload is the same for all subjects. A relative workload is determined by using a percentage of each individual's body weight or a percentage of the maximum strength of the muscle group to be tested (Caldwell, 1965).

Muscular endurance test results are employed to distinguish improvements derived from training or regression in fitness resulting from periods of inactivity. Favorable results provide positive reinforcement of the benefits of a successful program and offer a sence of accomplishment, helping the subject to stay motivated to continue the program. Results showing a low level of muscular endurance might motivate an individual to begin exercising properly.

Information pertaining to the effectiveness of various training programs or techniques can be obtained through the comparison of pre- and post-testing. Results of such testing can help identify effective programs which can be continued and unproductive programs which should be altered or eliminated. Data collected from testing provide vital information for use in the process of exercise prescription. Test scores are used to determine the type and intensity of programs that will be both safe and beneficial to each individual.

Statement of the Problem

The YMCA has long been a leader in the area of physical fitness. To enhance their fitness programs, members of the Y's staff and qualified consultants from across the country have compiled a battery of fitness tests for the purpose of assessing the fitness level of an individual in relation to the health related aspects of fitness (Golding, 1982). The YMCA's tests have been so widely accepted that many leaders in the fitness field model their testing procedures after those of the YMCA. However, there is a question regarding the Y's test of muscular endurance, the Bench Press Test (BPT). As previously stated, the degree of muscular endurance required for a healthy and enjoyable lifestyle depends on the individual. Obviously the workload that an individual must handle in terms of occupational tasks, daily living requirements, emergency situations, and recreational activities would be his/her own body weight. The Y's BPT is an absolute test which requires all members of the same sex to perform the test using the same workload, regardless of differences in body weight. The workload for males is set at 80 pounds and the workload for females is set at 35 pounds (Golding, 1982). In its present form, the BPT requires a person who weighs 100 pounds to perform the exercise with the same workload as a person who weighs 300 pounds. A 100 pound male is required to perform the exercise with a workload representing 80% of his body weight compared to a 300 pound male who works with only 27% of his body weight, yet they are evaluated on the same rating scale. The BPT appears to penalize individuals with less body weight. It seems logical that the BPT would provide a person with more information pertinent to his/her individual needs if the workload represented a percentage of his/her body weight.

Purpose

It was the purpose of this study to determine whether individuals would score differently on the BPT than they would on a modification of the BPT (MOD BPT). The only difference between the two tests was the manner in which workload was determined. The workload for the BPT was 80 pounds and the workload for the MOD BPT was determined as 50% of the individual's body weight. The intent of the use of these tests was to determine whether performance on the BPT would be significantly altered by the inclusion of a factor which determined the workload in relation to each individual's body weight.

Chapter 2

Related Literature

The primary purpose of this study was to determine whether performance on a test of muscular endurance, the Y's BPT, would be significantly altered if the test were transformed from an absolute test to a relative test by the inclusion of a variable which determined the workload in relation to each individual's body weight. It is the intent of this chapter to review the research which pertains to muscular endurance and muscular endurance testing. Because muscular endurance has only recently been categorized as a component of health related fitness, very little research has been conducted in the area of muscular endurance testing. The majority of available articles conclude with statements emphasizing the need for further research in this area.

It is difficult to determine when man actually became concerned with muscular endurance. Around the year 1900, scientists launched a campaign to develop tests which would offer a greater functional value than the anthropometric tests then used to measure body characteristics. The search for a test which would have a stronger relationship with physical fitness and ability led to the development of the first ergograph by Angelo Masso (Clarke, 1966). The ergograph was thought to be the earliest piece of equipment developed to test an isolated form of muscular endurance.

Masso's ergograph consisted of a leather sling which passed over the exercise finger. The sling was attached to weights by a sling which ran over a pulley. Performance was recorded by a pen carried by a small car which slid along two parallel steel tracks when the string was pulled. When the finger was flexed, the car and the pen were drawn forward. When the finger flexors were relaxed, the car and pen returned to the starting position. The pen markings represented muscular work (Masso, 1906).

Masso's ergograph was highly criticized as a device for testing muscular endurance. Criticisms centered around the facts that work was performed only during the contractile phase of the movement, the angle of pull changed continuously throughout the range of motion of the joint, and only small groups of muscles with little load lifting potential could be tested. Also, no standard method for determining workload was available (Clarke, 1966). Out of these criticisms grew attempts to revise and improve Massó's ergograph. Franz and Hough (1901) developed spring ergographs designed to record tension during isometric contraction. Larger ergographs designed to test the muscular endurance of primary muscles were developed. These devices proved no better than Masso's ergograph (Clarke, 1966).

For the next couple of decades muscular endurance performance evaluations were set aside in favor of developing tests to assess cardiovascular endurance. It was not until the 1940's, when World Was II left men with muscular injuries and deformities, that the importance of muscular performance was again recognized (Larson, 1951). In 1942 Frances A. Hellebrandt, a medical doctor, and L.E.A. Kelso, a professor of mechanical engineering, combined their talents and knowledge to design equipment appropriate for the analysis of the muscular performance of patients possessing muscular injuries and handicaps. The Kelso-Hellebrandt ergographs were developed to evaluate skeletal muscles of the upper extremities since contraction of these muscles is required in most occupations. The kelso-Hellebrandt ergographs consisted of the following instruments: a finger and wrist ergograph, a thumb ergograph, and a grip ergograph (Hellebrandt, 1948). At this time the majority of the tests employed to assess muscular endurance were designed to assess muscular performance of injured and disabled individuals.

During the post World War II years, people in the United States became increasingly aware of their fitness needs. A decree by President Eisenhower called for physical fitness to become a national topic of consideration. In 1955 Eisenhower established the President's Council on Youth Fitness (Bucher, 1955). Along with this increased awareness of physical fitness came the development of evaluation tools and tests to appraise health related aspects of physical fitness. This trend brought with it a number of new tests of muscular endurance which were designed to evaluate the muscular performance of relatively healthy individuals in contrast to previous tests which had been designed to evaluate the disabled.

Fitness tests of muscular endurance can be categorized into three types: dynamic tests, repetitive static tests, and timed static tests. A dynamic test demands that the muscle being tested travel through a full range of motion. The subject is required to execute identical repetitions of movement elicited by a chosen group of muscles over an unlimited period of time. Examples of such tests include: push-up tests, pull-up tests, dip-tests, sit-up tests, and submaximal barbell tests. Dynamic tests are scored in terms of the number of repetitions performed correctly (Johnson, 1969).

The second category of muscular endurance tests is repetitive static tests. The participant in this testing situation executes repetitions of pre-determined force against a static measuring device. These tests are scored in relation to the number of times the individual can successfully register the designated force. Testing of this type is generally performed with a metronome to set a cadence, thereby standardizing the amount of time elasped between each effort. An example of a repetitive static test is the number of times a person can register a force equal to 80 pounds on a grip dynamometer. The test is terminated when the performer fails to keep time with the cadence or fails to register a force great enough to meet the desired workload (Johnson, 1969).

