

NORMS AND PERCENTILE RANKINGS OF HEALTH-RELATED FITNESS
FOR FITNESS MAJORS
AT THE UNIVERSITY OF WISCONSIN - LA CROSSE

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University of Wisconsin - La Crosse

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by
Douglas Kent Carlyle
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ABSTRACT

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This study evaluated four health-related fitness components: cardiovascular endurance, flexibility, muscular endurance, and body composition. Data were collected on a varied number of subjects for each test. The subjects were enrolled in entry level fitness classes at the University of Wisconsin - La Crosse and consisted of 132 males and 107 females between the ages of 18 and 25 years. Each subject was evaluated for cardiovascular endurance with a 1.5 mile and 3 mile run. Flexibility was measured through the sit and reach test. Muscular endurance was tested with the modified curl up and bench press tests. The final component, body composition, was evaluated by hydrostatic weighing and anthropometric measurements. Means and standard deviations were calculated for each test. Norms and percentile rankings were then established using z-scores. A Pearson product moment correlation was used to determine which anthropometric measurements had the highest correlation with hydrostatic weight. A multiple regression was then used to determine which anthropometric measurements were the best predictors of hydrostatic weight.

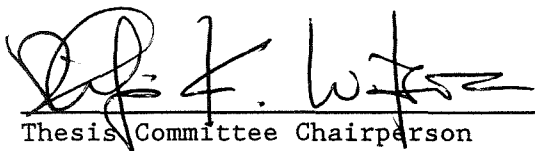
UNIVERSITY OF WISCONSIN - LA CROSSE
College of Health, Physical Education and Recreation
La Crosse, Wisconsin 54601

Candidate: Douglas Kent Carlyle

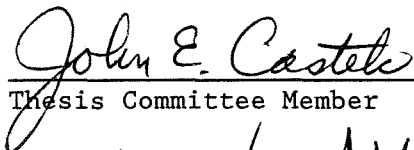
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Thesis Committee Chairperson

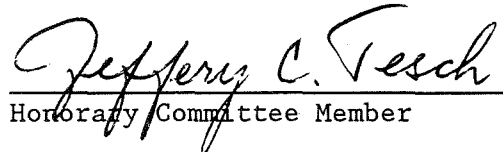
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Thesis Committee Member

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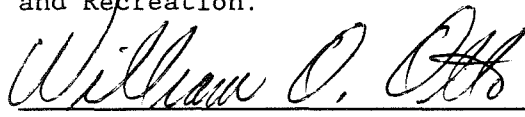

Thesis Committee Member

28 June 1989
Date


Honorary Committee Member

June 28, 1989
Date

This thesis is approved for the College of Health, Physical Education
and Recreation.


Dean, College of Health, Physical
Education and Recreation

6/29/1989
Date


Dean of Graduate Studies

30 June 1989
Date

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DEDICATION

I would like to dedicate my Master of Science Degree in Adult Fitness/Cardiac Rehabilitation and thesis to my grandmother, Mickey Davis, who died at an early age due to heart problems. Though I haven't seen you for many years I know you have been watching me grow and accomplish my goals.

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CHAPTER I

INTRODUCTION

Throughout history physical fitness has played various roles in American society (Pate, 1983; & Oxendine, 1985). Many of the current fitness trends have had their origins in the schools and the military (Oxendine, 1985). The most recent era of health and fitness evolved from a physical education program established by Edward Hitchcock at Amherst College in Massachusetts more than a century ago (Oxendine, 1985).

By the turn of the century thirteen colleges and universities had established physical education programs (Considine, 1985). Following World Wars I and II and again after the Korean War brief flurries of increased emphasis was placed on these physical education programs. During these wars many young men were deemed unacceptable for military service due to health-related problems (Oxendine, 1985). The origins of many of these problems were traced to a lack of physical fitness (Stone, 1987). However, over time the importance placed on physical fitness slowly diminished.

The current fitness boom of the 70's and 80's has lasted too long to be viewed as another health fad. It has become a lifestyle change for many Americans and it appears that it will continue to influence the lives of many more. Only in recent years has the link between physical fitness and the prevention of certain diseases been effectively documented (Pate, 1983). A shift in emphasis from motor fitness to a

narrower concept of health-related fitness has occurred (Pate, 1983). Health-related fitness includes only those fitness components that promote health or that can help prevent disease (Pate, 1983).

Statement of the Problem

The purpose of this study was to establish norms and percentile rankings of four health-related fitness components for fitness majors at the University of Wisconsin - La Crosse. By utilizing a set of field tests and one laboratory test, health-related fitness was evaluated. These tests included protocols to evaluate cardiovascular endurance, flexibility, muscular endurance, and body composition. Body composition was measured by two methods, hydrostatic weighing and anthropometric measurements. A comparison of these two methods was used to determine the most reliable set of anthropometric measurements to be used in predicting percent body fat. Based on the data collected from nine entry level fitness classes during the school year of 1988-89, norms and percentile rankings were determined. Each student received a computer print out with raw scores and percentile rankings of six health-related fitness tests, resting heart rate, and blood pressure (see Appendix A).

Delimitations

The delimitations for this study were:

1. The subjects for this study were limited to those students between the ages of 18 to 25 years and enrolled in entry level fitness classes for prospective fitness majors during the 1988-89 school year.
2. Though these classes were designed to be taken during the

freshman year, many students were sophomores, juniors, and seniors.

Limitations

The limitations for this study were:

1. All of the data collected were used to establish the norms and percentile rankings regardless of whether or not the students were freshmen.

2. Not all of the information was gathered on each individual due to injuries and sickness.

Assumptions

The assumptions for this study were:

1. It was assumed that all the subjects gave maximum effort on the field tests.

2. It was assumed that the class instructors followed the testing procedures in administering each test (see Appendix B).

3. It was assumed that the subjects fasted for at least twelve hours prior to each hydrostatic weighing.

Definition of Terms

The definition of terms for this study were:

Blood Pressure - Pressure that the blood exerts against the inner wall of the arteries (Prentice & Bucher, 1988).

Body Composition - The percentage of total body weight composed of lean tissue vs the percentage of total body weight composed of fat (Prentice & Bucher, 1988).

Cardiovascular Endurance - Ability of the heart, lungs, and blood vessels to deliver adequate amounts of oxygen and nutrients to the cells to meet the demands of prolonged physical activity (Hoeger, 1986).

Entry Level Class - Class designed to be taken either first or second semester during the freshman year.

Field Test - A test administered in a non-laboratory environment which is designed to measure a specific component of fitness. The test may be given to just one person or to a large group.

Flexibility - The capacity to move a limb or body throughout its range of motion (Liemohn, 1988).

Health-Related Fitness - The components of fitness that develop qualities necessary to function efficiently and maintain a healthy lifestyle. These include muscular endurance, cardiovascular endurance, flexibility, and body composition (Prentice & Bucher, 1988).

Muscular Endurance - The ability to exert force during a repeated series of submaximal efforts (Burke, 1977).

Raw Scores - The absolute values attained on fitness tests, resting heart rate, and blood pressure.

Resting Heart Rate - Heart rate taken by palpation of the carotid or radial arteries for one full minute before getting out of bed in the morning.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

Physical fitness has been an influence on American society for many years (Considine, 1985). The establishment of physical education programs in colleges and universities more than a century ago is credited for the evolution of the most recent era of health and fitness (Oxendine, 1985). Only in recent years has the link between physical fitness and the prevention of certain diseases been effectively documented. An emphasis has been placed on health-related fitness, which includes only those fitness components that promote health or help prevent disease (Pate, 1983). As a result, this modern era of fitness has become a lifestyle change for many individuals and has created diverse professional opportunities for physical educators.

For the purpose of this study, the review of literature includes a discussion of the following topics: fitness standards of physical educators, screening of professionally prepared fitness majors, age and physical performance, and physical fitness components. The physical fitness components are divided into related research and related tests.

Fitness Standards of Physical Educators

The fitness level of physical educators is very important. In a wellness program designed for the workplace, the goals of the physical

educator are simply to motivate and educate the employees toward a more healthy lifestyle (Shields, 1984). To accomplish this the physical educator must lead through a continuous example of personal fitness and well-being (Misner, 1984). This behavioral example has a stronger modeling effect than verbal communication (Westcott, 1979). The physical educator can not escape the responsibility of being a role model for fitness and an active lifestyle (Johnson, 1985). If the physical educator is overweight or poorly conditioned he/she can not expect to be taken seriously when giving health and fitness advice.

A study by Melville and Maddalozzo (in press) used two 20-minute videotapes. Each tape was made identical in content. In each tape a teacher explained and demonstrated information about flexibility and weight control. The only difference between the two tapes was the appearance of the teachers. In one tape the teacher's body dimensions were altered with a "fat suit". Each tape was shown to high school gym classes. One tape was viewed by 423 students while 427 students viewed the other tape. After viewing the tapes, the students were immediately given an examination and questionnaire. Those students who viewed the seemingly fat instructor scored much lower on the 13 question examination. They missed an average of two questions more than the students viewing the tape of the seemingly fit instructor. When scoring the questionnaire, using the Likert scale, the fat instructor was lower on likability and expertise. The influence of the instructor in improving the student's health habits was also lower in the videotape with the fat teacher. These results are in agreement with others

(Johnson, 1985; Misner, 1984; & Westcott, 1979) of the responsibility the physical educator has on being a positive role model.

The health and fitness habits of physical educators has been the topic of several recent studies. As a result of observations of smoking, caffeine intake, and obesity at the national Health, Physical Education, Recreation, and Dance (HPERD) meetings, a questionnaire was developed to assess if physical educators "practice what they preach". Karper and Dignan (1983) studied the exercise habits of 329 men and 218 women physical education professionals. The results of the questionnaire showed that 85% of the men and 78% of the women exercise at least three times per week. Each exercise session was a minimum of 30 minutes for 85% of the men and 71% of the women. This indicates that physical education professionals do "practice what they preach". However, the researchers pointed out that because only 51% of the questionnaires were returned these findings may not be a true representation of the population.

In a 1988 study Clark, Blair, and Culan addressed the lifestyle characteristics of health and physical educators. A sample of health and physical educators, representing a midwestern state, was sent a questionnaire which included questions on personal health and fitness habits and health and fitness knowledge. Of the questionnaires completed and returned, 117 of the subjects were men and 148 were women. The results of the survey indicated that health and physical educators have a high regard for positive lifestyle habits and good health practices. They consistently demonstrated participation in physical

activities on a regular basis and knowledge of health and fitness concepts.

In another survey of physical educators, Brandon and Evans (1988) distributed 100 questionnaires. Sixty of these questionnaires were completed and returned. These questionnaires contained twenty-five questions on personal health habits, personal exercise habits, and perception of personal fitness levels. Eighty-five percent of the subjects reported regular physical activity, with 77% exercising at least 3 times per week for 20 minutes or more. Sixty-six percent considered themselves to be in good physical condition. Of these 60 subjects, twenty were randomly selected and measured for physical fitness. The results of the body composition tests showed the percentage of fat was above the average values of 12% to 15% for men and 22% to 25% for women. The females did score in the "good" or "high" category for cardiovascular endurance but the males scored poorly. The subjects were not as fit as they thought. These results demonstrate the value of using surveys in determining health and fitness habits of physical educators but also the problems in assessing personal fitness levels.

Screening of Professionally Prepared Fitness Majors

The current fitness boom of the 70's and 80's has led to an increased number of health and fitness majors. Some schools have emphasized the importance of maintaining a proper level of fitness through required courses and fitness testing. A significant factor in being hired as a fitness specialist, in a competitive market, seems to

be the ability to "sell oneself" by a fit physical appearance (Nelson, 1984).

Oral Roberts University requires all students, not just physical education majors, to enroll in and pass a physical education activity course each semester. In addition, each student is required to participate in an individual aerobics program as part of the activity curriculum. In the 1976-77 school year, these university requirements resulted in 95% of men and 65% of women scoring in either "good" or "excellent" cardiovascular condition according to Cooper's standards for the 1.5 mile run (Brynteson, 1978).

In a 1988 study, Melville and Cardinal reported one university required minimum fitness standards to be met before a candidate is accepted for graduation. During the final semester of enrollment, Brigham Young University requires all physical education majors to complete Cooper's 1.5 mile run and an assessment of body fat using skinfold calipers. The students must score at least in the "good" category for the run and maintain percent body fat below 15% and 22% for men and women respectively (Brigham Young University, 1985).

In the same study, Melville and Cardinal (1988) reported that Eastern Washington University is implementing a proposal which would require all physical education majors to take part in physical fitness testing prior to admittance into a physical education degree program. During an interview prior to acceptance, if the student is below the norm in any variable tested, the department chairman will discuss the importance of being a role model for physical fitness. The student is then given one year to correct the fitness deficiencies.

Age and Physical Performance

There are many changes that occur in the aging process that effect physical performance. Some studies have shown that these changes decrease muscular strength, muscular endurance, and cardiovascular endurance (Astrand, Astrand, Hallback, & Kilbom, 1973; Astrand, 1968; Burke, Tuttle, Thompson, Janney, & Weber, 1953; Dehn, & Bruce, 1972). Smith and Serfass (1981) stated that, with age, skeletal muscles decrease in strength, both isometric and dynamic, and decrease to a lesser extent in speed of movement.

In a 1953 study, Burke et al. tested grip strength and grip strength endurance in a group of 311 normal males ranging in age from 12 to 79 years. A maximal effort using a hand dynamometer was used to evaluate grip strength. The average strength for a period of one minute was used to evaluate grip strength endurance. The age group intervals were 4 years up to age 20. After age 20 the group intervals were 5 years. The study found a rapid increase in both grip strength and grip strength endurance up to 25 years. This rapid increase was then followed by a gradual decrease after age 25.

Other studies have evaluated cardiovascular endurance and age. Astrand et al. (1973) studied reduction in maximal oxygen uptake with age. In 1949, 35 female and 31 male subjects performed submaximal and maximal exercise on bicycle ergometers. All the subjects were well trained and between the ages of 20 and 33. Twenty years later the subjects were re-tested. Most of the subjects were active during the 20 year period between tests. The results of the second test showed a decrease

in maximal oxygen uptake by approximately 20 percent. There were no exceptions to this decrease in maximal oxygen uptake.

Dehn and Bruce (1972), however, found that this decrease in maximal oxygen uptake with age may be slowed. In an eight year longitudinal study, the researchers obtained maximal oxygen uptake data on 40 men ranging in age from 40 to 72 years. The men were classified according to weekly activity levels. Those classified as active engaged in regular running activity more than once per week. Those that lacked regular weekly participation in running activity were classified as inactive. The results of the study showed annual decline in habitually inactive men greater than in habitually active men.

