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Relationship Between Actual And Perceived Physical Fitness In College Students

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RELATIONSHIP BETWEEN ACTUAL AND PERCEIVED PHYSICAL FITNESS IN COLLEGE STUDENTS

BARRY

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RELATIONSHIP BETWEEN ACTUAL AND PERCEIVED

PHYSICAL FITNESS IN COLLEGE STUDENTS

(TITLE)

BY

Barbara A. Barry

THESIS

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ABSTRACT

THE RELATIONSHIP BETWEEN ACTUAL AND PERCEIVED PHYSICAL FITNESS IN COLLEGE STUDENTS

BARBARA A. BARRY

The purpose of this study was to investigate the relationship between actual and perceived fitness levels in college students. In addition, the effects of actual fitness levels on perceived fitness means and the strength of the correlations was determined. One hundred and one subjects, 35 males and 66 females, ranging in age from 18 to 38 years were selected for this study. All subjects were students in the Health Studies 1200 class for the spring semester of 1989 at Eastern Illinois University. A Perception of Physical Fitness Survey was administered to students in class prior to actual fitness testing. Answers to all 20 statements were summed to determine perceived fitness. Five components of actual fitness were then measured for each subject: Cardiorespiratory endurance (submaximal step-bench test); body composition (by skinfolds); muscular strength (by 1-RM bench press); muscular endurance (1 minute sit-up test); and flexibility (sit and reach test). The actual fitness values were ranked and then summed to determine an overall actual fitness score. A Pearson Product Moment correlation indicated that there was a moderate, but significant relationship ($r=.5610$; $P < 0.05$) between actual and perceived physical

fitness. Gender did not appear to cause a significant difference ($P > 0.05$) in the relationship. A one-way analysis of variance indicated that actual fitness level has a significant effect on perceived physical fitness means. Actual fitness level did not have a significant effect on the correlation between actual and perceived fitness, although it did affect two intercorrelations between the 5 componenets of actual and perceived fitness (perceived and actual strength, perceived and actual flexibility). These effects that appear to be caused by actual fitness may occur because those who are more fit are more interested in fitness or have been exposed to more objective information about their own fitness levels than those subjects who are less fit. Muscular endurance was the component of actual fitness most closely correlated to overall fitness ($r=.6226$; $P < 0.05$). In conclusion, there is a moderate relationship between actual and perceived fitness. It seems that a self-report of fitness could be a marginally valid measure of actual fitness for inter-group comparisons. Actual fitness does apear to affect perceived fitness. If one were to use only one test for fitness, a sit-up (muscular endurance) test may be the test of choice.

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CHAPTER 1

STATEMENT OF THE PROBLEM

Physical fitness has become an important part of the American lifestyle during the past two decades. This increase in the awareness of the importance of physical fitness as a part of health originated with the President's Council on Physical Fitness and Sports established by President Kennedy in the early 1960's. The number one reason that so many individuals participate in some form of exercise is for good health (Blair, Mulder, & Kohl, 1987; Clarke, 1974). According to a report from the Physical Fitness Research Digest (Cklarke,1974), 45% of adults in our society are not engaging in any form of exercise. It also seems that there is a sharp decline in the prevalence of leisure time spent in physical activity that occurs concurrently with the end of high school, more so than in any other age group (Stephens, 1987). Few reasons are given to account for this trend. One explanation might be that young adults perceive themselves as highly fit individuals without as critical a need to exercise as older individuals. The purpose of this study was to further investigate these perceptions of fitness.

A great deal of research has centered on the relationship between level of fitness and self concept (Collingwood, 1972; Collingwood & Willett, 1971; Wilfley, 1986), attitude and exercise behavior (Biddle & Bailey, 1985; Booth, Richards, Sabina, Orban, 1986; Mobily et al., 1987; Rider, Imwold, and Johnson, 1986), and exercise and sense of self-efficacy (Godin & Shephard, 1985; McAuley & Gill, 1983; Ryckman, Robbins, Thornton and Cantrell, 1982). Studies have also investigated the relationship between perceived physical ability and activity level (Dishman, 1978; Safrit, Wood, and Dishman, 1985). Perceived fitness levels have been studied relative to level of physical activity (Netz, 1987) and self-concept (Leonardson, 1977). To date very little research has been completed on the relationship between perceived physical fitness and actual physical finess level. A preliminary literature search revealed only two studies that addressed this question (Booth, 1986; Brandon & Evans, 1988). The study of Booth et al. (1986) was limited to cardiovascular fitness and therefore, is of limited use in the understanding of total fitness. The study of Brandon and Evans (1988), using Physical Education Instructors as subjects, indicated that the actual fitness level was lower than the perceived fitness level. Currently, no known studies have investigated the relationship between perceived and actual levels of total physical fitness in college students.