The third category of muscular endurance tests is timed static tests. These tests require the performer to maintain one continuous contraction for as long as possible. The test is scored in accordance with the amount of time the contraction was maintained. An example of a timed static test of muscular endurance is the flexed-arm hang for women (Johnson, 1969).

Tests of muscular endurance are very practical for use in schools and physical fitness programs when the goals are:

(1) To determine the subject's level of health related fitness (Johnson, 1974).

(2) To motivate individuals to strive to enhance their present level of muscular fitness (Johnson, 1974).

(3) To determine improvements prompted by training programs (Johnson, 1974).

(4) To indicate an individual's present level of muscular fitness (Johnson, 1974).

This will provide the tester with valuable information as to the individual's degree of readiness for physical activity (Johnson,1974).

While the majority of muscular endurance field tests are convenient and easily implemented, there are variables associated with them that the tester must know and follow for proper test administration. These variables include: specificity of test to training, modes of training, relative versus absolute testing, speed of work, motivational stimulation, and warm-up prior to testing. Johnson and Nelson (1969) state that it is imperative that the nature of the muscular endurance test selected be specific to the mode of training employed. Thus, before a test is selected, the tester must give careful attention to the mode of training that will prove most practical for the majority of the individuals involved.

Pollock, Wilmore, and Fox (1978) maintain that muscular endurance can be developed through three modes of training: isometric, isotonic, and isokinetic. Muscular endurance developed through isometric work is obtained by exercising against a resistance greater than the force that can be applied. The performer generally applies pressure to an immobile object. No actual movement of the body parts is detectable (Pollock, 1983).

Isotonic training includes the actual movement or lifting of a constant resistance through a joint's entire range of motion (Pollock, 1983). Free weights and Universal Gym weight training are prime examples of isotonic training.

Isokinetic training produces a constant speed of movement against a variable resistance. Theoretically, the workload is altered to correspond with the strength of the muscle at each point in the range of motion (Hislop, 1967).

Dennison, Howel, and Morford (1960) conducted an experiment using a push-up test, a pull-up test, and an Arm Strength Index test to determine the effects of isometric and isotonic training programs on muscular endurance. Two groups of 10 college-aged males were used as subjects. Group I was placed on an eight week isotonic weight training program, while Group II performed the Commander Set Group series of isometric exercises for the same period of time. Both groups met twice a week at the same hour on the same day. The results showed that both groups improved on all three muscular endurance tests. They concluded that both isometric and isotonic exercise can enhance muscular endurance.

Thistle (1967) found that significant increases in muscular endurance could be obtained through isokinetic resistance procedures. Furthermore, he concluded that quite often these increases in muscular endurance were higher than the increases found for isotonic or iscmetric training procedures.

Although all three training modes can be used to enhance muscular endurance, all have drawbacks that should be evaluated before a training progarm or testing mode is implemented. B.L. Johnson (1967) states that isometric (static) tests of muscular endurance are unreliable due to the fact that it is difficulat to determine exactly the same position or angle of pull for various exercises for all subjects. Differences in amounts of fatty tissue, musculature, and length of body parts pose problems for accurate testing. These aspects cause the angle of pull and leverage to change.

Clarke (1971) reports that isometric exercises cause occulusion of the blood circulating to the working muscles. This interferes with the supply of oxygen being transported to the working muscles, thereby impairing muscular endurance. He discovered that middle-aged individuals and persons with heart disease might experience irregular heartbeats, premature ventricular contractions, and abnormally fast heartbeats as a result of performing isometric exercise. He found that isotonic exercise rarely produced any of the above listed abnormalities in middle-aged individuals. Clarke also discovered that motivation during isometric training programs was lower than the motivation level found for isotonic training programs and tests.

Pollock (1978) states that a major drawback of isotonic training lies in the fact that the strength of a muscle varies at various angles of pull. As the body part moves through the various angles of exercise, the leverage is altered. Thus, when lifting with a constant resistance (isotonic), the muscle is not exercised to the same extent throughout the entire range of motion.

Pollock (1978) identified the major drawback associated with isokinetic training and testing to be the necessity of having expensive equipment and specialized knowledge needed for operation of the equipment. Equipment of this type is generally found in scientific human performance laboratories and is too expensive for school systems and physical fitness programs.

A summary of literature by Anderson (1982) concludes that, of the three modes used to enhance muscular endurance performance, isotonic is the most frequently used mode in school systems and physical fitness programs. He explains that isometric training and testing is unsafe for middle-aged and elderly individuals.and is impractical from the standpoint that only one angle of the muscle can be worked at a time. Isokinetic exercises are impractical due to the expensive and sophisticated equipment required. Isotonic exercise can be performed with no equipment (i.e., push-ups) or with relatively inexpensive and readily available equipment. The vast majority of weight training equipment available is for isotonic training programs.

In addition to determining mode of training and testing for muscular endurance, the test administrator or fitness director must decide whether to use a relative or an absolute test. Relative tests of muscular endurance set a workload that is proportional to the individual's maximum strength or related to his/her body weight. Tests of absolute muscular endurance give no consideration to differences in individual strength or body wieght, workload is the same for everyone (Johnson, 1979).

Johnson (1979) states that tests of absolute muscular endurance should be utilized only for purposes of mass testing or when time is very limited. Johnson indicates that relative testing offers more personalized information in terms of an individual's muscular endurance level. Allsen, Harrison, and Vance (1980) also suggest that relative testing provides more individualized information than absolute testing.

When relative testing procedures have been selected, a decision must be made as to whether workload will be based on a percentage of the individual's maximum strength or a percentage of the individual's body weight. Pollock (1978) states that, to totally isolate muscular endurance from muscular strength, the test should be based on a set percentage of each individual's maximum strength. Maximum strength is represented by the greatest amount of weight a muscle group can move at one time (1-RM). Pollock offers the logic that if an individual cannot lift a set percentage of his/her body weight one time, he/she is already attempting to lift above his/her 1-RM. A test of this nature would be an evaluation of strength, not endurance.

Both Pollock (1978) and Fox (1983) indicated that muscular endurance tests which set workload at a percentage of an individual's maximum strength should determine the workload at 70% of the 1-RM of the group of muscles to be tested. Both men state that an individual with adequate muscular endurance should be able to perform 15 repetitions at this workload.