In 1968 Astrand studied 350 individuals ranging in age from 4 to 65 years. The results of the study showed that both men and women have peak maximal aerobic power at 18 to 20 years of age. However, athletes between 25 to 30 years of age usually obtain the best performances in endurance events. This may be explained by the type of activities individuals engage in after age 20. Generally, physical activity is more regular and vigorous for those less than 20 years old. If training is continued, the maximal aerobic power can be maintained or increased for another ten years.

Physical Fitness Components

Physical fitness may be defined in many different ways. An individual may be considered physically fit when he/she can meet the ordinary demands, as well as any unusual demands, of daily life safely and effectively without being overly fatigued, and still have enough

energy for leisure and recreational activities (Hoeger, 1986). This definition of fitness places an emphasis on health-related fitness rather than motor fitness.

In 1961, when the first American Alliance for Health, Physical Education and Recreation (AAHPER) Youth Physical Fitness Manual was published, it contained the following seven items to evaluate physical fitness; 50-yard dash, shuttle run, standing broad jump, pull ups, 600-yard run and softball throw. These seven items test qualities that may be desirable for sport activities where speed, power, and agility are necessary. They emphasize motor fitness and not the components involved in health-related fitness (Falls, Ismail, & Macleod, 1966). Slowly a shift in emphasis has moved away from the more traditional motor fitness toward the evaluation of health-related fitness.

After a five year process, the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) Board of Governors in a 1979 meeting gave final approval to the AAHPERD Health Related Physical Fitness Test. This test refers to those aspects of physiological and psychological functioning which are believed to offer protection against "hypokinetic diseases". These degenerative type of diseases such as coronary heart disease (CHD), obesity, and various musculo-skeletal disorders are often associated with low levels of energy expenditure common to a sedentary lifestyle. The four modern components of physical fitness are cardiovascular endurance, flexibility, muscular endurance, and body composition (Falls, 1980).

The most accurate way to assess physical fitness is in a well equipped laboratory. However, in most settings which involve a large

number of people laboratory assessment is not feasible. As a result field tests have been developed. Measurements obtained from field tests should correlate well with measurements obtained in a laboratory (Cooper, 1969). The field tests used for the AAHPERD health-related physical fitness tests are the 1.5 mile run, sit and reach, modified sit ups and skinfold measurements.

Cardiovascular Endurance

Of the four modern components of physical fitness, cardiovascular endurance is considered the most important. According to many cardiologists, physiologists, and other health professionals, physical activity at sufficient levels can aid in preventing circulatory disease or reducing its effect if it does occur (Falls, 1980). This may be the major reason that great importance is placed on cardiovascular function in evaluating health-related fitness (Cooper, 1969; & Falls, 1980).

Related Research. During the last few years, the belief that physical exercise has a protective effect on the development of CHD has gained support. No longer can one justify an inactive lifestyle because of the lack of inconclusive evidence. Changes in plasma lipoproteins that are now thought to be associated with a low risk of CHD have been abundantly documented (Dufaux, Assmann, & Hollmann, 1982; & Morgan, Cruise, Girardin, Lutz-Schneider, Morgan, & Qi, 1986). After a period of physical conditioning, untrained subjects as well as endurance-trained athletes have shown positive changes in plasma lipoprotein levels (Dufaux, et al., 1982).

Cooper, Pollock, Martin, White, Linnerud, and Jackson (1976) studied the relationship of cardiovascular endurance and CHD. Nearly

3,000 men had a sample of blood drawn and analyzed for serum cholesterol and triglycerides, glucose, and uric acid. In addition each subject was underwater weighed to determine percent body fat and given a maximal treadmill stress test (MTST). Just prior to the MTST resting heart rates and blood pressures were taken and recorded. The results of the data showed a direct inverse relationship between those variables associated with a higher CHD risk and levels of cardiovascular endurance. This strongly supports the hypothesis that a higher level of fitness appears to offer a protection from CHD.

Blair, Falls, and Pate (1983) stated that a more favorable lipoprotein profile is not caused by a high level of cardiovascular function, but a high level of cardiovascular function is a good indicator of one's exercise habits. This regular, dynamic, vigorous, large-muscle activity brings about positive changes in both cardiorespiratory function and lipoprotein profile.

In review of epidemiologic evidence of exercise and heart disease, Eichner (1983) found that the majority of evidence supports the view that a lower risk of coronary disease is associated with those who are vigorously active when compared to their sedentary counterparts. However, preventing coronary atherosclerosis from progressing cannot be guaranteed through vigorous exercise.

Many studies have researched the physical activity levels involved in different occupations with respect to CHD. In one of the first studies, Taylor, Klepetar, Keys, Parlin, Blackburn, and Puchner (1962) studied various railroad employees. The employees worked as clerks, switchmen or section men. After age-adjusted rates, it was found that

the clerks had the highest risk for developing CHD with 5.7 per 1,000. The second highest at risk were the switchmen at 3.9 per 1,000. The section men had the lowest risk at 2.8 per 1,000.

In a similar study, Kahn (1963) looked at 2,240 post office carriers and clerks. He found that post office clerks had 1.4 to 1.9 times higher risk for CHD than post office carriers. The results also suggested that the current physical activity level may be more closely associated with a higher risk of developing CHD than the persons lifetime "average" for physical activity.

Similar results of earlier studies by Taylor et al. (1962) and Kahn (1963) were found in a 16 year study following 3,263 longshoremen. Men who were physically more active sustained lower death rates from coronary heart disease than their less active co workers. Those workers who expended nearly 1000 calories more per day had a one quarter lower death rate from CHD than the more sedentary workers. The differences continued to be apparent even when patterns of cigarette smoking, blood-pressure level, and weight for height were taken into consideration (Paffenbarger, Laughlin, Gima, & Black, 1970).

In a second study involving 6,351 longshoremen, Paffenbarger and Hale (1975) researched the energy required per job and corresponding death rates from CHD. The jobs performed by the longshoremen were classified as high, moderate, or light work according to the energy output required. After following the men for 22 years or to death, the results showed a protective "threshold" for CHD. The coronary death rates were 49.0, 46.3, and 26.9 per 10,000 work years for light, moderate, and high work respectively. The "threshold" was especially

seen in the sudden death syndrome where death rates were 15.5, 19.9, and 5.6 per 10,000 work years for light, moderate, and high work.

In a study by Epstein, Miller, Stitt, and Morris (1976) a sample of 509 middle-aged male executive grade civil service officers were selected from approximately 17,000 men that recorded their leisure time activities for each Friday and Saturday for a two year period. All of these men engaged in sedentary or very light work. The sample of 509 men were further examined with a resting electrocardiogram, skinfold thickness, blood pressure, height and weight, and plasma total cholesterol. About 25% of these men reported vigorous exercise in leisure time activities. As a group they had significantly fewer electrocardiographic abnormalities than the other 75% not reporting vigorous exercise. Even when those that had any history suggestive of cardiovascular disease were excluded from the analysis the difference remained. Both vigorous exercise and electrocardiogram abnormalities were examined in relation to blood pressure, smoking habits, and plasma total cholesterol. The only relationship found with an increase in electrocardiogram abnormalities was an increase in blood pressure. Even in the subjects with higher blood pressures, those that reported vigorous exercise had fewer electrocardiogram abnormalities than those who did not report vigorous exercise.

Related Tests. Many field tests have been developed to indirectly measure maximal oxygen consumption in evaluating cardiovascular fitness. In 1966, Falls et al., investigated the validity of predicting maximal oxygen uptake (max VO_2) in adult subjects using items from the AAHPER Youth Fitness Test. The subjects were 87 male staff and faculty members

between the ages of 23 and 58 years at Purdue University. By collecting data on pull ups, standing broad jump, sit ups, 50-yd dash, 600-yd run-walk, and shuttle run the researchers found that it would be possible to estimate max VO_2 using only four of the test items - pull ups, 50-yd dash, shuttle run, and 600-yd run-walk - with the 600-yd run-walk as the best single indicator. Since max VO_2 is such an important component of physical fitness this study helped validate the Youth Fitness Test.

Willgoose, Askew, and Askew (1961) studied the reliability of the 600-yd run-walk with a sample of junior high school eighth graders. The sample consisted of 76 girls and 70 boys. After proper instructions, approximately 15 subjects ran the 600-yd run-walk at the same time. A week later the test was repeated. The results showed a high degree of reliability for both the girls (.92) and the boys (.92).

In a 1966 follow-up study on the 600-yd run-walk test, Askew studied 46 girls and 71 boys during the 11th grade. All subjects performed the field test two different times. Eighty-five percent of the students, while in junior high school, participated in an earlier study using the 600-yd run-walk (Willgoose et al., 1961). The results of this study demonstrated that personal motivation at the senior high school level decreased the reliability of the test. More teacher stimulation is required with the senior high school students than with the junior high school students.

Doolittle and Bigbee (1968) evaluated the 12 minute run-walk test as an indicator of cardiovascular fitness and compared it with the 600-yd run-walk test. All 153 subjects were ninth grade boys. The subjects completed two 12 minute run-walk tests, a 600 yard run-walk test, and a

maximum oxygen uptake test. The results of the study indicated that the 12 minute run-walk test is a highly reliable and valid indicator of cardiovascular fitness and is more valid than the 600 yard run-walk test.

These cardiovascular field tests rely heavily on subject motivation. In 1957, Ulrich and Burke studied the effects of two types of motivation on work output and cardiorespiratory functions as well as possible relationships in sex differences. The subjects were given three trials of pedalling a bicycle for one minute in which they were to produce as many revolutions as possible. The first trial was called the "base trial". On the second and third trials the subjects heard a buzzer ring periodically if the work was less than the base trial and a bell ring periodically if the work exceeded the records established on the base trial. Unknown to the subjects, the ringing of the bell and buzzer were predetermined before the tests. The results showed that the bell-motivated and the buzzer-motivated tests elicited greater work output from the subjects, with the accompanying changes in cardiorespiratory function in comparison to the base condition. Also, sex differences were not found to significantly influence the results.

Flexibility

The importance of flexibility as a health-related component of fitness is often overlooked. Many injuries and muscular skeletal problems in the adult population are related to a lack of flexibility.

In our society today, industry spends billions of dollars in lost work and productivity as a result of absenteeism due to low back pain. In addition millions more are spent in workmen's compensation (Hoeger,

1986). This major health problem ranks second, only to headaches, as the most frequently complained about pain (Stone, 1987). In the United States alone, approximately 80% of all cases involving low back problems are a direct result of an imbalance between flexibility and strength of the trunk and hamstring muscles (Hoeger, 1986).

Related Research. Research has shown that the maintenance of minimal levels of trunk and hip flexibility and muscular endurance is important in reducing many of the problems. In 1954, Kraus and Hirschland reported that over 1,000 patients with low back pain were examined by a team of specialists and found to be free from organic disease. Approximately 80% of these patients failed one or more of the six tests designed to measure strength of the trunk muscles and flexibility of the hamstring and trunk muscles. When treated with therapeutic exercises they improved their test results. In an 8-year follow-up, those patients that stopped exercising complained of reappearing back problems and failed their tests. The relief of pain ran parallel with the strength and flexibility of the involved muscles.

Many physical therapists, physical fitness proponents, and orthopedic surgeons agree with the study by Kraus and Hirschland (1954) that the high incidence of low back pain is linked to a lack of exercise (Plowman & Falls, 1978). Little or no exercise often results in an abnormal arch in the lower back caused by weak abdominal muscles which allow the pelvis to tilt forward (Falls, 1980; Hoeger, 1986; & Vincent & Britten, 1980). Accompanying the weakened abdominals is a decrease in trunk and hamstring muscle elasticity. These inflexible muscles result in decreased movement and increased possibilities of strain and pain.

Related Tests. Due to the widespread health-related problem of low back pain, the AAHPER Youth Fitness Test includes an evaluation of low back and hamstring flexibility (Pate, 1983). To accurately measure flexibility or the range of motion a joint possesses is difficult. There have been various devices that have been developed. Of these devices, the goniometer is the simplest to use. However, using a goniometer is not practical to assess the hamstring flexibility of a large group. Therefore the sit and reach test was developed for this purpose (Prentice & Bucher, 1988). This test is used by AAHPER and most others in evaluating both low back and hamstring muscle flexibility.

To administer the sit and reach test the person who is being evaluated assumes a sitting position on the floor with legs extended straight in front and back of legs pressed firmly against the floor. The heels, with shoes off, should be about six inches apart and touching the near edge of a line that is at a right angle with the legs. A yardstick is placed between the legs with the 15 inch mark resting on the near edge of the heel line. With fingers extended and one hand on top of the other the person slowly reaches toward the yardstick as far as possible. This position must be held for one second (AAHPERD, 1980; Allsen, Harrison, & Vance, 1984).

In evaluating the effectiveness of the sit and reach test, Jackson and Baker (1986) investigated the relationship of the sit and reach test to criterion measures of hamstring and low back flexibility. They administered the sit and reach test using the procedures in the AAHPERD Health Related Fitness Manual (1980). To evaluate hamstring flexibility a maximum passive straight leg raise was used while a Leighton

Flexometer was attached to the leg. The degrees of the range of motion were recorded for the flexibility of the involved joint and musculature.

The results showed that the sit and reach test was significantly related to both hamstring flexibility and lower back flexibility. A multiple regression placed hamstring flexibility as a significant predictor of the sit and reach but the low back measure did not significantly add to the predicted variance. The sit and reach test could be used as an acceptable measure of hamstring flexibility but not as a measure of low back flexibility.

Muscular Endurance

Although it is easy to understand the need for strength in sports, strength is also very important to general health. The development of muscular strength and endurance is a major component of health-related fitness. For normal healthy living, maintenance of at least a normal level of strength in a given muscle or muscle group is needed. Although muscular strength and endurance are closely related, most individuals should emphasize the development of muscular endurance, since muscular endurance is probably more critical in carrying out everyday activities (Prentice & Bucher, 1988).

Related Research. Studies have shown that the same methods can be used in evaluating muscular strength and endurance for males and females both young and old. In 1986, Brown and Harrison studied the effects of a strength training program on the rate of strength gains in both young and mature women. The young women ranged in age from 17 to 26 years and the mature women were between 40 and 49 years. The results showed that participation in a strength training program was effective in increasing

strength in both groups and the strength gain was similar for the young and mature women.

O'Shea and Wegner (1981) using the bench press and full squat documented the response of both men and women to an intense seven week power lifting program. At the conclusion of the study the results indicated that the women had the same physiological ability to tolerate and adapt to the demanding physical stress of power lifting as the men.

Related Tests. In addition to flexibility of the trunk and hamstring muscles, muscular endurance of the abdominals is critical in protecting against low back pain (Falls, 1980; Hoeger, 1986; Kraus & Hirschland, 1954; Plowman & Falls, 1978; & Vincent & Britten, 1980). To evaluate the endurance of these muscles, various tests have been used. The most common is the conventional sit up.