Total physical fitness has been defined by the American Alliance for Health, Physical Education, Recreation, and Dance to include: muscle strength, muscle endurance, cardiorespiratory endurance, flexibility and body composition (Caspersen, Powell, and Christenson, 1985). Units on physical fitness are commonly taught in introductory courses in health and physical education on college campuses. Information gained from a more comprehensive study of this issue would be of importance in such courses.

Purpose of the Study

The purpose of this study is to determine the relationship between perceived and actual fitness levels of college students.

Research Questions

1. What is the effect of actual overall fitness level on mean perceived fitness?
2. What is the relationship between perceived and actual fitness levels for varying levels of fitness?

Null Hypotheses

There is no relationship between perceived and actual fitness levels of college students.

Actual overall fitness level has no significant effect on perceived fitness.

Varying levels of fitness have no effect on the relationship between actual and perceived fitness levels.

Limitations

The survey instrument that was designed for use in this study has not been formally tested for validity or reliability. However, a few of the statements were based upon phrases from the Physical Self-Efficacy Scale (Ryckman et al., 1982). Only male and female students in three sections of the Health Studies 1200 class were considered as subjects. The Health Studies 1200 class is a required course for all undergraduates at Eastern Illinois University. The three sections were taught by the same instructor, who had expressed an interest in the use of a fitness test battery to aid in the instruction of the Physical Fitness Unit. The fitness testing was a mandatory component of the 1200 course.

Another limitation lies in the field tests used for fitness testing. As the time, expense and instrumentation of direct laboratory testing would have have been prohibitive for such a large group, indirect field testing was implemented for the 101 students.

The submaximal step bench test provides prediction values of VO2 max with a standard error of the estimate that is within 8% of the actual values. The predicted VO2 max from this test was shown to have a correlation coefficient of r=.76 with actual VO2 max values (McArdle, Katch, Pechar, Jacobson, & Ruck, 1972).

The sum of 3 skinfold measures has been shown to have a correlation coefficient greater than 0.97 with hydrostatic weighing (Jackson & Pollock, 1976, 1978, 1982; Pollock, Schmidt, & Jackson, 1980). Percent body fat as measured by skinfolds will range in accuracy from 3.5 to 3.9% of true body fat (Jackson & Pollock, 1982).

Available evidence indicates that the sit-up and the sit and reach tests are at least as valid and feasible as other indirect measures of abdominal muscle strength and endurance, as well as low back/hamstring flexibility (AAPHERD, 1984). The validity of the sit-up test is based primarily on clinical observation. The sit-up involves maximal participation of the upper and lower rectus abdominis, external and internal obliques and minimal involvement of hyperextension of the low back (Flint, 1965; Walters & Partridge, 1957). The reliability estimates for the sit-up test have ranged from 0.68 to 0.94 (AAPHERD Technical Manual, 1984).

Joint flexibility is highly specific throughout the body rather than being a general trait that is common throughout the body joints (Cotten, 1972; Harris, 1969; Hupprich & Sigerseth, 1950; Munroe & Romance, 1975). However, the incidence of lower back pain has prompted use of the sit and reach test. The sit and reach test (Wells & Dillon, 1952) was chosen to test flexibility of the lower back and posterior thigh because it has been noted through clinical observation that those experiencing low back problems tend to have restricted range of motion in the hamstring muscles, as well as the lower back. The reliability coefficents for this test range from 0.84 to 0.98 (AAHPERD, 1984).

Total muscular strength would best be evaluated by measuring strength at several sites on the body, but a one repetition maximal bench press has been shown to have a correlation coefficient of 0.84 with total strength (Berger, 1963) in males.