Pollock (1978) goes on to state, however, that in cases where physical fitness is concerned, it is not necessary to totally isolate muscular endurance from muscular stength. If an individual possesses adequate muscular endurance at a set percentage of his/her 1-RM for a group of muscles, this does not necessarily indicate adequate muscular fitness. The strength of the individual may be at a level so low that the individual does not possess sufficient ability to deal with his/her own body wieght. Muscular endurance determined at a percentage of this low level of strength would not indicate adequate muscular endurance in relation to health. Pollock concludes that relative endurance tests based on a percentage of an individual's body weight should be employed to assess muscular endurance. He offers the logic that strength is known to fluctuate and to be dependent on a number of variables. Body weight is more constant and a tester can be more certain of a measure of maximum body weight. Also, determination of body weight is easy, inexpensive and quick.

Fox (1983) recommends that for fitness based muscular endurance, tests should be relative in nature and workloads should be determined by a set percentage of an individual's body weight. He cites that procedures required to determine the 1-RM of a group of muscles is not practical for field testing situations. To determine 1-RM, each subject must complete at least three lifts. The time required for this procedure is too great for a field test. Fox also states that the 1-RM obtained will most likely not represent the individual's true 1-RM due to inexperience and fatigue resulting from previous lifts. He further implies that strength testing might be dangerous for unfit individuals and should be avoided.

Another variable to consider in muscular endurance testing is the rate of work. Research conducted by Moffroid and Whipple (1970) indicates that the rate at which work is done can greatly affect muscular endurance. Thirty college-aged male subjects were tested using an isotonic quadricep extention test to assess muscular endurance. Fifteen subjects were tested at a rate which required 10 repetitions per minute and 15 were tested at a rate which called for 30 repetitions per minute. The study demonstrated that the group which exercised at the higher rate performed a greater number of repetitions before reaching a level of fatigue great enough to cause the termination of work. Moffroid and Whipple concluded that to ensure that tests of muscular endurance are consistent for all individuals, the speed at which exercise is performed must be regulated. They recommend the use of a metronome to regulate rate of work for tests of muscular endurance.

Clarke's research (1966) indicated that there appears to be specific combinations of load and speed of movement which produce maximum work output for each muscle group on tests of muscular endurance. Clarke investigated the basic movement of four muscle groups commonly analyzed in tests of muscular endurance. These were: elbow flexion, elbow extension, shoulder flexion, and gripping. Twenty-five different combinations of load and cadence were studied. For each combination, five subjects were used. The results concluded the following in relation to optimal workload for measuring muscular endurance:

(1) Elbow Flexion - 25% of 1-RM for workload
76 beats (38 repetitions) per minute for cadence

(2) Shoulder Flexion - 75% of 1-RM for workload
84 beats (42 repetitions) per minute for cadence

(3) Grip - 50% of 1-RM for workload
76 beats (38 repetitions) per minute for cadence

(4) Elbow Extension - 50% of 1-RM for workload
84 beats (42 repetitions) per minute for cadence

Clarke concluded that the use of cadence aids in the maintenance of consistancy, reliability, and form. To date, little information is available as to optimal workloads and cadences to be used when workload is represented by a percentage of body weight.

Through a series of experiments, J.K. Nelson demonstrated the effects of a fourth variable, motivation, on tests of muscular endurance (Clarke, 1966). Nelson tested 250 randomly selected males. The subjects, ages 18 to 24 years, were divided into 10 groups of 25. Each group was exposed to a different form of motivation during the testing. The left elbow flexor was evaluated with the use of the Kelso-Hellebrandt ergograph. The load was set at 25% of each individual's 1-RM. The work was performed to a cadence of 76 beats (38 repetitions) per minute. The ten motivational situations used for the study were:

Group (1)- Normal Instructions: The subjects were simply asked to exercise as long as possible.

Group (2)- Verbal Encouragement: The subjects were verbally encouraged to continue. Praises such as "Good job!" and "You can do it." were common.

Group (3)-Individual Competition: Two subjects performed the test at the same time and were asked to compete.

Group (4)- Group Competition: Before the test, subjects were shown scores of classmates and norms for college males.

Group (5)- Obtainable Goal: Subjects were given a high, but obtainable goal to shoot for.

Group (6)- Observer's Presence: After the test had started an official looking observer walked into the room and intently watched with apparent interest.

Group (7)- Instructor's Interest: Before reporting for testing the subject's physical education teacher asked the subject to perform his best and to report his score when the test was completed.

Group (8)- Ego Involvement: The subjects were told that junior high and high school aged subjects had performed a certain number of repetitions (fictitiously high). The subjects were told, "Surely you can do better".

Group (9)- Air Force Space Program: The subjects were told that the norms from their test scores would be used to set standards for future astronauts.

Group (10)- Competition with Russian Students: The subjects were told that their results were to be compared with the results of tests performed by Russian students of the same age group.

The results indicated that the groups of subjects could be placed into one of three categories depicting varying levels of motivation: low, moderate, and high. Group 1, 2, and 7 fell into the low category. Groups 4, 5, 6, and 10 fell into the moderate category. Groups 3, 8, and 9 fell into the high category (Clarke, 1966).

In other research Nelson (1978) again attempted to discover the effect of motivation on performance on tests of muscular endurance. One hundred college men were randomly assigned to four groups. Muscular endurance was tested with 25% 1-RM on an elbow flexion exercise. Performance was evaluated with a cable tensiometer. All subjects were instructed to perform to the best of their abilities. Group (1), the control group, received no further instructions. Group (2) was given realistic norms. Group (3) was given high fictitious norms and subjects in Group (4) were told that they were expected to perform a minimum of 40 repetitions. Results of the study demonstrated that Groups 2, 3, and 4 all surpassed Group (1) in performance. Group (3) (fictitious norms) had achieved the highest mean scores. Group (3) also yielded the largest standard deviation. Group (4) (40 repetitions) yielded the second highest mean score. Nelson concluded that while motivating people with fictitiously high norms or giving them a minimum number of repetitions to strive for produced high levels of performance, it might not yield accurate results. Nelson explained that in the case of the fictitiously high norms, the highly fit individuals were motivated to meet the norms given to them, but many of the less fit individuals realized that they could not meet the norms and generally quit before physical fatigue forced them do so. He also observed that in Group (4) many subjects would reach the minimum goal, 40 repetitions, and quit. Thus, a tester must be very careful as to the type of motivational stimulus he/she choses to use when testing muscular endurance.

Lopez and Dausman (1981) compiled and summarized research dealing with active warm-up and its effect on muscular endurance exercises. They concluded that the benefits of warm-up, as an aid to muscular performance, are psychophysiological in nature. They found that the psychological factors, such as a subject's predisposition to the effectiveness of warm-up, had a pronounced effect on the subject's physical performance. They concluded that if a subject performs an appropriate warm-up and he/she believes that warm-up will improve performance, it is likely that the performance will benefit. Conversely, the exact same warm-up routine may have no effect or even a detrimental effect if he/she feels that warm-up has little or nor effect on performance.