By performing a sit up while in the bent-knee position there is a widespread misconception that the action of the hip flexor muscles is minimized or eliminated and the abdominal muscles are isolated (Kendall, 1965). This is not the case. The hip flexor action can not be eliminated when the action of the sit up is performed past the initial trunk flexion phase of the movement.

In addition, whether or not the feet are held down while performing a sit up determines to a large extent the degree to which the strength of the abdominal muscles are being tested. Those that have weak abdominal muscles can have the weakness covered up by holding the feet during the sit up. If using the conventional sit up to evaluate abdominal muscular endurance, the tester should avoid holding the feet during the initial phase of trunk flexion (Kendall, 1965).

In 1982, Kelley also evaluated the muscular action involved in the sit up. His findings were in agreement with previous studies. The completion of the sit up is not required if the primary objective is to mildly strengthen the rectus abdominis (RA). While in the supine position simply lifting the head off of the floor will elicit a contraction of the RA. By continuing to curl the trunk upward to a held position additional activity of the abdominal muscles is elicited.

In 1980, Vincent and Britten gave three reasons why the bent knee sit up is unacceptable. First, approximately 20 to 30 degrees of trunk flexion during the initial movement is a result of the abdominal muscles. The hip flexors accomplish the rest of the movement. Second, most normal activities are sufficient for the development of the hip flexor muscles and further strengthening is usually not necessary. Further strengthening may result in an imbalance between the abdominal and hip flexor muscles. Third, in the bent knee position the hip flexors are required to contract while in an already shortened position. Without specific stretching of the hip flexors, an adaptive shortening of the muscles will occur over a long period of time and will add to an anterior pelvic tilt. These are three reasons the curl up has been devised as an acceptable substitute. However, the curl up test was not a reliable measure of muscular endurance of the abdominals. Still the authors feel that the curl up is superior in developing muscular endurance of the abdominals compared to the bent knee sit up. The bent knee sit up may be used occasionally as an acceptable testing instrument, but for daily or regular development of the abdominal muscles the curl up appears to be the better exercise.

In 1971, with the use of electromyography (EMG), Gutin and Lipetz studied the intensity of contraction in the rectus abdominis (RA) during 10 abdominal exercises. The muscle action potentials (MAP's) were recorded for the upper and lower RA. Both intensities of exercises were combined and averaged before being ranked. The rankings demonstrated that the conventional sit up was eighth out of ten tests, while the curl up test finished one place higher at seventh. This is in agreement with Vincent and Britten's (1980) suggestion that the curl up is superior to the conventional bent knee sit up in developing abdominal muscle endurance.

Though earlier studies found the curl up test unreliable in measuring abdominal muscle endurance (Vincent & Britten, 1980), Robertson and Macnusdottir (1987) evaluated and compared the modified curl up test (CUT) as an alternative to the modified sit up test (SUT). They found a low degree of association between CUT and SUT. The more specific muscular demands on the abdominals in the absence of the hip flexor involvement in CUT is one suggested reason for the low association. A second reason may be accounted for in differences in the angular displacement of the trunk required for both tests. The evidence presented suggests when evaluating abdominal muscular endurance for healthy adults, the CUT may provide a more sensitive test than the SUT.

In testing muscular endurance of the upper body, pull ups, flexed arm hang, push ups, and bench press are often used. With the exception of the bench press, the resistance being applied during the test is the person's body weight. When using the bench press to evaluate muscular strength and endurance a resistance must be added.

In 1962, Berger suggested that the one repetition maximum (1 RM) serves as a criterion of isotonic strength. This suggestion is in agreement with others such as Wilmore (1977). Berger devised a stepwise procedure for determining 1 RM values. First, the subject predicts a maximum strength level and then completes a repetition at a weight near this level. After each successful repetition, the resistance is increased by a standard amount and another repetition is attempted. A minimum of three minutes rest should be allowed between trials. This process continues until the subject fails an attempted lift. The last successful lift is recorded as the 1 RM weight.

Johnson and Nelson (1979), as well as others (Baumgartner and Jackson, 1982; & Mood, 1980), indicated a problem in evaluating individual differences in strength due to differences in body weight. Comparisons between subjects can not be made using a 1 RM unless individual differences in body weight are taken into consideration. To make comparisons between subjects, strength must be measured in relationship to the individuals body weight. Thus, a 150 pound person may be considered stronger than a 200 pound person even if he/she is unable to lift as much absolute weight as the person weighing 200 pounds.

Two methods of evaluating individual differences in strength while controlling for individual differences in body weight were reviewed (Jackson, 1986). Using these procedures, individual differences in strength can be assessed with greater validity.

Johnson and Nelson (1979), and Mood (1980) reported a method that controls for the difference that occur with respect to body weight while

using a 1 RM. They recommend dividing the 1 RM by the individual's body weight. For example, a person's 1 RM on the bench press is 225 pounds and he/she weighs 160 pounds. The weight adjusted 1 RM would be $225/160$ or 1.40. With this new number individuals can easily be compared.

A second method reported by Baumgartner and Jackson (1982) suggested that through the use of regression equations and residual scores body weight can be statistically controlled and strength comparisons between individuals can be made. The following form is a prediction equation that can be used:

$$1 \text{ RMP} = A + B(\text{body weight})$$

where 1 RMP is a prediction of a 1 repetition maximum, A is a constant and B is a regression coefficient.

The method that is the simplest and easiest to calculate is the first method where the 1 RM is divided by body weight. The second method, using the residual score procedure, is more accurate but also more complicated. Thus, the evaluator may not want to use it for a large group.

Body Composition

One of the most common medical disorders in America today is obesity. It is a state characterized by excess body fat. Bray, Jordan, and Sims (1976) have defined obesity for females as more than 30% of total body weight in the form of fat and more than 25% for males. It has been associated with many common diseases that may enhance morbidity and mortality. A few of these diseases and disorders are CHD, hyperlipidemia, and hypertension. Though an association between these disorders and obesity is easy to indentify, some studies have found a

less clear casual relationship between obesity and health. Still with this association between obesity and these disorders the AAHPERD task force believed strongly in the need to demonstrate the importance of body composition as part of health-related fitness. Even though determining body composition using skinfold calipers requires a trained person, the need for body composition assessment is necessary (Blair et al., 1983).

Related Research. In studying the degree to which obesity effects these disorders, Weinsier, Fuchs, Kay, Triebwasser, and Lancaster (1976) measured the percent body fat of 1,483 USAF male air crewmembers. Blood pressures and serum cholesterol were also measured for each subject. When percent body fat was compared between subjects with probable or overt CHD and subjects free of CHD, average body fat was slightly higher in those with heart disease than those without. Subjects with a greater percent body fat also tended to be more hypertensive and have problems with hyperlipidemia. This suggests that obesity may influence the management of these variables to some degree, though it may be small.

Mann (1974) also found that the part obesity plays in fighting against CHD is either small or nonexistent. He concluded that taking preventive measures against CHD by combating obesity is not a promising approach. This is in agreement with a study of middle-aged men that found obesity as having no independent contribution to the risk of developing CHD (Keys, Aravanis, Blackburn, Van Buchem, Buzina, Djordjevic, Fidanza, Darvonen, Menotti, Puddu, & Taylor, 1972).

These studies have shown the influence obesity has on blood lipids and blood pressure is small or nonexistent. Other studies have found a decrease in percent body fat will often result in a decrease in blood

pressure (Keys et al., 1972), and a positive change in plasma lipoprotein levels (Dufaux et al., 1982).

Maintenance of an acceptable percent body fat throughout life is desirable. Increase in percent body fat often occurs as a consequence of aging. Researchers have tried to determine if this "creeping obesity" is a result of the aging process or due to a decrease in activity later in life.

In a study of fifteen well-trained men from 52 to 56 years, Bjorntorp, Fahlen, Grimby, Gustafsen, Holm, Renstrom, and Schersten (1972) examined the subjects with an adipose tissue composition test. When compared with randomly selected men of the same age and same geographic region, the well-trained men had a tendency for lower body weight. Along with a lower body weight, the body fat mass was significantly smaller. When comparing the adipose tissue between the groups there was no differences in the number of fat cells. The difference was in the size of the cells. The fat cells in the well-trained men were only 1/2 the size of the controls.

In 1974 Oscai, Babirak, Dubach, McGarr, and Spirakis studied male rats for the effects of early life exercise on body composition. The rats were exercised by swimming for a 28 week period. They then remained sedentary for 34 weeks. Swimming in early life caused body weight to plateau below that of sedentary freely eating controls at 62 weeks of age. The difference in body weight was due largely to a difference in the total-body content of fat. These results demonstrate that exercise in early life is effective in significantly reducing the

rate of accumulation of cells in epididymal fat-pads of rats resulting in significant reduction in body fat in later life.

The effect of 15 weeks of regular, vigorous swimming on serum and hepatic cholesterol in rats was studied. The effect of exercise on body composition and the interrelation of body composition and serum and hepatic cholesterol was also investigated. Caloric restriction without exercise was imposed on another group of rats in an effort to produce animals with body composition similar to those subjected to exercise. The calorie-restricted animals were retarded in growth but their body composition on a percentage basis was almost identical to the fed animals who were exercised. It was concluded that exercise was effective in preventing most of the increase in body fatness and serum cholesterol concentrations associated with an increase in age. Neither total nor free cholesterol concentration in the liver was affected by exercise, but the concentration of total hepatic lipids was reduced (Jones, Montoye, Hohanson, Martin, Van Huss, & Cederquist, 1964).

In studying body composition of three male endurance athletes between the ages of 72 to 74 years, Wilmore, Miller, and Pollock (1974) compared the subject's results with younger endurance athletes as well as a normal population sample of equivalent age. The subject's values were below the average values of those of the same age and only slightly higher than the younger endurance athletes. These results would indicate that older men can maintain a body composition similar to the young adult and that "creeping obesity" is not a natural consequence of aging.

It appears that an adult's problem with obesity is strongly related

to activity patterns. After the developmental years a person often becomes less active, expending fewer calories. This creates a caloric intake greater than caloric expenditure. With this imbalance the person slowly begins to gain weight. To fight against this slow weight gain a caloric debt must be created. Through exercise and diet a reduction in body weight and fat will occur by creating this caloric debt. This is based on the fact that an increased number of calories are expended through physical activity and a reduced amount are consumed. This creates a question of the effects of exercise and diet on changes in body composition. Does exercise and diet affect body composition changes any differently?

After equal periods of fasting and of a low calorie, high fat diet gross body composition was compared in 7 obese male subjects. The results showed 64.6% of weight loss while fasting was lean tissue and only 35.4% was adipose tissue. With the high fat diet only 3% of the weight loss was composed of lean tissue. These results suggest that although clinically desirable weight reduction occurs during fasting, it is at the expense of lean tissue which is physiologically undesirable (Benoit, Martin, & Watten, 1965).

Wilmore (1983) evaluated the effectiveness of exercise training on body composition. He found moderate losses in total body weight, moderate to large losses in body fat, and small to moderate increases in lean body weight. The degree of these changes varies directly with the frequency, duration and intensity of the exercise.

Gwinup (1975) studied the effects of exercise, with no dietary restrictions imposed, in obese women. The women progressively increased

periods of walking each day for one year or longer. The results showed no weight loss occurred until the duration of walking exceeded 30 minutes daily. Generally weight loss paralleled length of time spent walking. When weight stabilized at a lower level an increase in weight loss occurred with an increase in walking. A marked change in skinfold measurements in the upper part of the arm suggested that the weight loss was mostly fat.

Blair, Blair, Pate, Howe, Rosenberg, and Parker (1981) examined a working population for interaction of dietary patterns and physical activity on skinfolds. The data collected included sum of skinfolds (SUMSF), a food pattern questionnaire, and a leisure time physical activity (LTPA) questionnaire. The results showed that both men and women dieters had thicker SUMSF. Those that reported more vigorous LTPA were leaner. When looking at the interaction of both LTPA and dieters on skinfolds it appeared that the leaner dieters tended to engage in more vigorous LTPA than fatter dieters.

Related Tests. Hydrostatic weighing is one of the most accurate and widely used methods for assessing body composition in a laboratory setting. This method uses the basic physical principle of Archimedes that states an object placed in a liquid loses an amount of weight equal to the weight of the fluid it displaces (World Encyclopedia, 1988). When a person is totally submerged under water and weighed, the loss of weight in water is equal to the total body volume, corrected for the corresponding water temperature changes and density of water (Behnke & Wilmore, 1974). When using this method, an estimation of residual

volume and gas remaining in the gastrointestinal tract must be made before determining body density.

A second laboratory method is radiographic analysis. This method uses soft tissue x-rays to differentiate between various layers of skin, fat, muscle, and bone. The amount of radiation involved is minute and places no age restriction on its use.

Ultrasound is another indirect method used to determine body composition. Since bone, muscle, and fat have different densities high frequency sound waves can be used to assess body composition. As the sound waves pass into the tissue the change in density results in a portion of the wave being reflected, picked up, and converted to an electrical impulse. The wave is then passed on to a device for recording (Behnke & Wilmore, 1974).

The use of these laboratory techniques in determining body composition is not feasible or practical for the general population. For this reason field tests have been developed involving various anthropometric measurements (Pollock & Jackson, 1977). Based on measurements derived from height, weight, diameters, circumferences, and skinfold thicknesses prediction of body composition can be made through regression equations. Discretion must be used when choosing a body density equation. Research has shown that body density equations are population specific (Pollock, Hickman, Kendrick, Jackson, Linnerude, & Dawson, 1976; & Pollock, Laughridge, Coleman, Linnerud, & Jackson, 1975).

Conclusion

Discussed in the review of literature were the following topics; fitness standards of physical educators, screening of professionally prepared fitness majors, age and physical performance, and physical fitness components. The physical educator can not escape the responsibility of leading through a continuous example of personal fitness. This behavioral example has a stronger modeling effect than verbal communication (Johnson, 1985; Melville & Maddalozzo, 1988; Misner, 1984; Shields, 1984; & Westcott, 1979). Recent studies have found that physical educators do have a high regard for positive lifestyle habits. They consistently demonstrated participation in physical activities on a regular basis and knowledge of health and fitness concepts (Brandon & Evans, 1988; Clark et al., 1988; & Karper & Dignan, 1983).

In preparing students for the workplace, some colleges and universities have emphasized the importance of maintaining a proper level of fitness. Part of the screening process of professionally prepared fitness majors may include required fitness courses and fitness testing (Brigham Young University, 1985; Brynteson, 1978; Melville & Cardinal, 1988; & Nelson, 1984).

There are many changes that occur in the aging process that affect physical performance. Some studies have shown that these changes decrease muscular strength, muscular endurance and cardiovascular endurance (Astrand et al., 1973; Astrand, 1968; Burke et al., 1953; Dehn, & Bruce, 1972; & Smith & Serfass, 1981).