Definitions

Actual body composition

Actual body composition refers to the amount of fat weight and lean weight (bone, muscle, blood, connective tissue, organs, etc.) that comprise the total body weight, as measured by the skinfold test to determine % body fat.

Actual cardiorespiratory endurance

Actual cardiorespiratory endurance refers to the ability of the circulatory and respiratory systems to supply the body with oxygen and to eliminate waste products during periods of exercise without fatigue, as measured by the submaximal step bench test. Maximal oxygen consumption was estimated from post-exercise heart rates.

Actual flexibility

Actual flexibility involves the ability to move the joints through a wide range of motion without undue strain, as measured by the sit and reach test.

Actual muscular endurance

Actual muscular endurance relates to the ability of muscles to exert force repetitively or in successive exertions, as measured by the bent-knee sit-up test.

Actual muscular strength

Actual muscular strength is the ability of a muscle to exert external force against an object, as measured by the one repetition maximum bench press test.

Health

Health relates to the condition of a being at any one time; it is usually used to describe optimal well-being (American Heritage Dictionary, 1982).

Maximal oxygen consumption

Maximal oxygen consumption is the greatest amount of oxygen that an individual can consume and the greatest amount of energy that an individual is able to generate from the aerobic system at maximal exercise; an indicator of cardiorespiratory endurance.

Perceived body composition

Perceived body composition refers to an individual's awareness of the amount of fat weight and lean weight that comprises his/her total body weight as measured by the Perception of Physical Fitness Survey.

Perceived cardiorespiratory endurance

Perceived cardiorespiratory endurance refers to an individual's awareness of the ability of his/her body to supply the body with oxygen and to eliminate waste products during periods of exercise without fatigue, as measured by the Perception of Physical Fitness Survey.

Perceived flexibility

Perceived flexibility refers to an individual's awareness of the ability of his/her body to move the joints through a wide range of motion without undue strain, as measured by the Perception of Physical Fitness Survey.

Perceived muscular endurance

Perceived muscular endurance refers to an individual's awareness of his/her muscles' ability to exert force repetitively, as measured by the Perception of Physical Fitness Survey.

Perceived muscular strength

Perceived muscular strength refers to an individual's awareness of his/her muscles' ability to exert external force against an object, as measured by the Perception of Physical Fitness Survey.

Perception

Perception is " the process through which we become aware of our environment by organizing and interpreting the evidence of our senses" (Kagan, Haveman, & Segal, 1984).

Perception of physical fitness

Perception of physical fitness refers to an individual's awareness of his/her actual cardiorespiratory endurance, body composition, muscular strength, muscular endurance, and flexibility.

Physical fitness

Physical fitness is " the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" (Clarke, 1974). It includes a set of attributes that people are able to attain including body composition, cardiorespiratory endurance, flexibility, muscular endurance and muscular strength.

Self-efficacy

Self-efficacy refers to a type of self confidence that is situation-specific (Bandura, 1977), as measured by the Physical Self-Efficacy Scale (Ryckman, Robbins, Thornton, & Cantrell, 1982).

CHAPTER 2

REVIEW OF RELATED LITERATURE

Introduction

Physical fitness has become an important part of the American lifestyle during the past two decades. Both physical, health-related benefits and psychological benefits have been ascribed to some form of regular exercise participation (Taylor, Sallis, & Needle, 1985). The public health perspective of exercise participation will first be addressed. Next, the many associations between psychology and exercise will be explored, and more specifically, how the perception of fitness relates to actual fitness. Finally, each of the five components of health-related physical fitness will be discussed, and their relationship to freedom from disease, as well as the measurement methods for best obtaining values for a fitness battery.

Public Health Perspective

Much attention has been focused on health related-physical fitness in the United States in the past two decades, and participation in exercise has increased accordingly. No single source of research has been able to define this participation. Much of the research that has been done is unreliable (Stephens, 1987). Lack of good definitions of exercise and physical activity makes comparison difficult, and samples chosen for these surveys have not always been representative of the entire population. Self-report of such activities is also suspect, as exercise is now seen as a desirable norm and there is societal pressure to conform to this trend. Despite these shortcomings, no major error could negate the general overall trend that shows an increase in leisure time activity (Stephens, 1987).