Conversely, Astrand (1977) found that physical performance significantly increases as a result of warm-up. He found that the heavier the warm-up the greater the improvement in performance. Astrand explains that warm-up exercise increases the temperature of the blood and the body cells. The benefit of higher temperature during exercise performance can be attributed to the fact that the metabolic processes are temperature sensitive. The higher the temperature, the faster the rate of metabolism. For each degree of temperature increase, the cellular metabolic activities increase approximately 13%. The exchange of oxygen from the blood to the tissues is also enhanced by higher temperatures. These factors all contribute to increased work capacity. Furthermore, Klafs and Arnheim (1981) state that a sufficient period of active warm-up prior to bouts of muscular exercise will greatly reduce the chance of injury. They state that injury can be greatly reduced by static stretching of the muscles to be worked and light aerobic exercise. Therefore, it appears that warm-up exercises prior to performance of muscular endurance tests are necessary, however, the tester must be aware of the psychological factors which can override physiological affects.

Summary

Since the turn of the century the emphasis on tests of muscular endurance has shifted from the medical testing of the injured and disabled to the evaluation of muscular fitness in relatively healthy individuals. In order to promote the new emphasis on muscular endurance as a component of health related fitness, field tests were developed to evaluate muscular endurance.

Anderson's summary (1981) of muscular endurance training indicated that isotonic exercising was the most widely used. Johnson and Nelson's theory (1969) that exercise tests should be specific to the nature of the training suggests that the most practical and widely usable test to assess muscular endurance would be isotonic in nature.

J.K. Johnson (1979) and Allen (1980) indicate that absolute testing should be utilized only for mass testing purposes when it is necessary to test a large number of subjects at the same time. Pollock (1978) and Fox (1983) advocate relative workloads, particularly the use of a set percentage of an individual's body weight instead of the use of a set percentage of the muscle group's 1-RM.

Research by Moffroid and Whipple (1970) determined that muscular endurance could be greatly affected by the speed at which the exercise is performed. Clarke (1966) produced evidence that there is an optimal cadence and workload for producing maximum performance of muscular endurance for the testing of each muscle group. Nelson's studies (1978) showed that motivation can greatly affect performance on tests of muscular endurance. He concluded that, for consistant and reliable results, motivational stimulation should be identical for each subject.

Lopez and Dausman (1981) determined that warm-up prior to exercise could effect performance psychologically. Astrand (1977) found that warm-up exercise raises blood temperature and subsequently enhances muscular endurance. Klafs (1981) recommends the use of warm-up exercises to reduce the possibility of injury.

"While a certain degree of muscular endurance is necessary for performing daily activities and sports skills, a high degree of muscular endurance is regarded as a luxury which makes for greater ease of performance and a feeling of vitality well worth the effort necessary to acquire and maintain it" (Johnson, 1979, p. 94). Since muscular endurance is such a desireable component of health related fitness, but has received little research attention, there is a need for further research to determine how to most effectively evaluate it.

YMCA's BPT

The YMCA included the Bench Press Test in their battery of fitness tests as an assessment of muscular endurance. Because no criterion test was available to validate tests of muscular endurance Golding, Sinning, and Meyers, consultants for the YMCA, developed the Bench Press Test using the same physiological premises used to develop other commonly used tests of muscular endurance (push-ups, pull-ups, ect.). The Y's test appears to be a reliable test of muscular endurance in accordance with the literature previously presented. The BPT is based on the number of repetitions a male can perform using 80 pounds or a female can perform using 35 pounds. The bench press exercise, an isotonic exercise, is performed to a cadence of 60 beats (30 repetitions) per minute.

The Y's review of literature in the area of muscular endurance revealed that a high correlation exists between elbow extention/flexion and total body muscular endurance (Larry Golding, personal communications, April 10, 1985). At the time when the YMCA developed the BPT, commonly used tests of elbow extention and elbow flexion were various protocols of push-up, pull-up, and dip-tests. Research conducted by the YMCA indicated that these protocols might prove too strenuous for many of their middle-aged clients, thus the BPT was developed (Golding, 1982).

The only aspect of the BPT that doesn't meet the guidelines offered by the literature is that the test is absolute in nature. Absolute testing is recommended only for mass testing situations. The Y's fitness assessments are generally conducted in private and on a one to one basis. It appears that the Y's BPT would be a better test of muscular endurance if a variable were added to make the test relative in nature.

Chapter 3

Methods

This chapter will describe the methods and procedures used to investigate whether performance of the BPT is significantly altered when workload is set at 50% of each individual's body weight instead of using the absolute weight of 80 pounds. The design of the study, the instrumentation used, the population involved, the sampling procedures, and the methods used for the statistical analysis of the data are all described in this chapter.

Target Population

Data were collected from 96 male subjects randomly selected from the P.E. 100 Lifetime Fitness classes at Emporia State University. The ages of the subjests ranged from 18 to 26 years. P.E. 100 Lifetime Fitness is a graduation requirement for all students attending Emporia State University. It is not a class for physical education majors. Because the testing sample included male students from all divisions of the university, the sample represents the male population at Emporia State University.

College students throughout this country are physiologically similar. Muscular endurance is developed through training. Thus, scores obtained by subjects will reflect exercise habits and not geographic location. For this reason it can be concluded that results and conclusions drawn from this study can be generalized to all undergraduate college males in the United States who are attending normally populated institutions.

Sampling Population

There were 140 males enrolled in P.E. 100 Lifetime Fitness during the Spring semester 1985. Each was assigned a number. A random numbers table was employed using the last three numbers on the chart to provide a list of 100 randomly selected numbers. The numbers were matched with the corresponding names of the subjects.

Four subjects were dropped from the study for various reasons. One subject dropped his P.E. 100 Lifetime Fitness class before the data collection process had begun. The other three subjects were dropped due to medical handicaps which prevented them from physically performing the tests.

Design of the Study

The research was classified as quasi-experimental due to the fact that it was not possbile to obtain a sample from the entire population of college-aged males. The design of the study was one of repeated measures. This experimental design controlled the majority of the extraneous variables in the experiment. Thus, significant differences in performance between the two tests can be attributed to the body weight variable being tested.

Before the actual collection of data was begun,a pilot study was conducted to determine the set percentage of body weight that would be used to determine workload for the MOD BPT. Procedures followed for the completion of the pilot study can be found in Appendix A.

During the first testing session, the first 50% of the subjects on the randomly selected list were required to perform the BPT which consisted of bench pressing 80 pounds at rhythmical two-second intervals to the point where muscular fatigue prevented the subjects from properly performing the exercise. The other 50% of the subjects first performed the MOD BPT which required the subjects to complete the same testing procedures using a workload equal to 50% of each individual's body weight as measured at the beginning of the experiment. At the second testing session the subjects performed the other test. This design was selected to counterbalance alterations in performance created by the performance of one test before the other.