The four modern components of physical fitness are cardiovascular endurance, flexibility, muscular endurance, and body composition (Falls, 1980). Many studies have found that through physical activity at sufficient levels improved cardiovascular function can aid in preventing circulatory disease or reducing its effect if it does occur (Blair et al., 1983; Cooper et al., 1976; Dufaux et al., 1982; Eicher, 1983; Epstein et al., 1976; Falls, 1980; Kahn, 1963; Paffenbarger & Hale, 1975; Paffenbarger et al., 1970; & Taylor et al., 1962). Evaluation of cardiovascular fitness can be indirectly measured through various field tests (Askew, 1966; Doolittle & Bigbee, 1968; Falls et al., 1966; Ulrich & Burke, 1957; & Willgoose et al., 1961).

An often overlooked component of fitness is flexibility. Research has shown that maintenance of minimal levels of trunk and hip flexibility is important in reducing many low back problems (Hoeger, 1986; Kraus & Hirschland, 1954; Plowman & Falls, 1978; Stone, 1987; & Vincent & Britten; 1980). To measure the flexibility of the low back and hamstring muscles the sit and reach test has been widely used. The sit and reach test has been found to be an acceptable measure of hamstring flexibility (AAHPERD, 1980; Allsen et al., 1984; Jackson & Baker, 1986; Pate, 1983; & Prentice & Bucher, 1988).

Maintenance of at least a normal level of strength in a given muscle or muscle group is needed (Prentice & Bucher, 1988). Studies have shown that the same methods can be used in evaluating muscular strength and endurance for males and females both young and old (Brown & Harrison, 1986; & O'Shea & Wegner, 1981). A common method to evaluate muscular endurance of the abdominals is the conventional sit up. A

problem with the sit up is the involvement of the hip flexors may cover up abdominal weaknesses. The modified curl up may be used as an alternative method (Gutin & Lipetz, 1971; Kelley, 1982; Kendall, 1965; Robertson & Macnusdottir, 1987; & Vincent & Britten, 1980). If a resistance is added while testing for muscular endurance adjustment for individual body weight is necessary. This can be done by dividing the weight lifted by the individual's body weight. Prediction equations are also used to adjust for body weight differences so comparisons can be made more accurately and easily (Baumgartner & Jackson, 1982; Berger, 1962; Johnson & Nelson, 1979; & Mood, 1980).

Obesity is one of the most common medical disorders in America today. It has been associated with many diseases. A few of these diseases are coronary heart disease, hyperlipidemia, and hypertension (Keys et al., 1972; Mann, 1974; & Weinsier et al., 1976). Maintenance of an acceptable level of body fat is desirable throughout life (Bray et al., 1976). Studies have shown that "creeping obesity" is not a natural consequence of aging (Bjorntorp et al., 1972; Jones et al., 1964; Oscai et al., 1974; & Wilmore et al., 1974). A combination of exercise and dietary control is the most effective way of maintaining a desirable percentage of body fat (Benoit et al., 1965; Blair et al., 1981; Gwinup, 1975; & Wilmore, 1983). There are various indirect methods of determining percent body fat such as hydrostatic weighing, radiographic analysis, and ultrasound (Behnke & Wilmore, 1974). These techniques are not feasible or practical for the general population. Because of these reasons field tests involving various anthropometric measurements used to predict body composition through regression equations have been

developed (Pollock & Jackson, 1977). Research has shown that discretion must be used when choosing body density equations since the equations are population specific (Pollock et al., 1976; & Pollock, et al., 1975).

CHAPTER III

METHODS

Introduction

The purpose of this study was to establish norms and percentile rankings of four health-related fitness components for fitness majors at the University of Wisconsin - La Crosse. By utilizing a set of field tests and one laboratory test, health-related fitness was evaluated. The tests included protocols to evaluate cardiovascular endurance, flexibility, muscular strength and endurance, and body composition. Each test was to be given by an instructor with up to 35 students per class. Accuracy and ease of administering the test was of high priority. Specific procedures were developed before any tests were given. The first data were collected from a pilot class during the 1988 fall semester. There were both pre- and post- tests given at the beginning and ending of the semester respectively. The results of the raw data were evaluated and discussed by a committee composed of three faculty members assigned to teach the entry level fitness classes for fitness majors, the Technical Director of the Human Performance Laboratory at the University of Wisconsin - La Crosse, and the researcher. With revisions made to the testing protocols given to the pilot class further data were collected during the 1988-89 school year on eight additional classes.

Selection of Subjects

The subjects in this study were all enrolled in entry level fitness classes for prospective fitness majors. The subjects in the pilot group ranged in age from 18 to 22 years and included 21 males and 9 females. Additional data were gathered from 111 males and 98 females ranging in age from 18 to 25 years.

Components

Four components: cardiovascular endurance, flexibility, muscular strength and endurance, and body composition were used to evaluate health-related fitness in this study. Various field tests and one laboratory test were administered to a pilot group to evaluate each component. The pilot class was tested for cardiovascular endurance using the 1.5 mile run, 12 minute run, and the 3 mile run. The flexibility tests were sit and reach, trunk extension, and shoulder lift. Grip strength, bench press, pull ups, flexed arm hang, and modified curl ups were used to evaluate muscular strength and endurance. The final component, body composition, was measured by anthropometric measurements and hydrostatic weighing. A comparison of these two methods was used to determine the most reliable set of anthropometric measurements used in predicting percent body fat.

After review by the committee, data from eight additional classes were gathered from results of the 1.5 mile run, 3 mile run, sit and reach, bench press, modified curl ups, anthropometric measurements, and hydrostatic weighing.

Cardiovascular Endurance

Cardiovascular endurance was evaluated on the pilot group at the beginning of the semester using both the 12 minute and 1.5 mile runs. At the end of the semester a 3 mile run was used to evaluate cardiovascular endurance. The 12 minute and 1.5 mile runs were administered on an outdoor 440 yard paved track. Due to inclement weather, the 3 mile run was completed indoors on a 220 yard flat track.

1.5 Mile Run (Cooper, 1978)

The subjects were given adequate time to warm up and stretch prior to the test. After the warm up, the subjects were gathered around the starting line. They were instructed to run six laps around the 440 yard track as fast as possible. It was emphasized that a maximal effort was important. During the run, as the subjects passed the timer standing at the start/finish line, they called out the number of completed laps in exchange for the current running time. At the completion of the sixth lap the timer gave each runner his/her final time (see Appendix B). Each subject then printed his/her name and time on a numbered piece of paper located at the side of the track.

12 Minute Run

The 440 yard track was divided into fourths. The subjects were again gathered at the starting line after an adequate warm up period. This time they were instructed to complete as many laps as possible in a twelve minute period. Each time the runners passed the start/finish line they called out the number of completed laps in exchange for the current time. Six minutes into the run the timer shouted out the time

remaining. This was again done with three minutes and one minute remaining in the run. The final ten seconds of the twelve minute run were counted out loud. At the completion of the run, the subjects recorded on their data sheets the number of laps completed to the nearest quarter of a lap.

3 Mile Run

The three mile run was administered in the same manner as the 1.5 mile run with a few exceptions. Because of inclement weather an indoor 220 yard track was used instead of the 440 yard outdoor track. The subjects were paired up with a partner. The three mile run was administered twice, with one partner running in each trial. During the run both partners kept track of the number of completed laps. As each lap was completed, the runner called out the number of completed laps and his/her partner confirmed that number. The timer also shouted out the current running time at the completion of each lap (see Appendix B). At the completion of the run, the runner printed his/her name and time on a numbered piece of paper located at the finish line. The second trial was then administered to the group of subjects that did not run with the first group.

Flexibility

Three flexibility tests, sit and reach (Allsen, et al., 1984), trunk extension (Prentice & Bucher, 1988), and shoulder lift (Prentice & Bucher, 1988), were administered to the pilot group. The sit and reach test was used to determine the amount of flexibility in the hamstring muscles while the trunk extension was used to determine the range of

motion of the back when arched from the prone position. The third test, the shoulder lift, was for the purpose of determining the amount of flexion possible at the shoulder joint.

Sit and Reach

A standard wooden yardstick was taped perpendicular to the painted mid court line on a basketball court with the 15 inch mark corresponding to the edge of the line. The subjects assumed a sitting position on the floor with one leg on each side of the yardstick and feet about six inches apart. Heels, with shoes off, were placed on the edge of the line corresponding to the 15 inch mark. The subjects were instructed to place one hand, fingers extended, on top of the other hand. While keeping the legs straight and flat on the floor, the subjects slowly leaned forward and upon exhalation, reached as far as possible on the yardstick. This position was held for a one second count (see Appendix B). Three trials were given with the best score, rounded to the nearest inch, being recorded (see Appendix D).

Trunk Extension

The subjects lay in a prone position on the floor with hands grasped behind their neck. Keeping the hips and legs on the floor, the subjects lifted their upper body as high as possible off of the floor. A wooden yardstick was used to measure the distance from the floor to the subjects's chin. Three trials were given with the best score, rounded to the nearest inch, being recorded.

Shoulder Lift

Subjects lay in a prone position with arms extended over their head while holding a pencil between their hands. A yardstick was placed next

to the pencil and running perpendicular to the floor. The subjects lifted the pencil up, as far as possible, on the yardstick while keeping their chest and face flat on the floor. Three trials were given to each subject with the best score, rounded to the nearest inch, being recorded on the data sheet.

Muscular Strength and Endurance

Muscular strength and endurance were evaluated through the following tests: grip strength, bench press, modified curl ups, pull-ups for men and flexed arm hang for women.

Grip Strength

Grip strength was evaluated using a hand dynamometer (Lafayette Instrument Co. - Lafayette, IN.). Each subject was given two trials. Both trials were done with the right hand and arm extended down to the side, not touching the body. Each subject was told to keep the arm extended and grip the dynamometer with maximum effort. The reading on the dynamometer was read to the nearest pound with the best trial being recorded on the data sheet.

Bench Press

Bench press was tested using an OEI seated bench press machine. The weight was set at a percentage of body weight for a maximum number of repetitions. The first group of 9 males was instructed to lift 80% of body weight while 50% of body weight was set for a group of 14 females. The second group comprised of 23 males and 29 females pressed 90% and 60% of body weight respectively. After review by the committee,

further data were gathered on the bench press using 90% of body weight for men and 60% for women (see Appendix C).

The subjects were weighed in gym clothes, without shoes, using a Health-O-Meter scale. The body weights were rounded to the nearest 10 pounds. The subjects aligned themselves in the bench press chair with feet flat on the floor and back flat against the back pad. The horizontal handgrips were aligned between nipple height and two inches above the nipples. The weight stack was set at the proper percentage (rounded to nearest 5 pounds) of body weight. Each subject grasped the horizontal hand grips and extended his/her arms straight forward until they were fully extended, then returned to the starting position with the hand grips even with the chest (see Appendix B). This was continued until no more repetitions could be completed correctly.

Pull Ups (Men Only)

Pull ups were tested on a horizontal pull up bar braced against a wall approximately eight feet from the ground. The men were instructed to face away from the wall, use a palm out hand grip, and begin with arms fully extended. The subjects were allowed to use a chair to get into the starting position. Each subject pulled his body up until his chin was at least level with the bar before returning to the starting position. As many correct pull ups as possible were done and recorded on the data sheet. A pull up was not counted if either the chin did not reach the bar or arms were not fully extended at the beginning of the pull up.

Flexed Arm Hang (Women Only)

The flexed arm hang for women was tested on the same horizontal

pull up bar as the mens pull ups. The women were also instructed to face away from the wall and use a palm out hand grip. In the starting position the arms were flexed so the chin was at least level with the bar. A chair was used to get into this position which was to be held as long as possible. Once the subjects were in the starting position the time was started. The time stopped when the subjects chin dropped lower than the horizontal bar. The time in seconds was then recorded on the data sheet.

Modified Curl Ups

A tape with a cadence of 80 beats per minute was used to administer the modified curl up test. Each curl up consisted of an 8 count repetition with four counts on the concentric phase and four counts on the eccentric phase. A total of 50 repetitions were recorded on the tape.

The subjects lay on their backs with knees bent, feet flat on the floor and approximately 18 inches from their hips. The feet were not held down by anyone or any object. Fingers were interlaced, not interlocked, and placed in a cupped position behind the head. Keeping the lower back on the floor at all times, the subjects curled the upper body up toward their legs. A partner took note of the amount of maximal trunk flexion reached during the initial curl up. Once the tape had begun, each curl up was required to reach the maximal trunk flexion position.

As many correctly performed curl ups, up to fifty, were recorded on the data sheet (see Appendix D). Some of the criteria for incorrect curl ups were; curl ups were not being controlled on the eccentric

phase, maximal trunk flexion was not being reached, the feet were further than 18 inches from the hips or the feet were being lifted off of the ground.

Due to the amount of subjectivity involved in evaluating a properly completed curl up and as a result of nearly all of the subjects in the pilot study completing all fifty curl ups, additional data were gathered on the modified curl up test using the same eight count repetition with a maximum of 100 repetitions instead of the original 50 repetitions.

Body Composition

Two methods of determining body composition were used to predict the percent body fat of all subjects. The first method was a series of anthropometric measurements. The second method was hydrostatic weighing. The results of the hydrostatic weighing were used as the indicator of body composition. All measurements were done in the Human Performance Laboratory at the University of Wisconsin - La Crosse.

Anthropometric Measurements

A series of 12 anthropometric measurements were taken for males and

11 measurements for females to determine body density and percent fat.

The measurements were:

MALES ONLY

- | | |
|-------------------------|--------------------------|
| 1. Height | 9. Chest Skinfold |
| 2. Weight | 10. Midaxillary Skinfold |
| 3. Biceps Skinfold | 11. Umbilical Skinfold |
| 4. Subscapular Skinfold | 12. Waist Girth |
| 5. Suprailiac Skinfold | |

6. Thigh Skinfold

FEMALES ONLY

7. Triceps Skinfold

9. Forearm Girth

8. Wrist Diameter

10. Maximal Abdominal Girth

11. Maximal Gluteal Girth

Measurement Procedures. All anthropometric measurements were taken and recorded on the standard data sheet used in the Human Performance Laboratory (see Appendix E). Skinfolds were measured with Harpenden skinfold calipers (British Indicators Ltd. - Herffordshire, England). Three measurements, on the right side of the body, were taken at each site. If two of the three measurements agreed, the common number was recorded. However, an average of the three measurements was recorded if the numbers differed. The calipers were applied to the fold just below the thumb and index finger of the tester holding the skinfold. The wrist diameters were determined using a Swiss made GPM sliding caliper (Seritex, Inc. - Carlstadt, NJ). Weights were determined using a Health-O-Meter scale. A wall mounted height scale (Novel Product - Addison, IL) was calibrated with a Swiss made GPM anthropometer

(Seritex, Inc. - Carlstadt, NJ) and used to measure height. Girths were taken in centimeters with a standard fiberglass tape measure.