One of the best known surveys was given to a number of Harvard University alumni (Paffenbarger, 1979). The results from this survey indicate an increase in the number of alumni involved in sports and vigorous activities from 1962-1977.

Another series involved a number of men in the northern Midwest from 1957-1960 to 1979-1983 (Jacobs, 1985). These data imply an increase in leisure time energy expenditure for men in Minnesota.

Results from the 1981 Canada Fitness Survey (Stephens, 1983b) display an increased involvement in sports, but little change in exercise activity in comparison to a 1976 survey.

As far as overall trends are concerned, there seems to be more people involved in vigorous activity (NCHS, 1986; Clarke, 1974; Stephens, Jacobs, White, 1985; ;

Stephens, 1987). Estimates of the numbers involved in exercise range from 20% of the population when using very strict definitions of intense exercise (Caspersen, Christenson, & Pollard, 1986; Stephens, 1987; Stephens et al., 1985) to 60% with less precise definitions (NCHS, 1986; Clarke, 1984; Stephens et al., 1985). The number of sedentary individuals seems to have decreased in the 14 years from 1971-1985 from 40% (NCHS, 1971; Stephens et al., 1985) to near 30% of the population (NCHS, 1986; Stephens, 1987). The most significant trends for increased activity have been seen in women and the aged (Murray and Jarman, 1987; Stephens, 1987).

The main reason that all of these individuals participate in some form of exercise is for good health (Blair, Mulder, & Kohl, 1987; PFRD, 1974). The increase in activity that has occurred over the past two decades seems to coincide with a decreased incidence of coronary heart disease (Cooper et al., 1976; LaPorte et al., 1984; Morris, Pollard, Everett, & Chave, 1980; Paffenbarger, Wing, & Hyde, 1978). This reduced risk of heart attack has been attributed to two mechanisms: 1) direct effects on the heart and 2) risk factor changes (LaPorte, et al., 1984).

It is not clear whether it is improvement in the level of physical fitness (Blair, 1975; Cooper et al., 1976) or the increased activity level, regardless of a change in fitness level that decreases the incidence of coronary heart disease (Corbin, 1987; Cureton, 1987; LaPorte et al., 1984; Morris et al., 1980; Paffenbarger et al., 1978; Ramlow, Kriska, & LaPorte, 1987). Regardless of the proposed mechanism to cause a decrease in the risk of coronary heart disease, maintaining an optimal level of physical fitness is important for other reasons. Physical fitness (cardiorespiratory endurance, muscular strength and endurance, body composition, and flexibility) is necessary to enable individuals to "...carry out routine daily, occupational, recreational, and sport activities, and meet unforseen emergencies" (p.316, Cureton, 1987).

Despite the conflicting data concerning the number of adults participating in exercise and the derived benefits, one consistent trend remains: there is a sharp decline in the prevalence of leisure time physical activity that occurs concurrently with the end of high school, more so than in any other age group (Stephens, 1987). Few reasons are given to account for this trend. One explanation might be that young adults perceive themselves as highly fit individuals without as critical a need to exercise as older individuals. The purpose of this study was to further investigate these perceptions of fitness.

Psychology and Exercise

Exercise has been promoted not only because of its effects on health, but beneficial psychological effects have also been noted due to exercise. Much research has focused on the relationship of exercise and physical fitness to psychological functioning. Investigations have focused on topics such as: The relationship between aerobic capacity and personality traits (Sharp and Reilley, 1975); and the relationship of exercise behavior and attitudes (Biddle, & Bailey, 1985; Godin, Valois, Shephard, 1986; Mobily, Lemke, Drube, Wallace, Leslie and Weissinger, 1987; Onifade, 1985; Richardson, 1960). Others focus on self-motivation and exercise adherence (Dishman, Ickes, & Morgan, 1980; Godin, Desharnais, Jobin and Cook, 1987); self-efficacy and exercise behavior (Bandura, 1977) and sports as a vehicle for developing personal competence (Danish, 1983). The relationship of perception of physical ability to biopsychosocial characteristics is another area of study (Robbins, 1985).