Equipment

The three key pieces of equipment used in the study were a metronome, a weight scale, and a bar with weight plates.

(A) Metronome - A metronome is a device used to keep rhythmical time. The metronome used for this study was a Fran II metronome manufactured by the Lafayette Instrument Company. The metronome was calibrated before each daily session by synchronizing the rhythm of the metronome to a second hand on a clock.

(B) Scale - The scale used to obtain the body weights of the subjects was a Healthometer brand produced by the Continental Scale Corporation. The scale was calibrated before each daily session by adjusting the scale's balance weights.

(C) Bar and Weight Plates - The major concern surrounding the use of a bar and weight plates, which were produced by the Olympic Company, was that they might not weigh exactly what they were supposed to weigh. To establish the validity of the bar and weight plates, a bar and enough weight plates to test a 350 pound subject at 50% of his body weight were weighed on the scales of the Emporia Wholesale Coffee Company in Emporia, Kansas. The scales at this particular company are checked for reliability by certified government officials every week. Table 1 summarizes the various sizes of plates used and the error determined by the certified scales.

Table 1

Error for Bar and Weight Plates

Plate Size	Error
45 lbs.	0 oz.
45 lbs.	+4 oz.
25 lbs.	0 oz.
25 lbs.	0 oz.
10 lbs.	+2 oz.
10 lbs.	-2 oz.
10 lbs.	0 oz.
10 lbs.	+1 oz.
5 lbs.	0 oz.
5 lbs.	+2 oz.
2.5 lbs.	0 oz.
2.5 lbs.	0 oz.
Bar 45 lbs.	0 oz.

A degree of error for the workload was calculated at .0363632 pounds for the workload of the heaviest subject (325 lbs.). A degree of error for the workload was calculated at .0333328 pounds for the workload of the lightest subject (119 lbs.).

Procedures

The BPT, a widely used and accepted test of muscular endurance, was the primary instrument used. For the purposes of this study the BPT was utilized in both its original form and in a modified format (MOD BPT). The MOD BPT was identical to the BPT with the exception of a variable added to determine workload at 50% of an individual's body weight instead of an absolute weight of 80 pounds. Requiring the same subjects to perform both tests provided the opportunity to analyze the effect of the addition of the weight variable.

The testing sessions took place during the subject's P.E. 100 Lifetime Fitness class periods. This was done in an attempt to reduce the occurence of subjects missing testing sessions. A 48-hour period between testing sessions was chosen because it allowed a sufficient period of time for the subjects to recover from muscular fatigue or discomfort sustained during the previous testing session. This relatively short period of time also ensured that the body weights of the subjects would not change to a great extent during the time elasped between the two testing sessions.

Before the first testing session all subjects were given a informed consent form (Appendix B) explaining the purposes of the study and the risk involved in participation. Each subject was required to read, sign, and date the form.

Prior to data collection at each of the testing sessions, a series of warm-up exercises were performed by all of the subjects. The warm-up exercises were conducted to raise blood temperature and to reduce the possibility of injury. Illustrations of the warm-up exercises performed prior to the collection of data can be found in Appendix C.

In an attempt to ensure that the circumstances were as similar as possible for each subject during the data collection process, one tester conducted the data collection process for all subjects at both testing sessions. Identical instructions were given to each subject prior to the beginning of each test. The procedures were explained to the subjects in a simple and clear manner. The subjects were asked to perform as many repetitions as possible, staying in rhythm with the metronome until unable to continue or until unable to maintain the proper pace. During the data collection process, verbal encouragement was the type of motivational technique used to stimulate each subject to perform to the best of his ability. Verbal praise such as, "Good job!", "You are doing fine.", and "Come on, you can do it." were commonly used.

For the MOD BPT the subjects were weighed in workout clothes with shoes off. Fifty percent of the subject's body weight was calculated for the use as the workload for the testing procedures. This weight was rounded to the nearest 5-pounds. When 50% of the subject's body weight fell exactly between the two 5-pound increments, the workload was rounded to the next higher weight. Thus, the greatest variance between 50% of a subject's body weight and the workload actually used was 2.5 pounds. Since this 2.5 pounds represents the greatest degree of error for the lightest subject in relation to percentage of body weight, a degree of error was calculated using that individual's body weight (119 lbs.). The degree of error was calculated to be 2.1 percent.

With the exception of the calculation of the workload, the procedures for the BPT and the MOD BPT were identical. The subject was placed on a supine bench with his knees bent and his feet flat on the floor. Instructions were given to the subject to perform as many repetitions as possible in rhythm with the metronome which was set at a cadence of 60 beats (30 repetitions) per minute. The subject was informed that each beat of the metronome should represent the lowering (shoulder flexion) or the raising (shoulder extention) of the bar and weight plates. The subject was told that the weight must be lowered to the chest and then raised in a controlled manner to a locked elbow position. When the subject indicated that he was ready to begin the test, the tester handed the subject the weight. The test was begun with the subject holding the weight in an up (shoulder extention) position. He was instructed to begin the test when he felt that he could comfortably synchronize repetitions with the cadence of the metronome. Each successful performance of shoulder flexion and shoulder extention was counted as one repetition. The subject's score was determined by the number of repetitions he successfully completed. The test was terminated when the subject failed to lift the weight or failed to keep up with the metronome.

A series of cool-down exercise were conducted following the testing procedures. This was done to prevent blood from pooling in the muscles and to prevent, or reduce, the occurence of muscle soreness. The cool-down exercises performed were identical to those performed as warm-up. They can be seen in Appendix C.

Data Collection

The number of repetitions successfully performed by each subject was recorded for each test. A rating was given to describe the subject's fitness level in relation to muscular endurance. The ratings were given in accordance with the norms the YMCA uses for the BPT. The norms are age specific. An example of the recording form used for this study can be found in Appendix D.

Data Analysis

Due to the random selection of the subjects, parametric statistics were employed to complete a statistical analysis of the data. Data were analyzed with descriptive statistics, means and standard deviations, as well as with inferential statistics, a t-test for dependent groups. The null hypothesis for the t-test was non-directional and two-tailed. An alpha level of .05 was selected for the rejection of the null hypothesis.

Substantive Hypothesis (Null Hypothesis)

There is no significant difference between the mean number of repetitions performed on the BPT and the mean number of repetitions performed on the MOD BPT.

Statistical Hypothesis

Null Hypothesis:

Alternate Hypothesis:

= the mean number of repetitions performed by the subjects on the BPT.

= the mean number of repetitions performed by the subjects on the MOD BPT.

A rejection of the null hypothesis would indicate that the addition of a variable which set workload at 50% of a subject's body weight significantly altered performance on the BPT. The rejection of the null hypothesis would make it possible to employ multiple regression techniques to determine the predictive value of BPT scores and body weight in terms of predicting performance on the MOD BPT.