Male subjects were dressed in gym shorts or swimming suits, while the females were dressed in swimming suits only. The female skinfold sites covered by the suits were determined with the suit as part of the skinfold. The fold of the suit was then deducted from the skinfold measurement. The sites were located according to the following procedures:

1. Height - Subjects stood with their backs to the wall-mounted height scale, bare feet together and hands down to the side. With head erect and facing forward, the sliding height arm was positioned on the top of the head. The height was recorded to the nearest quarter inch.
2. Weight - Subjects stood barefoot on a Health-O-Meter scale with their weight evenly distributed. The scale weight was recorded to the nearest quarter pound.
3. Triceps Skinfold - A vertical fold on the posterior midline of the upper arm (over triceps muscle), halfway between the acromion and olecranon processes with the elbow extended and relaxed.
4. Biceps Skinfold - A fold taken over the mid-point of the muscle belly with the arm resting supinated at the side.
5. Subscapular Skinfold - A fold taken just below the tip of the inferior aspect of the scapula, at an angle of about 45 degrees.
6. Suprailiac Skinfold - A diagonal fold just above the iliac crest in the midaxillary line.

7. Thigh Skinfold - A vertical fold on the anterior aspect of the thigh, halfway from the inguinal fold to the top of the patella (no weight on foot).
8. Chest Skinfold - A fold just adjacent to the nipple along the line between the anterior crease of the axilla and the nipple, not to include any glandular tissue.
9. Midaxillary Skinfold - A vertical fold on the midaxillary line at the level of the xiphoid process of the sternum.
10. Umbilical Skinfold - A vertical fold taken at a lateral distance of approximately 2 cm from the umbilicus on right side.
11. Wrist Diameter - Distance between the styloid processes of the radius and ulna with the elbow flexed and hand supinated.
12. Forearm Girth - A maximal forearm girth with the arm extended in front of the body.
13. Maximal Abdominal Girth - A girth taken at the maximal abdominal circumference.
14. Maximal Gluteal Girth - A girth taken at the maximal gluteal circumference.

Computation of Body Density and Percent Fat. Body density and percent fat were calculated based on the anthropometric measurements using several equations. For men these equations were:

Durnin and Rahaman, 1967:

$$BD = 1.1533 - .0643 \log(M1 + M2 + M3 + M4) \quad (\text{Boys})$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

$$BD = 1.1610 - .0632 \log(M1 + M2 + M3 + M4) \quad (\text{Men})$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Durnin and Womersley, 1974:

$$BD = 1.1765 - .0744 \log(M1 + M2 + M3 + M4)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Jackson and Pollock, 1978:

$$BD = 1.10938 - .0008267(M5 + M6 + M8) +$$

$$.0000016(M5 + M6 + M8)^2 - .0002574(\text{age in years})$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Katch and McArdle, 1973:

$$BD = 1.09665 - .00103(M1) - .00056(M3) - .00054(M8)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Pascale, Grossman, Sloane, and Frankel, 1956:

$$BD = 1.088468 - .0007123(M7) - .0004834(M6) - .0005513(M1)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Pollock, Schmidt, and Jackson, 1980:

$$BD = 1.1125025 - .0013125(M1 + M3 + M6) + .0000055(M1 + M3 + M6)^2 - .0002440(\text{age in years})$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Sloan, 1967:

$$BD = 1.1043 - .001327(M5) - .00131(M3)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Wilmore and Behnke, 1969:

$$BD = 1.08543 - .000886(M8) - .00040(M5)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Zuti and Golding, 1973:

$$BD = 1.0806 - .001187(M9) - .001076(M6) + .015306(M10)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

M1=triceps skinfold, M2=biceps skinfold, M3=subscapular skinfold,
 M4=suprailiac skinfold, M5=thigh skinfold, M6=pectoral skinfold,
 M7=midaxillary skinfold, M8=umbilical skinfold, M9=suprailiac girth,
 M10=wrst diameter. Skinfolds in mm; girths and diameter in cm.

For women these equations were:

Durnin and Rahaman, 1967:

$$BD = 1.1369 - .0598 \log(F1 + F2 + F3 + F4) \quad (\text{Girls})$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

$$BD = 1.1581 - .0720 \log(F1 + F2 + F3 + F4) \quad (\text{Women})$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Durnin and Womersley, 1974:

$$BD = 1.1567 - .0717 \log(F1 + F2 + F3 + F4)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Katch and McArdle, 1973:

$$BD = 1.08347 - .000060(F1) - .00151$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Katch and McArdle, 1968:

$$BD = 1.14100 - .001817(F1) - [(.001876(F8))/(2.54)]$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Jackson, Pollock, and Ward, 1980:

$$BD = 1.0994921 - .0009929(F1 + F4 + F5) + .0000023(F1 + F4 + F5)^2 \\ - .0001392(\text{age in years})$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Sloan, Burt, and Blyth, 1962:

$$BD = 1.0764 - .00081(F4) - .00088(F1)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Wilmore and Behnke, 1970:

$$BD = 1.06234 - .00068(F3) - .00039(F1) - .00025(F5)$$

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

F1=triceps skinfold, F2=biceps skinfold, F3=subscapular skinfold,
 F4=suprailiac skinfold, F5=thigh skinfold, F6=forearm girth,
 F7=abdominal girth, F8=buttocks girth, F9=wrists diameter.

Skinfolds in mm; girths and diameter in cm.

Determination of Residual Volumes

Determination of residual volume (RV) was done by the closed circuit dilution method (Wilmore, 1969). A fast responding electronic nitrogen analyzer (W. E. Collins, Inc. - Braintree, MA) was used to continuously sample the gas being respired at the subject's mouth and the nitrogen content was recorded during the maximal exhalation and subsequent rebreathing by a chart recorder (Omega model 585 - Stamford, CN). The calibration of the nitrogen analyzer and chart recorder was checked at frequent intervals throughout the testing.

In order to select an appropriate volume of oxygen for the rebreathing procedure to follow, preliminary measurements of vital lung capacity (VC) were made on each subject with a 9 liter wet spirometer (W. E. Collins, Inc. - Braintree, MA). Before each residual volume (RV)

trial a rebreathing bag was repeatedly flushed with oxygen, emptied with a vacuum pump, and then filled with the preset oxygen volume. During all the rebreathing procedures the subjects were seated. When an audible signal was given by the tester the subject initiated a forced expiratory maneuver which had been previously demonstrated. Each subject was asked to strive to minimize body movement during the forced expiratory effort and, after expelling as much air as possible, to signal by raising the right index finger. Immediately after this signal was given by the subject the valve connecting the respiratory hose to room air was switched to connect the hose to the rebreathing bag. A second audible signal by the tester cued the subject to commence deep and rapid rebreathing of oxygen. Each subject continued deep and rapid ventilations until a relative equilibrium was attained with respect to the nitrogen content of the respired gas. Based on the closed circuit oxygen dilution method the following equation was used:

$$RV = VO_2(EN_2 - IN_2)/(AN_2 - FN_2) - DS \times 1.1$$

VO_2 = Initial bag volume in system

AN_2 = Initial percent of nitrogen in alveolar air

IN_2 = Impurity of oxygen

EN_2 = Percent nitrogen in equilibrium

FN_2 = Percent nitrogen in alveolar air at end of test

DS = Dead space of mouthpiece and area containing nitrogen sensing needle

Hydrostatic Weighing

Hydrostatic weighing was used as a post- test for body composition each semester as a comparative method of determining body density and percent body fat. An informed consent form was read and signed by each subject before any procedures were begun (see Appendix E).

All subjects were weighed using a Health-O-Meter scale. They were then instructed to shower and enter the weighing tank without drying off. Once the subjects were in the weighing tank they were seated in the center of a submerged chair hanging from a 15 kg capacity spring scale (Chatillon, Inc. - Kew Gardens, NY). An effort was made by the subjects to remove all air bubbles that could have accumulated in their swim suits or hair. With subject's feet on the bottom rung and hands gently grasping the sides of the chair, they were instructed to exhale maximally and slowly lean forward pulling the upper body down towards the thighs until the body was completely submerged. The subjects were required to hold this position steadily until the tester could obtain a measurement from the scale. Once the weight had been recorded, the tester tapped the front of the tank to inform the subject that the weight had been obtained. A minimum of four trials were given to allow the subject to get accustomed to being submerged without air.

Computation of Body Density and Percent Fat. Based on hydrostatic weighing the following equations were used:

BD = Body density
 MA = Mass in air
 MW = Mass of water displaced
 DW = Density of water
 RV = Residual volume

$$BD = MA/MA - MW/DW - RV - .1L$$

Brozek, Grande, Anderson, and Keys, 1963:

$$\text{Percent Fat} = (4.57/BD - 4.142) \times 100$$

Statistical Analysis

For the purpose of statistical analysis of the data the researcher used means and standard deviations to establish norms of the field tests. The field tests used were the 1.5 mile run, 3 mile run, sit and reach, modified curl up, and bench press. A Pearson product moment correlation was used to determine the relationship of percent body fat derived from hydrostatic weighing and anthropometric measurements. Means and standard deviations were used to establish norms for percent body fat. Percentile rankings of the data using z-scores were also determined.

CHAPTER IV
RESULTS AND DISCUSSION

Introduction

The purpose of this study was to establish norms and percentile rankings of four health-related fitness components for fitness majors at the University of Wisconsin - La Crosse. Health-related fitness was evaluated through a set of field tests and one laboratory test. These tests included protocols to evaluate cardiovascular endurance, flexibility, muscular endurance, and body composition. Body composition was measured by two methods, hydrostatic weighing and anthropometric measurements. A multiple regression was used to determine which anthropometric measurements were the best predictor of hydrostatic weight. Based on the data collected from nine of these entry level classes during the school year of 1988-89, norms and percentile rankings were determined.

The results of this study will be presented and discussed in the following order: 1) cardiovascular endurance, 2) flexibility, 3) muscular endurance, and 4) body composition. The procedures for the norms and percentile rankings, followed by the prediction of hydrostatic weight will then be presented and discussed.

Cardiovascular Endurance

The field tests used to evaluate cardiovascular endurance were the

1.5 mile and 3 mile runs. The means and standard deviations for the men are shown in Table 1. The men had a mean time of 10.3 minutes with a standard deviation of 1.2 minutes (1.5 mile run = 10.3; s.d. = 1.2) for the 1.5 mile run. The times ranged from a minimum of 7.7 minutes to a maximum of 15.8 minutes. The mean time for the 3 mile run was 21.4 minutes with a standard deviation of 4.8 minutes (3 mile run = 21.4; s.d. = 4.8) and a range of 16.5 to 31.3 minutes.

Table 1. Means and Standard Deviations for the 1.5 Mile and 3.0 Mile Runs for Men.

Test	N	Mean	Standard Deviation
1.5 Mile Run	126	10.3	1.2
3.0 Mile Run	119	21.4	4.8

Table 2 shows the means and standard deviations of the 1.5 mile and 3 mile runs for the women. The mean time of the 1.5 mile run for the women was 12.7 minutes with a standard deviation of 1.6 minutes (1.5 mile run = 12.7; s.d. = 1.6) and a range of 8.6 to 18.5 minutes. The mean of the 3 mile run was 25.2 minutes with a standard deviation of 3.0 minutes (3 mile run = 25.2; s.d. = 3.0). The times of the 3 mile run ranged from 17.5 to 37.8 minutes.

Flexibility

Flexibility was evaluated by the sit and reach test. Using a yardstick the subjects feet were placed even with the 15 inch mark on a

yardstick. With legs fully extended, each subject reached with both hands as far as possible on the yard stick. The scores were recorded to the nearest inch. The mean and standard deviation for men are shown in Table 3. The men had a mean of 20.5 inches with a standard deviation of 2.8 inches (sit and reach = 20.5; s.d. = 2.8). The scores ranged from a minimum of 8 inches to a maximum of 26 inches.

Table 2. Means and Standard Deviations for the 1.5 Mile and 3.0 Mile Runs for Women.

Test	N	Mean	Standard Deviation
1.5 Mile Run	98	12.7	1.6
3.0 Mile Run	91	25.2	3.0

Table 3. Means and Standard Deviations of the Sit and Reach Test for Men.

Test	N	Mean	Standard Deviation
Sit and Reach	132	20.5	2.8

The results of the sit and reach test for women are shown in Table 4. The women had a mean of 21.9 inches and a standard deviation of 2.6 inches (sit and reach = 21.9; s.d. 2.6). The women's scores ranged from a minimum of 10 inches to a maximum of 27 inches.

Muscular Endurance

Muscular endurance was evaluated by the modified curl up test and the bench press. The modified curl up test was initially administered to 78 male and 82 female subjects with a maximum of fifty repetitions allowed. An additional 52 male and 25 female subjects were then tested with the modified curl up test which allowed for a maximum of 100 curl ups. The results of the men are shown in Table 5. For the fifty repetition maximum the men had a mean of 49.5 repetitions with a standard deviation of 2.6 (50 Reps = 49.5; s.d. = 2.6). Seventy-five out of 78 subjects were able to complete all 50 repetitions allowed. The modified curl test which allowed for a maximum of 100 repetitions resulted in a mean of 98.7 repetitions with a standard deviation of 9.2 (100 Reps = 98.7; s.d. = 9.2). Only one subject was unable to complete the maximum of 100 modified curl ups.

The weight for the bench press was set at 90% of body weight for men and 60% of body weight for women. Each subject performed as many repetitions as possible. The mean and standard deviation for the men are shown in Table 5. The men had a mean number of repetitions for the bench press of 18.9 with a standard deviation of 6.5 (bench press = 18.9; s.d. = 6.5). The number of completed repetitions ranged from a minimum of 2 to a maximum of 33.

Results of the modified curl up and bench press for women are shown in Table 6. The women had a mean of 49.8 repetitions and a standard deviation of 2.1 (50 Reps = 49.5; s.d. = 2.1) for the fifty repetition modified curl up. Only one out of 82 subjects completed less than the

maximum allowed. For the 100 repetition modified curl up test the women completed a mean of 99.4 with a standard deviation of 2.9 (100 Reps = 99.4; s.d. = 2.9). Twenty-four out of 25 subjects were able to complete the 100 repetition maximum.

The women completed a mean of 14.6 repetitions on the bench press with a standard deviation of 6.7 (bench press = 14.6; s.d. = 6.7). The minimum number of completed repetitions was zero and the maximum was 33.

Table 4. Means and Standard Deviations of the Sit and Reach Test for Women.

Test	N	Mean	Standard Deviation
Sit and Reach	107	21.9	2.6

Table 5. Means and Standard Deviations of the Modified Curl Up and Bench Press for Men.