Chapter 4

Analysis of Data

This chapter contains the results of the analysis of data from the comparison of performance on the YMCA's BPT to performance on the MOD BPT. The statistical procedures used for analysis included t-test for dependent groups, standard error, percentages and frequencies in terms of fitness rating categories, and multiple regression.

A group of 96 college-aged males was required to perform both the BPT and the MOD BPT. The scores of the two tests were subjected to a t-test to determine if a significant difference existed at the .05 level. Additional statistical procedures included multiple regression techniques to determine the suitability of BPT scores and body weight as predictors of performance on the MOD BPT.

t-test Analysis of Data

Performance on the BPT produced a mean score of 26.323 repetitions with a standard deviation of 12.360. Performance on the MOD BPT yielded a mean score of 23.750 repetitions with a standard deviation of 10.917.

A t-test value of 1.9883 was extrapolated as necessary to indicate significance at the .05 level with 95 degrees of freedom. A t-test value of 2.800 was calculated from the data and was significant at the .05 level. Statistics pertaining to the t-test analysis have been summarized in Table 2.

Table 2

t-table For Scores

On BPT and MOD BPT

Scorce	Mean	Standard Deviation	df	t
BPT	26.323	12.360	95	2.8000*
MOD BPT	23.750	10.917	95	

* significant at the .05 level, with df = 95

The results of the analysis disclosed that there were significant differences between the scores on the BPT and the MOD BPT. This indicates that the inclusion of a factor to set workload in relation to each individual's body weight does significantly atler the YMCA's BPT.

To further demonstrate the effect of determining workload relative to a subject's body weight in contrast to all subjects performing with an absolute workload of 80 pounds, the scores from both tests were rated in accordance with the YMCA's present fitness rating scale for the BPT. The frequencies and relative percentages of these scores can be found in Table 3.

Table 3

Comparison of Subjects in

Terms of Categorical Placements

Using BPT and MOD BPT

Fitness Ratings (Repetitions)	BPT (n)	Pct. of Subjects In Category	MOD BPT (n)	Pct. of Subjects In Category
Excellent 35-up	22	23	13	14
Good 29-34	13	14	14	15
Above Average 24-28	19	20	28	29
Average 20-23	11	11	8	8
Below Average 15-19	15	16	12	13
Fair 11-14	9	9	7	7
Poor 7-10	7	7	13	14

As can be seen in Table 3, 22 subjects' performances on the BPT were rated excellent, while 13 subjects' performances were rated as excellent on the MOD BPT. Thirteen subjects were rated as good on the BPT, while 14 subjects were rated as good on the MOD BPT. The performances of 19 subjects were rated as above average on the BPT, while the performances of 28 subjects were rated as above average on the MOD BPT. Eleven subjects performed enough repetitions to fall into the average category on the BPT, while 8 subjects performed enough repetitions to fall into the average category on the MOD BPT. Fifteen subjects' performances were rated as below average on the BPT, while 12 subjects were rated as below average on the MOD BPT. Nine subjects fell into the fair category on the BPT, while 7 subjects fell into the fair category on the MOD BPT. Seven subjects were rated as poor on the BPT, while 13 subjects were rated as poor on the MOD BPT.

The subjects who performed in the middle three categories, above average, average, and below average, were not significantly affected by the weight variable included in the MOD BPT. Subjects who fell into the extreme categories, excellent and poor, were significantly affected. This indicated that the MOD BPT tends to distinguish between the extreme performances better than the BPT does, but it does not appear to differentiate scores from the center of the distribution.

For those subjects whose fitness rating on the BPT changed as a result of the weight variable being considered in the MOD BPT, 67 percent changed one or more fitness categories, while 25 percent changed two or more categories. Eleven percent changed three or more categories, while 4 percent changed four or more categories. Data pertaining to the numbers and percentages of the subjects whose performances on the BPT and the MOD BPT were different enough to cause their fitness ratings to change have been summarized in Table 4.

Table 4

Percentages and Numbers of Subjects Changing Fitness Categories From Performance of the BPT to Performance of the MOD BPT.

Number of Categories Changed	Number	Percentage
Changed 1 Category or More	64	67
Changed 2 Categories or More	25	24
Changed 3 Categories or More	11	11
Changed 4 Categories or More	4	4

It appeared that the subjects who represented the extremes in body weight were the ones most significantly affected by the MOD BPT's consideration of body weight. Each subject classified as representing the top 5% of the sample in terms of possessing the highest body weights dropped an average of 3.4 fitness categories. Subjects representing the lightest 5% of the sample increased an average of 3.2 fitness categories. The heaviest subject in the population, 325 pounds, received a rating of above average for his performance on the BPT. When his weight was used to determine the workload for the MOD BPT he received a rating of very poor. The lightest subject in the population, 119 pounds, received a very poor rating on the BPT and a rating of fair on the MOD BPT. It would appear that the advantages experienced by the heavier subjects and the disadvantages experienced by the lighter subjects on the BPT could be greatly reduced by the by the inclusion of a factor which considers weight.

Multiple Regression

A multiple regression was run to determine the efficiency of two variables, BPT scores and body weight, as predictors of performance on the MOD BPT. Results indicated that both BPT scores and body weight are very significant as predictors of performance on the MOD BPT. Scores on the BPT were found to be the single most accurate predictor of performance on the MOD BPT. The standard error of prediction using BPT scores was 7.6800. Multiple correlation (R) between the BPT and the MOD BPT was .818164. By adding body weight as a second index variable it was determined that the standard error could be reduced to 5.0791 and the multiple correlation (R) between the two tests was increased to .8882. Data are summarized in Table 5. By combining BPT scores and body weight, 78% of the variance between the two tests was accounted for (R^2 = .78).

Table 5

Standard Error of Prediction

and Multiple Correlations

	BPT	BPT and Weight
Standard Error	7.6800	5.0691
Multiple Correlation	.818164	.8882

Summary

The results of the t-test showed a significant difference between performance on the BPT and the MOD BPT. Frequencies and percentages were calculated to further demonstrate the difference between performance on the two tests in terms of changes of fitness rating categories. The majority of these changes occurred in subjects at both extremes of body weight. The MOD BPT placed more subjects in the poor category and less in the excellent category than did the BPT. This would indicate that the accuracy of the MOD BPT increases at the extremes of the distribution.

The value of the BPT scores and body weight as predictors on the MOD BPT were analyzed through multiple regression techniques. BPT scores were determined to be the single best predictor. When weight was included, the combination of the two variables accounted for 78% of the variance between the two tests and the standard error was reduced. Since the inclusion of weight as a variable strengthens the predictive value of the BPT, it appears that body weight is an important variable. Since the MOD BPT contains a variable which accounts for body weight, it appears that the MOD BPT is a more accurate test of muscular endurance than the BPT.

Chapter 5

This study was completed to determine whether performance on the YMCA's BPT would be significantly altered by the inclusion of a factor which determined the workload in relation to each individual's body weight. Data were collected and analyzed as previously described in Chapters 3 and 4.

Summary

Review of the literature indicates that reliable tests of muscular endurance should meet these four specifications:

(1) The test should be specific to the training mode, perferably isotonic.

(2) The test should be relative in nature. The workload should be based on an individual's body weight instead of 1-RM.

(3) The speed of work for the test should be regulated.

(4) The motivational stimulation employed to stimulate subjects should be the same for all subjects.

The t-test calculated from the means and standard deviations of the BPT and the MOD BPT indicated a difference between the two tests significant at the .05 level. A multiple regression run to determine the efficiency of BPT scores and body weight as predictors of performance on the MOD BPT indicated that both variables are significant as predictors. BPT scores were found to be the most accurate predictor. The addition of weight strengthened the accuracy of the prediction.

Percentages, calculated as to the numbers and percentages of subjects whose fitness rating on the BPT changed as a result of the weight variable being added in the MOD BPT, indicated that 67% of the subjects changed one or more categories. Twenty-five percent changed two or more categories. Eleven percent changed three or more categories, and 4 percent changed four categories or more. The greatest changes were evident at the extremes (i.e., excellent and poor categories).

Conclusions

The YMCA's BPT meets all of the requirements for a reliable test of muscular endurance with one exception, it is an absolute test. The majority of the training modes used to enhance muscular endurance by the general public are isotonic. The BPT is an isotonic test. Therefore, the BPT is specific to the majority of the training programs used. The BPT is performed to the cadence of a metronome, therefore speed of work is regulated. The type of motivational stimulation used by the tester at a YMCA is usually decided by the test administrator. The tester must be sure to maintain consistency in this area.

The purpose of this study was to determine whether the inclusion of a factor which accounted for body weight, thereby making the test relative, would significantly alter test results. The statistical analysis of this study indicated that the BPT would be significantly altered, for subjects with extreme body weights, high, or low, by the inclusion of the body weight factor.

Suggestions

Because every individual has to deal with his/her own body weight in a variety of circumstances, it would appear that the BPT would be a more accurate test in terms of assessing each individual's muscular endurance needs if a factor were added to determine workload at 50% of an individual's body weight. It is the recommendation of this researcher that the workload for the YMCA's BPT be set at 50% of the body weight of the individual being tested for all college-aged males. The additional time and effort required to implement this change would be minimal and well worth the effort. This alteration in the test's format would eliminate the disadvantages experienced by individuals with lower body weights and the advantages experienced by individuals with heavier body weights. The BPT would be standardized for everyone.

Recommendations for Further Study

On the basis of the results of this study, the following areas are suggested topics for further investigation:

(1) This study investigated the testing of muscular endurance using males as subjects. Because females possess a significantly lower percentage of lean body weight (muscle) in relation to their overall body weight than do males, it is not logical to expect them to be able to handle the same workloads as males. Research pertaining to the optimal percentage of body weight to be used for females for the performance of the BPT would provide

valuable information.

(2) This study investigated the testing of muscular endurance using college-aged males. Because a decrease in lean body weight (muscle) is known to accompany the aging process, it may be necessary to determine workload at a lower percentage of total body weight for older individuals. Further research is necessary to determine if this is the case and what percentages of body weight should be used to determine workload for various age groups. This same line of research needs to be pursued in relation to younger individuals as well.

(3) Because the motivational techniques used to stimulate the performance of the subject is left up to the test administrator, the test may not be the same for all individuals. Research pertaining to the type of motivational stimulus which will most effectively enhance performance of the BPT would be valuable. If a single type of motivational stimulus were included in the test's format, the test would be more standardized for all individuals.

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APPENDIX A

Pilot Study

Pilot Study

The purpose of the pilot study was to ascertain a percentage of body weight to be utilized to determine the workload for the MOD BPT. The intent was to set the workload low enough that the test remained a test of muscular endurance.. If the workload was set to high, the number of repetitions performed by the subjects would have been reduced and the test would have leaned toward being a test of muscular strength.

The two percentages of body weight which were considered were 40% and 50%. Forty subjects randomly selected from the same population that was used for the actual study were used for data collection for the pilot study. Each subject was required to attend two testing sessions scheduled 48 hours apart. These sessions were scheduled during the subject's P.E.100 Lifetime Fitness class periods. During the first testing session half of the subjects performed a modification of the BPT using 40% of their body weight as a workload, while the other half of the subjects performed a modification of the BPT using 50% of their body weight as a workload. During the second testing session each subject performed the modification of the BPT using the other percentage. The testing procedures were identical to those used for the data collection in the actual study.

The data was collected and put into frequency distibutions. The distribution represented by the scores obtained on the test determining workload at 50% of the subject's body weight distributed much more normally than did the scores obtained using 40% of body weight to determine workload. For this reason, 50% of a subject's body weight was chosen to represent workload for the MOD BPT.

APPENDIX B

Informed Consent Form

Informed Consent Form

I, Mike Tudeen, am requesting your participation in a study designed to individualize the Y.M.C.A.'s muscular endurance assessment, the Bench Press Test. The principle objective of this research is to determine whether the information obtained through performance on the Bench Press Test would prove to be more valuable if the test were individualized by the inclusion of a factor which determined the workload in relation to each individual's body weight. The inclusion of such a factor would transform the test from an absolute test in which all individuals used the same workload to a relative test which would supply each individual with information based on his own body weight. Such information would allow for better exercise prescription.

As a subject in the study, your presence will be required at two testing sessions which will be scheduled approximately 48 hours apart. During the first testing session fifty percent of the subjects will be required to perform the Y's Bench Press Test which consists of bench pressing 80 pounds at rhythmical two-second intervals to the point where muscular fatigue prevents the subject from properly performing the exercise. The other fifty percent of the subjects will be required to perform a modification of the Y.M.C.A.'s Bench Press Test which requires the subject to complete the same testing procedures as above but using fifty percent of his individual body weight rather than the standard 80 pounds. At the second testing session, each subject will complete the other test.

The testing sessions will require physical exertion which might induce temporary physical discomfort and possibly muscle soreness in the upper body. A series of both warm up and cool down exercises will be performed by each subject to aid in the reduction of this possibility. The risk of physical harm to you as a subject is minimal. The data gathered will be in terms of the number of repetitions performed by each subject during each of the testing sessions.

Your permission to use the data described above is requested for the purpose of conducting research for a thesis. All data will remain confidential. Results will be presented in a manner which will not allow individual participants to be identified. Mike Tudeen, the primary investigator, will possess the only list matching code numbers to the names of the participants. If you have any further questions in reference to this research study, please contact Mike Tudeen at 343-1200 ext.354, or at home, 343-2185.