Test	N	Mean	Standard Deviation
Modified Curl Up			
50 Reps	78	49.5	2.6
100 Reps	52	98.7	9.2
Bench Press	116	18.9	6.5

Body Composition

Body composition was measured by hydrostatic weighing. The mean

and standard deviation for men are shown in Table 7. The results of the hydrostatic weighing showed the men to have a mean of 13.3 percent body fat with a standard deviation of 4.7 (hydrostatic weighing = 13.3; s.d. = 4.7). The minimum and maximum percentage of body fat are 4.2 and 28.8 percent respectively.

Table 6. Means and Standard Deviations of the Modified Curl Up and Bench Press for Women.

Test	N	Mean	Standard Deviation
Modified Curl Up			
50 Reps	82	49.8	2.1
100 Reps	25	99.4	2.9
Bench Press	89	14.6	6.7

Table 7. Means and Standard Deviations of Percent Body Fat for Men Determined by Hydrostatic Weighing.

Test	N	Mean	Standard Deviation
Hydrostatic Weighing	117	13.3	4.7

The body composition results for the women are shown in Table 8. The mean percent body fat for the women was 24.0 with a standard deviation of 5.8 (hydrostatic weighing = 24.0; s.d. = 5.8). The women ranged from a minimum of 11.6 percent to 40.2 percent body fat.

Norms and Percentile Rankings

Norms and percentile rankings were computed for five of the health-related fitness tests completed based on a standard normal curve. Z-scores were used to establish the percentile rankings of both men and women for the 1.5 mile and 3 mile runs, sit and reach, bench press, and body composition. For the sixth test, the modified curl ups, a maximum of 50 and 100 repetitions were allowed. Because of the limited number of repetitions percentile rankings were not calculated.

1.5 Mile and 3 Mile Runs

The results of the 1.5 mile run for men are shown in Table 9. Ten percent of the men were able to complete the 1.5 mile run in 8.8 minutes or less. Nearly all of the subjects, ninety percent, were able to finish in less than 11.8 minutes.

Table 8. Means and Standard Deviations of Percent Body Fat for Women Determined by Hydrostatic Weighing.

Test	N	Mean	Standard Deviation
Hydrostatic Weighing	91	24.0	5.8

Ten percent of the men were able to finish the 3 mile run in 18.6 minutes or less while ninety percent completed the run in at least 24.2 minutes. The percentile rankings of the 3 mile run for the men are shown in Table 10.

The results of the 1.5 mile run for women are shown in Table 11. The 10th percentile of the 1.5 mile run for women was 14.7 minutes, while the 90th percentile was 10.7 minutes.

Table 12 shows the results of the 3 mile run for women. Ninety percent of the women were able to complete the 3 mile run in 29 minutes or less. Only ten percent of the women completed the run in 21.4 minutes or less.

Table 9. Percentile Rankings of the 1.5 Mile Run for Men.

% ile	Time/Min	Freq	Cumm Freq
10	11.8	14	14
20	11.3	9	23
30	10.9	15	38
40	10.6	10	48
50	10.3	10	58
60	10.0	14	72
70	9.7	7	79
80	9.3	20	99
90	8.8	19	118

Sit and Reach

The results of the sit and reach test for men can be seen in Table 13. The table shows that ninety percent of the subjects were able to reach at least 16.8 inches. However, only ten percent of the subjects reach 24.2 inches or greater.

Table 14 summarizes the results of the women's sit and reach test. Ninety percent of the women could reach at least 18.6 inches while only ten percent were able to reach 25.2 inches or more.

Bench Press

The percentile rankings of the men's bench press are summarized in Table 15. The results show that ninety percent of the men were able to lift 90% of their body weight at least 10.6 times. Only ten percent were able to lift this same weight 27.2 times or more.

Table 10. Percentile Rankings of the 3 Mile Run for Men.

Percentile	Time/Min	Freq	Cumm Freq
10	24.2	12	12
20	23.2	3	15
30	22.5	17	32
40	22.0	10	42
50	21.4	12	54
60	20.9	14	68
70	20.3	11	79
80	19.6	21	100
90	18.6	10	110

The weight for the women's bench press was set at 60% of their body weight. Ninety percent of the women were able to lift this weight at least 6 times. Ten percent were able to lift the weight 23.2 times or more. The results are shown in Table 16.

Body Composition

The results of body composition for men measured by hydrostatic weighing are summarized by percentile rankings in Table 17. Ninety percent of the male subjects were 19.3 percent body fat or less. Only ten percent were 7.3 percent fat or less.

Table 18 shows the percentile rankings of body composition for women. In ninety percent of the women their body fat was 31.4 percent or less. Only ten percent of the women had a percent body fat of 16.6 or less.

Table 11. Percentile Rankings of the 1.5 Mile Run for Women.

Percentile	Time/Min	Freq	Cumm Freq
10	14.7	12	12
20	14.0	6	18
30	13.5	9	27
40	13.1	6	33
50	12.7	12	45
60	12.3	10	55
70	11.9	9	64
80	11.4	13	77
90	10.7	13	90

Prediction of Hydrostatic Weight

A multiple regression was used to determine which variables were the best predictor of hydrostatic weight. The following steps were used

in this process. A Pearson product moment correlation was used to determine which anthropometric measurements had the highest correlation with hydrostatic weighing (see Appendix F). The men's results are shown in Table 19 and the women's results are shown in Table 20. The midaxillary skinfold explained the largest percent of variance for men (.83) and the subscapular skinfold explained the highest percent of variance for women (.73).

The variable with the highest correlation was then combined with all other possible variables to determine the two best predictors of hydrostatic weight. The result for the men are shown in Table 21. The two best predictors for men were the midaxillary and thigh skinfolds (.88). By combining the midaxillary and thigh skinfolds the explained percent of variance was increased 5 percent.

The two best predictors for women, shown in Table 22, were the subscapular skinfold and maximal gluteal or maximal abdominal girths. These combinations resulted in an increase of 7 percent of explained variance (.80).

The two best variables were combined with all other possible variables to determine the three best predictors of hydrostatic weight. The three best predictors for men are shown in Table 23. They were the midaxillary, thigh, and umbilical skinfolds (.89). The explained percent of variance was only increased by 1% when adding a third variable.

The results of the women are shown in Table 24. The best three predictors of hydrostatic weight were the subscapular and triceps

skinfolds and the maximal gluteal girth (.82) By adding the third variable the explained percent of variance increased by 4%.

Table 12. Percentile Rankings of the 3 Mile Run for Women.

% ile	Time/Min	Freq	Cumm Freq
10	29.0	8	8
20	27.7	6	14
30	26.8	5	19
40	26.0	10	29
50	25.2	15	44
60	24.5	4	48
70	23.6	17	65
80	22.7	10	75
90	21.4	12	87

Table 13. Percentile Rankings of the Sit and Reach Test for Men.

% ile	Inches	Freq	Cumm Freq
10	16.8	14	14
20	18.1	8	22
30	19.0	18	40
40	19.8	0	40
50	20.5	11	51
60	21.2	32	83
70	22.0	19	102
80	22.9	0	102
90	24.2	24	126

Table 14. Percentile Rankings of the Sit and Reach Test for Women.

Per- centile	Inches	Freq	Cumm Freq
10	18.6	11	11
20	19.7	7	18
30	20.5	9	27
40	21.3	18	45
50	21.9	0	45
60	22.6	15	60
70	23.3	18	78
80	24.1	13	91
90	25.2	10	101

Table 15. Percentile Rankings of the Bench Press for Men.

Per- centile	Reps	Freq	Cumm Freq
10	10.6	13	13
20	13.4	10	23
30	15.5	12	35
40	17.3	9	44
50	18.9	13	57
60	20.5	13	70
70	22.3	4	74
80	24.4	16	90
90	27.2	17	107

Table 16. Percentile Rankings of the Bench Press for Women.

Percentile	Reps	Freq	Cumm Freq
10	6.0	10	10
20	9.0	13	23
30	11.1	6	29
40	12.9	4	33
50	14.6	8	41
60	16.3	14	55
70	18.1	4	59
80	20.2	18	77
90	23.2	7	84

Table 17. Percentile Rankings of Body Composition for Men.

Percentile	% Fat	Freq	Cumm Freq
10	19.3	13	13
20	17.2	8	21
30	15.7	7	28
40	14.5	10	38
50	13.3	13	51
60	12.1	10	61
70	10.9	13	74
80	9.4	19	93
90	7.3	21	114

Table 18. Percentile Rankings of Body Composition for Women.

Percentile	% Fat	Freq	Cumm Freq
10	31.4	11	11
20	28.9	7	18
30	27.0	6	24
40	25.5	9	33
50	24.0	10	43
60	22.6	9	52
70	21.0	13	65
80	19.1	8	73
90	16.6	15	88

Table 19. Correlation of Anthropometric Measurements and Hydrostatic Weighing for Men.

Variable	R
Midaxillary Skinfold	.83
Biceps Skinfold	.82
Thigh Skinfold	.82
Subscapular Skinfold	.80
Umbilical Skinfold	.79
Waist Girth	.79
Triceps Skinfold	.79
Chest Skinfold	.77
Suprailiac Skinfold	.67

Table 20. Correlation of Anthropometric Measurements and Hydrostatic Weighing for Women.

Variable	R
Subscapular Skinfold	.73
Maximal Gluteal Girth	.72
Biceps Skinfold	.70
Triceps Skinfold	.68
Maximal Abdominal Girth	.66
Weight in Pounds	.62
Suprailiac Skinfold	.59
Thigh Skinfold	.44
Forearm Girth	.40

Table 21. Table Showing all Variables Combined with the Men's Midaxillary Skinfold.

Variable	R
Thigh Skinfold	.88
Triceps Skinfold	.87
Biceps Skinfold	.85
Umbilical Skinfold	.85
Subscapular Skinfold	.84
Chest Skinfold	.84
Waist Girth	.84
Suprailiac Skinfold	.83

Table 22. Table Showing all Variables Combined with the Women's Subscapular Skinfold.

Variable	R
Maximal Gluteal Girth	.80
Maximal Abdominal Girth	.80
Triceps Skinfold	.77
Biceps Skinfold	.76
Weight in Pounds	.75
Thigh Skinfold	.74
Suprailiac Skinfold	.74
Forearm Girth	.73

Table 23. Table Showing all Variables Combined with the Men's Midaxillary and Thigh Skinfolds.

Variable	R
Umbilical Skinfold	.89
Triceps Skinfold	.89
Chest Skinfold	.88
Biceps Skinfold	.88
Waist Girth	.88
Subscapular Skinfold	.88
Suprailiac Skinfold	.88

Table 24. Table Showing all Variables Combined with the Women's Subscapular Skinfold and Maximal Gluteal Girth.

Variable	R
Maximal Abdominal Girth	.82
Triceps Skinfold	.81
Biceps Skinfold	.81
Weight in Pounds	.81
Forearm Girth	.81
Weight in Pounds	.81
Thigh Skinfold	.80
Suprailiac Skinfold	.44

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to establish norms and percentile rankings of four health-related fitness components for fitness majors at the University of Wisconsin - La Crosse. Data were collected from four health-related fitness components; cardiovascular endurance, flexibility, muscular endurance, and body composition. The tests used to evaluate cardiovascular endurance were the 1.5 and 3 mile runs. Flexibility was measured with the sit and reach test. Two tests, the modified curl up and the bench press, were used to test muscular endurance. The final component, body composition, was evaluated by hydrostatic weighing and anthropometric measurements. The results of the tests were used to establish norms and percentile rankings.

Conclusions

The following conclusions were made based on the data obtained:

Cardiovascular Endurance

1. The men averaged 10.3 minutes for the 1.5 mile run and 21.4 minutes for the three mile run.
2. The average times for the women were 12.7 minutes and 25.2 minutes for the 1.5 and three mile runs respectively.

Flexibility

1. The men averaged 20.5 inches for the sit and reach test.
2. The average distance of the sit and reach test for the women was 21.9 inches.

Muscular Endurance

1. The modified curl up test was administered with a maximum of 50 and 100 repetitions allowed. The men averaged 49.5 for the 50 repetition test. For the 100 repetition test, the men averaged 98.7 repetitions.
2. The women averaged 49.5 for the 50 repetition test and 99.4 for the 100 repetition test.
3. The average number of repetitions for the bench press were 18.9 for the men.
4. The women averaged 14.6 repetitions for the bench press.

Body Composition

1. The average percent body fat for men determined by hydrostatic weighing was 13.3 percent.
2. Twenty-four percent was the average percentage of body fat for the women.

Recommendations

Based on the results of this study the following recommendations are made:

1. It is recommended that continued testing and data collection of health-related fitness be done for fitness majors at the University of Wisconsin - La Crosse.

2. It is recommended that an alternative test for muscular endurance be used instead of the 50 or 100 repetition modified curl up test.

3. It is recommended that the students get a computer print out of raw scores and percentile rankings for both pre- and post- tests.

4. It is recommended that additional data on body composition be collected using anthropometric measurements only.

REFERENCES CITED

- AAHPERD (1980). Health related physical fitness test manual. Reston, VA: AAHPERD Publications.
- Allsen, P. E., Harrison, J. M., & Vance, B. (1984). Fitness for life: An individualized approach. Dubuque: Wm. C. Brown Publishers.
- Askew, N. R. (1966). Reliability of the 600-yard run-walk test at the secondary school level. Research Quarterly, 37, 451-454.
- Astrand, I., Astrand, P.-O., Hallback, I. & Dilbom, A. (1973). Reduction in maximal oxygen uptake with age. Journal of Applied Physiology, 35, 649-654.
- Astrand, P.-O. (1968). Physical performance as a function of age. Journal of the American Medical Association, 205, 105-109.
- Baumgartner, T. A., & Jackson, A. S. (1982). Measurements for evaluation in physical education, Dubuque: W. C. Brown.
- Benoit, F. L., Martin, R. L., & Watten, R. H. (1965). Changes in body composition during weight reduction in obesity: Balance studies comparing effects of fasting and a ketogenic diet. Annals of Internal Medicine, 63, 604-612.
- Behnke, A. R., & Wilmore, J. H. (1974). Evaluation and regulation of body build and composition, Englewood Cliffs, New Jersey: Prentice-Hall.
- Berger, R. A. (1962). Effect of varied weight training programs on strength. Research Quarterly, 33, 168-181.
- Bjorntorp, P., Fahlen, M., Grimby, G., Gustafson, A., Holm, J., Renstrom, P., & Schersten, T. (1972). Carbohydrate and lipid metabolism in middle-aged, physically well-trained men. Metabolism, 21, 1037-1044.
- Blair, S. N., Blair, A., Pate, R. R., Howe, H. G., Rosenberg, M., & Parker, G. M. (1981). Interactions among dietary pattern, physical activity and skinfold thickness. Research Quarterly for Exercise and Sport, 52, 505-511.
- Blair, S. N., Falls, H. B., & Pate, R. R. (1983). A new physical fitness test. The Physician and Sports Medicine, 11(4), 87-95.
- Brandon, L. J., & Evans, R. L. (1988). Are physical educators physically fit? Perceived and measured physical fitness of physical educators. Journal of Physical Education, Recreation, and Dance, 59(7), 73-75.