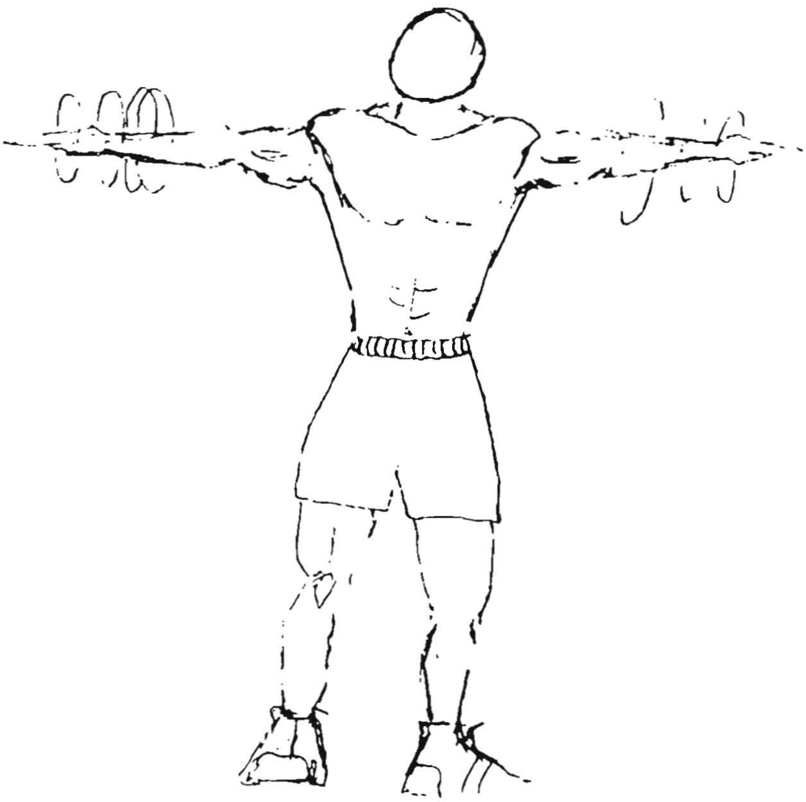
"I have read the above statements and have been fully advised of the procedures to be used in this project. I have been given sufficient opportunity to ask any questions I had concerning the procedures and possible risk involved. I understand the potential risks involved and I assume them voluntarily. I likewise understand that I can withdraw from the study at any time without being subject to reproach.

____________________	____________________
Date	Subject

APPENDIX C

Warm-up and Cool-down Exercises

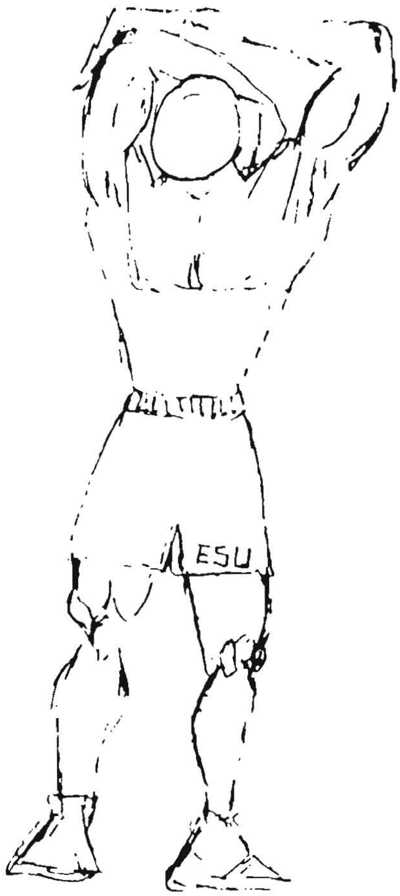
ARM CIRCLES



Sets: One

Ten Foward, Ten Backward

ELBOW PULLS



Sets: Three on each arm

Hold each stretch for 10 seconds

JOG IN PLACE

Sets: One

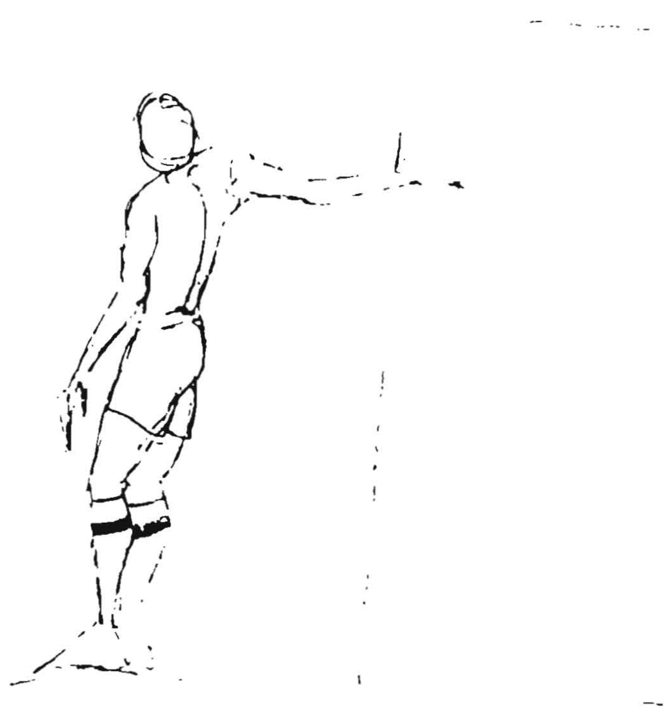
30 Seconds

SHOULDER STRETCH

Sets: Three on each side

Hold each stretch for ten seconds

WALL STRETCH



Sets: Three on each side

Hold each stretch for 10 seconds

LATERAL BENDS

Sets: Three on each side

Hold each stretch for 10 seconds

JUMPING JACKS

Sets: One

25 Jumping Jacks

SITTING TWIST

Sets: Two on each side

Hold each set for 10 seconds

TRUNK ROTATORS

Sets: One

5 repetitions in each direction

Data Recording Sheet

Subject's Code #______

Bench Press Test

Number of Repetitions Performed ________

YMCA Muscular Endurance Fitness Rating ________

Number of Hours of Sleep ________

Injury/Illness in the Last 48 Hours ________

Level of Activity 3 Hours Prior to Testing Session

1 - Sedentary

2 - Light Exercise, Walking, e

3 - Mild Workout, Less than 1

4 - Vigorous Workout, 1 hr. or More.

Modified Bench Press Test

Subject's Body Weight ________

Workload ________

Number of Repetitions Performed ________

YMCA Muscular Endurance Fitness Rating ________

Number of Hours of Sleep ________

Injury/Illness in the Last 48 Hours ________

Level of Activity 3 Hours Prior to Testing Session

1 - Sedentary

2 - Light Exercise, Walking, e

3 - Mild Workout, Less that 1

4 - Vigorous Workout, 1 hr. or More