- Bray, G. A., Jordan, H. A., & Sims, E. A. H. (1976). Evaluation of the obese patient. Journal of the American Medical Association, 235, 1487-1491.
- Brigham Young University (1985, March 1), Brigham Young University Bulletin, USPS # 06512000, 82,235.
- Brown, R. D., & Harrison, J. M. (1986). The effects of a strength training program on the strength and self-concept of two female age groups. Research Quarterly for Exercise and Sport, 57, 315-320.
- Brozek, J., Grande, F., Anderson, T., & Keys, A. (1963). Densitometric analysis of body composition: Revision of some quantitative assumptions. Annals New York Academy of Science, 110, 113-140.
- Brynteson, P. (1978). Fitness for life: Aerobics at Oral Roberts University. Journal of Physical Education, and Recreation, 49(1), 37-39.
- Burke, E. J. (Ed). (1977). Toward an understanding of human performance: Readings in exercise physiology for the coach and athlete. Ithaca, NY: Movement Publications.
- Burke, W. E., Tuttle, W. W., Thompson, C. W., Janney, C. D., & Weber, R. J. (1953). The relation of grip strength and grip strength endurance to age. Journal of Applied Physiology, 5, 628-630.
- Clark, D. G., Blair, S. N., & Culan, M. R. (1988). Are HPE teachers good role models? Journal of Physical Education, Recreation, and Dance, 59(7), 76-80.
- Considine, W. J. (1985). Basic instruction programs: A continuing journey. Journal of Physical Education, Recreation, and Dance, 56(7), 31-54.
- Cooper, K. H. (1969). The role of exercise. Journal of Health, Physical Education, and Recreation, 40(5), 22-25.
- Cooper, K. H. (1978). The aerobics way, New York: Bantam Books.
- Cooper, K. H., Pollock, M. L., Martin, R. P., White, S. R., Linnerud, A. C., & Jackson, A. (1976). Physical fitness levels vs selected coronary risk factors: A cross-sectional study. Journal of the American Medical Association, 236(2), 166-170.
- Dehn, M. M., & Bruce, R. A. (1972). Longitudinal variations in maximal oxygen intake with age and activity. Journal of Applied Physiology, 33, 805-807.

- Doolittle, T. L., & Bigbee, R. (1968). The twelve-minute run-walk: A test of cardiorespiratory fitness of adolescent boys. Research Quarterly, 39, 491-495.
- Dufaux, B., Assmann, G., & Hollmann, W. (1982). Plasma lipoproteins and physical activity: A review. International Journal of Sports Medicine, 3, 123-136.
- Durnin, J. V. G. A., & Rahaman, M. M. (1967). The assessment of the amount of body fat in the human body from measurements of skinfold thickness. British Journal of Nutrition, 21, 681-689.
- Durnin, J. G. V. A., & Womersley, J. (1974). Body assessment from total body density and its estimation from skinfold thickness: Measurements on 481 men and women aged from 16 to 72 years. British Journal of Nutrition, 32, 77-97.
- Eichner, E. R. (1983). Exercise and heart disease: Epidemiology of the "exercise hypothesis". American Journal of Medicine, 75, 1008-1023.
- Epstein, L., Miller, G. J., Stitt, F. W., & Morris, J. N. (1976). Vigorous exercise in leisure time, coronary risk-factors, and resting electrocardiogram in middle-aged male civil servants. British Heart Journal, 38, 403-409.
- Falls, H. B. (1980). Modern concepts of physical fitness. Journal of Physical Education, and Recreation, 51(4), 25-27.
- Falls, H. B., Ismail, A. H., & Macleod, D. F. (1966). Estimation of maximum oxygen uptake in adults from AAHPER youth fitness test items. Research Quarterly, 37, 192-201.
- Gutin, B., & Lipetz, S. (1971). An electromyographic investigation of the rectus abdominis in abdominal exercises. Research Quarterly, 42, 256-263.
- Gwinup, G. (1975). Effect of exercise alone on the weight of obese women. Archives of Internal Medicine, 135, 676-680.
- Hoeger, W. W. K. (1986). Lifetime physical fitness and wellness: A personalized program, Englewood, Colorado: Morton.
- Jackson, A. (1986). Strength measurement: Controlling for individual differences. Journal of Physical Education, Recreation, and Dance, 57(6), 82-84.
- Jackson, A. W., & Baker, A. A. (1986). The relationship of the sit and reach test to criterion measures of hamstring and back flexibility in young females. Research Quarterly for Exercise and Sport, 57, 183-186.

- Jackson, A. S., & Pollock, M. L. (1978). Generalized equations for predicting body density of men. British Journal of Nutrition, 40, 497-504.
- Jackson, A. S., Pollock, M. L., & Ward, A. (1980). Generalized equations for predicting body density of women. Medicine and Science in Sports and Exercise, 12, 175-182.
- Johnson, B. L., & Nelson, J. K. (1979). Practical measurements for evaluation in physical education. Minneapolis: Burgess.
- Johnson, M. W. (1985). Physical education - fitness or fraud? A call for curriculum reform. Journal of Physical Education, Recreation, and Dance, 56(1), 33-35.
- Jones, E. M., Montoye, H. H., Johnson, P. B., Martin, M. J. M., Van Huss, W. D., & Cederquist, D. (1964). Effects of exercise and food restriction on serum cholesterol and liver lipids. American Journal of Physiology, 207, 460-466.
- Kahn, H. A. (1963). The relationship of reported coronary heart disease mortality to physical activity of work. American Journal of Public Health, 53, 1058-1067.
- Karper, W. B., & Dignan, M. B. (1983). Exercise habits: Do physical education professionals in higher education practice what they preach? Journal of Physical Education, Recreation, and Dance, 54(3), 27-29.
- Katch, F. I., & McArdle, W. D. (1973). Prediction of body density from simple anthropometric measurements in college-age men and women. Human Biology, 45, 445-454.
- Katch, F. I., & Michael, E. D. Jr. (1968). Prediction of body density from skinfold and girth measurements of college females. Journal of Applied Physiology, 25, 92-94.
- Kelley, D. L. (1982). Exercise prescription and the kinesiological imperative. Journal of Physical Education, Recreation, and Dance, 53(1), 18-20.
- Kendall, F. P. (1965). A criticism of current tests and exercises for physical fitness. Physical Therapy: Journal of the American Physical Therapy Association, 45(3), 187-197.
- Keys, A., Aravanis, C., Blackburn, H., Van Buchem, F. S. P., Buzina, R., Djordjevic, B. S., Fidanza, F., Karvonen, M. J., Menotti, A., Puddu, V., & Taylor, H. L. (1972). Coronary heart disease: Overweight and obesity as risk factors. Annals of Internal Medicine, 77, 15-26.

- Kraus, H., & Hirschland, R. P. (1954). Minimum muscular fitness tests in school children. Research Quarterly, 25, 178-188.
- Liemohn, W. (1988). Muscular strength and flexibility. Journal of Physical Education, Recreation, and Dance, 59(7), 37-40.
- Mann, G. V. (1974). The influence of obesity on health, part 2. The New England Journal of Medicine, 291, 226-232.
- Melville, D. S., & Cardinal, B. J. (1988). The problem: Body fatness within our profession. Journal of Physical Education, Recreation, and Dance, 59(7), 85-96.
- Melville, D. S., & Maddalozzo, J. G. F. (in press). The effects a physical educator's appearance of body fatness has on communicating exercise concepts to high school students. Journal of Teaching in Physical Education.
- Misner, J. E. (1984). Are we fit to educate about fitness? Journal of Physical Education, Recreation, and Dance, 55(9), 26-28.
- Mood, D. P. (1980). Numbers in motion: A balanced approach to measurement and evaluation in physical education. Palo Alto: Mayfiels.
- Morgan, D. W., Cruise, R. J., Girardin, B. W., Lutz-Schneider, V., Morgan, D. H., Qi, W. M. (1986). HDL-C concentrations in weight-trained, endurance-trained, and sedentary females. The Physician and Sportsmedicine, 14, 166-176.
- Nelson, K. H. (1984). Is corporate fitness really the career of the future? Physical Educator, 41, 100-103.
- Oscari, L. B., Babirak, S. P., Dubach, F. B., McGarr, J. A., & Spirakis, D. N. (1974). Exercise on food restriction: Effect on adipose tissue cellularity. American Journal of Physiology, 227, 901-904.
- O'Shea, J. P., & Wegner, J. (1981). Power weight training and the female athlete. The Physician and Sports Medicine, 9(6), 109-120.
- Oxendine, J. B. (1985). 100 years of basic instruction. Journal of Physical Education, Recreation, and Dance, 56(7), 32-37.
- Paffenbarger, R. S. Jr., & Hale, W. E. (1975). Work activity and coronary heart mortality. The New England Journal of Medicine, 292, 545-550.
- Paffenbarger, R. S. Jr., Laughlin, M. E., Gima, A. S., & Black, R. A. (1970). Work activity of longshoremen as related to death from coronary heart disease and stroke. The New England Journal of Medicine, 282, 1109-1114.

- Pascale, L. R., Grossman, M. I., Sloan, H. S., & Frankel, T. (1956). Correlations between thickness of skinfolds and body density in 88 soldiers. Human Biology, 28, 165-176.
- Pate, R. R. (1983). A new definition of youth fitness. The Physician and Sports Medicine, 11(4), 77-83.
- Plowman, S. A., & Falls, H. B. (1978). AAHPER youth fitness test revision. Journal of Physical Education and Recreation, 49(9), 22-24.
- Pollock, M. L., Hickman, T., Kendrick, Z., Jackson, A., Linnerud, A. C., & Dawson, G. (1976). Prediction of body density in young and middle-aged men. Journal of Applied Physiology, 40, 300-304.
- Pollock, M. L., Laughridge, E. E., Coleman, B., Linnerud, A. C., & Jackson, A. (1975). Prediction of body density in young and middle-aged women. Journal of Applied Physiology, 38, 745-749.
- Pollock, M. L., Schmidt, D. H., & Jackson, A. S. (1980). Measurements of cardiorespiratory fitness and body composition in the clinical setting. Exercise and Sports Medicine, 6, 12-27.
- Prentice, W. E., & Bucher, C. A. (1988). Fitness for college and life, St. Louis: Times Mirror/Mosby College Publishing.
- Robertson, L. D., & Macnusdottir, H. (1987). Evaluation of criteria associated with abdominal fitness testing. Research Quarterly for Exercise and Sport, 58, 355-359.
- Smith, E. L., & Serfass, R. C. (Eds.). (1981). Exercise and aging: The scientific basis, Hillside, NJ: Enslow Publishers.
- Shields, S. L. (Ed.). (1984). The physical education profession in the corporate sector: Its role and influence. Journal of Physical Education, Recreation, and Dance, 55(3), 32-34.
- Sloan, A. W. (1967). Estimation of body fat in young men. Journal of Applied Physiology, 23, 311-315.
- Sloan, A. W., Burt, J. J., & Blyth, C. S. (1962). Estimation of body fat in young women. Journal of Applied Physiology, 17, 967-970.
- Stone, W. J. (1987). Adult fitness programs: Planning, designing, managing, and improving fitness programs, Glenview, Illinois: Scott, Foresman and Company.
- Taylor, H. L., Klepetar, E., Keys, A., Parlin, W., Blackburn, H., & Puchner, T. (1962). Death rates among physically active and sedentary employees of the railroad industry. American Journal of Public Health, 52, 1697-1707.

- Ulrich, C., & Burke, R. K. (1957). Effect of motivational stress upon physical performance. Research Quarterly, 28, 403-412.
- Vincent, W. J., & Britten, S. D. (1980). Evaluation of the curl up: A substitute for the bent knee sit up. Journal of Physical Education and Recreation, 51(2), 74-75.
- Weinsier, R. L., Fuchs, R. J., Kay, T. D., Triebwasser, J. H., & Lancaster, M. C. (1976). Body fat: Its relationship to coronary heart disease, blood pressure, lipids and other risk factors measured in a large male population. The American Journal of Medicine, 61, 815-824.
- Westcott, W. L. (1979). Physical educators and coaches as models of behavior. Journal of Physical Education, Recreation, and Dance, 50(3), 31-32.
- Willgoose, C. E., Askew, N. P., & Askew, M. P. (1961). Reliability of the 600-yard run-walk test at the junior high school level. Research Quarterly, 32, 264-266.
- Wilmore, J. H. (1969). A simplified method for determination of residual lung volumes. Journal of Applied Physiology, 27, 96-100.
- Wilmore, J. H. (1977). Athletic training and physical fitness: Physiological principles and practices of the conditioning process. Boston: Allyn & Bacon.
- Wilmore, J. H. (1983). The 1983 C. H. McCloy research lecture: Appetite and body composition consequent ot physical activity. Research Quarterly for Exercise and Sport, 54, 415-425.
- Wilmore, J. H., & Behnke, A. R. (1969). An anthropometric estimation of body density and lean body weight in young men. Journal of Applied Physiology, 27, 25-31.
- Wilmore, J. H., & Behnke, A. R. (1970). An anthropometric estimation of body density and lean body weight in young women. American Journal Clinical Nutrition, 23, 267-274.
- Wilmore, J. H., Miller, H. L., & Pollock, M. L. (1974). Body composition and physiological characteristics of active endurance athletes in thier 8th decade of life. Medicine and Science in Sports, 6, 44-48.
- World Book Encyclopedia. Archimedes, 1, 604-605. World Book, Inc. Chicago.
- Zuti, W. B., & Golding, L. A. (1973). Equations for estimating percent fat and body density of active adult males. Medicine and Science in Sports, 5, 262-266.

APPENDIX A

STUDENT COMPUTER PRINT OUT
OF
RAW SCORES AND PERCENTILE RANKINGS

NAME: A. B.

<u>ITEM</u>	<u>RAW DATA</u>	<u>UNITS</u>	<u>%ILE</u>
Age	21	Years	79
Weight	130	Pounds	43
Rest HR	65	Beats/Min	63
Systolic	118	Mm of Hg	47
Diastolic	80	Mm of Hg	66
Fat %	17.0	% By Wt.	93
Sit & Reach	21	Inches	23
Curl Ups	100	Reps	98
Bench Press	21	Reps	86
1.5 Miles	13:00	Min:Sec	58
3 Miles	25:36	Min:Sec	40

NAME: S. H.

<u>ITEM</u>	<u>RAW DATA</u>	<u>UNITS</u>	<u>%ILE</u>
Age	20	Years	38
Weight	150	Pounds	16
Rest HR	52	Beats/Min	54
Systolic	122	Mm of Hg	52
Diastolic	82	Mm of Hg	79
Fat %	12.7	% By Wt.	49
Sit & Reach	20	Inches	30
Curl Ups	100	Reps	98
Bench Press	29	Reps	94
1.5 Miles	9:58	Min:Sec	68
3 Miles	19:52	Min:Sec	77

APPENDIX B

PROCEDURES OF HEALTH-RELATED FITNESS TESTS

1.5 MILE RUN

EQUIPMENT: Stopwatch, pen and paper to be placed at the finish line to list order of finishers and times. Indoor or outdoor track with a known distance. The University of Wisconsin - La Crosse outdoor track is a 1/4 mile track (six laps = 1.5 miles). The indoor track is a 220 yard track using the inside lane. Twelve laps, running in the inside lane would be 1.5 miles.

1. Allow adequate time for warm up exercises including stretching and jogging.
2. Gather participants at the starting line. Instruct subjects to cover the 1.5 mile run as quickly as possible. Have them shout out the lap just completed each time they pass the start/finish line. In exchange for the number of laps completed, the timer will shout out the running time from the stopwatch.
3. As the subjects finish the 1.5 mile run they will print their name and time on the numbered paper located at the finish line. If a subject is unable to fill in his/her name and time, a blank will be left so they can fill it in later.
4. Instruct subjects to continue to walk and cool down after they complete the run. Before being dismissed to shower, end the cool down period with stretching.
5. After all instructions have been given, set the participants on the starting line and begin the 1.5 mile run with the commands "set" and "go".

3 MILE RUN

The administration of the three mile run are the same procedures as the 1.5 mile run with a few exceptions.

1. Each runner should pair up with a partner before the run.
2. The test will be given in two groups. One partner from each pair will run with the first group. The other partners will run with the second group.
3. Both the runner and his/her partner will keep track of the total laps completed. As each lap is completed, the runner will shout out the total laps to his/her partner who will then verify the total.
4. The total laps for three miles on the outdoor track at UW-L is twelve. On the inside track, using the inside lane, twenty-four laps must be run.

SIT AND REACH

1. Mark or locate a line on the floor. Place a yardstick perpendicular to the line with the 15" mark corresponding to the near

edge of the line. The yardstick should be taped to the floor to ensure a constant position.

2. Have subject assume a sitting position on the floor with the back straight up and down. The legs are extended straight forward and the back of the legs are pressed firmly against the floor. The heels, with shoes off, should touch the near edge of the line and be about six inches apart. (A partner's feet may be used to brace the subject's feet so that, on the reach, the heels will not slip over the line).

3. Have subject place one hand with fingers extended, palm down on top of the other hand.

4. While keeping the legs straight and flat on the floor, have the subject reach forward upon exhalation, with both hands held together, as far as possible on the yardstick and hold.

5. The farthest point touched by the fingertips must be held for a 1 second count. The farthest point reached and held on the yardstick is recorded to the nearest half inch. DO NOT BOUNCE.

6. The best score of three trials is recorded as the test score.

Bench Press

(using OEI seated bench press machine)

1. The weight stack for men is set at approximately 90% of body weight while dressed in gym clothes. The women's weight is approximately 60% of body weight while dressed in gym clothes. Body weights are rounded to the nearest ten pounds. (ie. 164 lbs. = 160 lbs. and 165 lbs. = 170 lbs.)

2. Set the weight by placing the pin in the appropriate hole in the weight stack. It may be necessary to place a 5 pound weight on the pin to allow for proper setting.

10	o
20	o
30	o
40	o

3. Align body in chair so the horizontal hand grips are between nipple high and two inches above nipples. Adjust seat to the proper height by pulling spring-loaded pin out and raising or lowering the seat. The pin is located under the seat.

4. During all phases of the lift, keep feet flat on the floor with back and head flat against the back pad. NO ARCHING OF THE BACK.

5. Using the horizontal hand grips, begin repetitions with the hand grips just anterior to the chest. It may be necessary to use the foot bar to move the hand grips to the starting position. Once the hand grips are in the proper position, remove foot off of the foot bar.

6. Each complete repetition consists of pushing the hand grips straight out in front of body until both arms are locked, then returning hand grips back to the starting position.

7. The subject repeats the exercise until they fail to push the hand grips away from the body and lock out the arms. The number of properly completed repetitions is recorded as the score.

Modified Curl ups

1. Lie on back with knees bent and feet flat on the floor. Feet are not hooked or held.
2. Interlace fingers and place hands behind head. Bring elbows close together so they are perpendicular to the shoulders.
3. Perform one curl up by keeping lower back flat against the floor, raise shoulders off the ground to allow maximal trunk flexion. Have partner take note of the amount of flexion. This is the distance that must be reached on each curl up during the test.
4. Perform curl ups in cadence with an eighty beats per minute rhythm. Each curl up consists of four smooth counts up and four smooth counts down for an eight count repetition. A tape with a cadence of 80 beats per minute will be used during the test. This allows for twenty curl ups per minute to be performed.
5. Maximum repetitions have been reached when; a) no more curl ups can be performed or b) the curl ups are being performed incorrectly. (ie. curl ups aren't being controlled for four counts on the down phase, curl ups aren't being completed as fast as the cadence or maximal trunk flexion isn't being reached).

APPENDIX C

BENCH PRESS WEIGHT STANDARDS

Weight Standards for Women
(60% of Body Weight)

Weight Standards for Men
(90% of Body Weight)

BODY WEIGHT	WEIGHT LIFTED	BODY WEIGHT	WEIGHT LIFTED
85	50	90	80
90	55	95	85
95	55	100	90
100	60	105	95
105	65	110	100
110	65	115	105
115	70	120	110
120	70	125	115
125	75	130	115
130	80	135	120
135	80	140	125
140	85	145	130
145	85	150	135
150	90	155	140
155	95	160	145
160	95	165	150
165	100	170	155
170	100	175	160
175	105	180	160
180	110	185	165
185	110	190	170
190	115	195	175
195	115	200	180
200	120	205	185
205	125	210	190
210	125	215	195
215	130	220	200
220	130	225	205
225	135	230	205
230	140	235	210
235	140	240	215
240	145	245	220
245	145	250	225
250	150	255	230
		260	235
		265	240
		270	245
		275	250
		280	250
		285	255
		290	260
		295	265
		300	270
		305	275
		310	280

APPENDIX D

PERSONAL FITNESS ASSESSMENT FORM

Name _____ Age _____ M/F _____

Physical Limitations _____

Other _____

Resting Heart Rate:

Pre-Test _____ bpm

Post-Test _____ bpm

Blood Pressure:

Pre-Test _____/_____

Post-Test _____/_____

Cardiovascular Endurance:

	<u>Time</u>	<u>Category</u>	<u>Points Earned</u>
1.5 Mile Run Pre-Test	_____	_____	_____
2 Mile Run Mid-Term	_____	_____	_____
3 Mile Run Post-Test	_____	_____	_____

Coopers's 1.5 Mile Run
Standards:

M > 15:31 W > 18:31	Poor	0
M 12:11 - 15:30 W 16:55 - 18:30	Fair	1
M 10:49 - 12:10 W 14:31 - 16:54	Average	2
M 9:41 - 10:48 W 12:30 - 14:30	Good	3
M < 9:40 W < 12:29	Excellent	4

Muscular Endurance:

BENCH PRESS

Body Weight (BW) _____ lbs. Weight Lifted _____ lbs.

	<u># of Reps</u>	<u>Category</u>	<u>Points Earned</u>
Pre-Test	_____	_____	_____
Post-Test	_____	_____	_____

Bench Press Standards:

Men 90% of Body Weight

0 - 4	Poor
5 - 9	Fair
10 - 16	Average
17 - 23	Good
24 +	Excellent

Women 60% of Body Weight

0 - 3	Poor	0
4 - 8	Fair	1
9 - 13	Average	2
14 - 19	Good	3
20 +	Excellent	4

MODIFIED CURL UPS

	<u># Completed</u>	<u>Category</u>	<u>Points Earned</u>
Pre-Test	_____	_____	_____
Post-Test	_____	_____	_____

Muscular Flexibility:

SIT AND REACH TEST

	<u>Inches</u>	<u>Category</u>	<u>Points Earned</u>
Pre-Test	_____	_____	_____
Post-Test	_____	_____	_____

Standards:

0 - 9 inches	Poor	0
10 - 13	Fair	1
14 - 18	Average	2
19 - 20	Good	3
21 +	Excellent	4

Body Composition:

	<u>% Body Fat</u>	<u>Category</u>	<u>Points Earned</u>
Pre-Test	_____	_____	_____
Post-Test	_____	_____	_____

Standards:

Men	Women		
17 +	30 +	Poor	0
14 - 17	26 - 29	Fair	1
11 - 13	23 - 25	Average	2
9 - 10	20 - 22	Good	3
9 >	20 >	Excellent	4

APPENDIX E

BODY COMPOSITION - HUMAN PERFORMANCE LABORATORY

Subject's Name _____ Age _____ Sex (1=Male/2=Female)

Tester's Name _____ Date (mo/da/yr) _____

Reason for Test _____

***** INFORMED CONSENT AGREEMENT *****

The procedures involved in underwater weighing, residual volume measurement and anthropometric measurements (skinfolds, girths and diameters) have been explained clearly to me and I understand them. To my knowledge I have no physical handicaps or medical conditions that would prevent participation in these tests. I agree to hold harmless the University of Wisconsin - La Crosse and its employees for any accidental injury that might occur as a result of these tests, which I have agreed to take.

Signed _____ Date _____

Vital Lung Capacity: #1_____ liters (to .1) #2_____ liters (to .1)

RESIDUAL VOLUME DATA	TEST 1	TEST 2
Bag Volume of Oxygen (BV)	_____ L to .01	_____ L to .01
Alveolar Nitrogen (AN)	_____ % to .1	_____ % to .1
Impurity Nitrogen (IN)	_____ % to .1	_____ % to .1
Equilibrium Nitrogen (EN)	_____ % to .1	_____ % to .1
Final Nitrogen (FN)	_____ % to .1	_____ % to .1

ANTHROPOMETRY - Subject in swimsuit - DRY - NO SHOWER YET!!

Dry Weight _____ lbs

Height _____ inches

MALES AND FEMALES

MALES ONLY

Triceps Skinfold _____ mm

Chest Skinfold _____ mm

Biceps Skinfold _____ mm

Midaxillary Skinfold _____ mm

Subscapular Skinfold _____ mm

Umbilical Skinfold _____ mm

Suprailiac Skinfold _____ mm

Waist Girth _____ cm

Thigh Skinfold _____ mm

FEMALES ONLY

Wrist Diameter _____ cm

Forearm Girth _____ cm

Max Abdominal Girth _____ cm

Max Gluteal Girth _____ cm

Direct subject to toilet to void any solid, liquid or gas possible.

Direct subject to shower to wash hair and shower completely. Jewelry and contact lenses should be removed before underwater weighing!

DENSITOMETRY:

Immersed weight of Apparatus (MY) _____ kg (to .1) Water temp _____ C
 MX:

(1)_____ (2)_____ (3)_____ (4)_____ (5) _____

(6)_____ (7)_____ (8)_____ (9)_____ (10)_____

Immersed weight of subject and apparatus (MX) _____ kg (to .1)

RESULTS:

APPENDIX F

*** CORRELATION MATRIX ***
(men)

Variables:

TRI	1.00000					
BI	0.80895	1.00000				
SCAP	0.73035	0.86947	1.00000			
ILI	0.60337	0.66935	0.66603	1.00000		
THI	0.80467	0.79719	0.76230	0.62569	1.00000	
CH	0.70575	0.78262	0.79624	0.70507	0.69678	1.00000
AX	0.75889	0.86610	0.92758	0.76995	0.76542	0.76542
UMB	0.76002	0.75761	0.77972	0.75644	0.66197	0.66197
WAIST	0.70000	0.86697	0.86520	0.69097	0.76312	0.76312
WRIST	0.13644	0.11431	0.14024	0.14646	0.20618	0.20618
WTLB	0.61012	0.77113	0.77960	0.60347	0.67319	0.67319
HTIN	0.11698	0.10293	0.02252	0.07769	0.12614	0.12614
BD	-0.79098	-0.81970	-0.80498	-0.66794	-0.81716	-0.81716
	TRI	BI	SCAP	ILI	THI	

CH	1.00000					
AX	0.84481	1.00000				
UMB	0.83168	0.83792	1.00000			
WAIST	0.73315	0.87819	0.73597	1.00000		
WRIST	0.11894	0.16290	0.07814	0.30175	1.00000	
WTLB	0.62767	0.77189	0.61126	0.93067	0.49725	1.00000
HTIN	0.07296	0.03975	0.02904	0.23046	0.54214	0.54214
BD	-0.77306	-0.83090	-0.79292	-0.79121	-0.07500	-0.07500
	CH	AX	UMB	WAIST	WRIST	

WTLB	1.00000			
HTIN	0.43945	1.00000		
BD	-0.64344	0.04895	1.00000	
	WTLB	HTIN	BD	

*** CORRELATION MATRIX ***
(women)

Variables:

TRI	1.00000					
BI	0.67553	1.00000				
SCAP	0.68504	0.72736	1.00000			
ILI	0.71153	0.69572	0.68098	1.00000		
THI	0.73963	0.40453	0.45895	0.58552	1.00000	
FORE	0.47686	0.55765	0.43746	0.40909	0.36656	1.00000
MAXABD	0.36019	0.60740	0.50387	0.38300	0.12725	0.36656
MAXGLU	0.60292	0.65092	0.65399	0.57229	0.43934	0.12725
WRIST	0.14648	0.13634	0.13191	0.10179	0.16533	0.43934
WTLB	0.57468	0.67517	0.63858	0.55666	0.40366	0.16533
HTIN	0.11649	0.13104	0.07349	0.08756	0.08866	0.40366
BD	-0.67935	-0.69924	-0.72616	-0.58644	-0.44190	0.08866
	TRI	BI	SCAP	ILI	THI	
FORE	1.00000					
MAXABD	0.54549	1.00000				
MAXGLU	0.68442	0.72736	1.00000			
WRIST	0.50224	0.19711	0.36575	1.00000		
WTLB	0.79485	0.71543	0.90184	0.45179	1.00000	
HTIN	0.41601	0.20094	0.35734	0.37636	0.52949	1.00000
BD	-0.39506	-0.66143	-0.72306	-0.00904	-0.61904	0.52949
	FORE	MAXABD	MAXGLU	WRIST	WTLB	
HTIN	1.00000					
BD	-0.06341	1.00000				
	HTIN	BD				