Training effects

A great deal of what has been done relates the effects of physical training to psychology. Most of these focus on some kind of aerobic training, although weight training has been noted to produce beneficial changes in one's self-concept (James, 1982; Tucker, 1983).

Little empirical evidence has documented what effect changes in physical fitness, especially aerobic capacity, have on psychological fitness. Limitations of the research include correlational observations which make cause/effect conclusions difficult, selection bias and confusion as to whether the changes observed are actually due to physical aspects or social and expantancy theory aspects. Many of the surveys employed are those that are global or general in nature, and are perhaps less objective than what would be desirable.

Rider, Imwold and Johnson (1986) showed that 60 high school students' attitudes towards physical activity improved after 15 weeks of participation in the Florida Personal Fitness Course.

Self-attitude has been shown to improve with healthy females after a 12 week exercise program (Franzoi, 1986). An improved self-attitude and a greater self-acceptance have been achieved following training in both male rehabilitation clients (Collingwood, 1972) and male obese teenagers (Collingwood, & Willet, 1971). Self-perception of body consciousness and body competence improved significantly after 6-8 weeks of running and vigorous activity (Skrinar, Bullen, Cheek, McArthur, & Vaughan, 1986). Indeed, changes in body consciousness tended to increase in proportion to improved fitness. Body competence as perceived by the individual, was shown to be affected by changes in neuromuscular coordination, in addition to strength and endurance.

Tennessee Self-Concept Scale

The Tennessee Self-Concept Scale developed by Fitts (1965) contains a subscale which measures how "...the individual is presenting his view of his body, his state of health, his physical appearance, skills and sexuality " (p. 3, Fitts,1965). The reported test-retest reliability for this instrument is 0.92. This scale is often used to measure changes in self concept as a result of training (Hilyer, & Mitchell, 1979; McGowan, Jarman, & Pedersen, 1974; Wilfley, & Kunce, 1986).

One such study (Hilyer, & Mitchel, 1979) involved 120 college students (male and female). Forty students acted as controls, forty students were enrolled in a running program, and forty students were enrolled in a running plus counseling program on a random basis. Both counseling and running only groups showed significant improvements in fitness, as tested by the Cooper 12 Minute Run. Those students with a lower self concept prior to training experienced significant improvements in self concept, whereas those with an already high self concept changed little. The authors attribute the improved self concept in part to increased efficiency gained through training. This improvement in fitness and in self concept with the use of the Tennessee Self-Concept Scale and Cooper's 12 minute run for measurement was also shown by McGowan, Jarman and Pedersen (1974).

Wilfley and Kunce (1986) also demonstrated an improved physical self concept in 49 adults after completing an eight week individualized exercise program. They showed that fitness correlated highly with physical self-concept. Others agree with the conclusion that training has positive influences on an individual's self concept (Hughes, 1984) and the individual's confidence in physical activities (Jasnoski, Holmes, Solomon, & Aguiar, 1981).

It has been suggested that when changes in psychological fitness are related to changes in physical fitness, those that are in the poorest physical and/or psychological condition tend to improve the most (Folkins, Lynch, & Gardner, 1972). Women tended to improve the most in their study involving college students participating in a semester-long running program.

Most of the training studies involving self concept and training show positive results, although some have shown that self-esteem and perception of physical competence did not improve with training (Jirkovsky, 1986; Vedder, 1986).

Physical Self-Efficacy Scale

Many of the previously mentioned studies measured general forms of self concept and self esteem. There are also scales (Ryckman, Robbins, Thornton, & Cantrell, 1982; Sonstroem, 1974) which have been used to assess perceived fitness more specifically.

One of these is the Physical Self-Efficacy (PSE) Scale (Ryckman et al, 1982). It appears that self confidence is situation-specific. Bandura (1977) named this specific self confidence self-efficacy. He suggested that it is the main cognitive mechanism that brings about behavioral change. Perceived self-efficacy is purported to mediate behavior if the proper incentives and necessary skills are present.

The PSE scale contains two subscales, a Perceived Physical Ability (PPA) subscale and a Physical Self-Presentation Confidence (PSPC) subscale. The authors report good test-retest reliabilities (.85 for PPA, .69 for PSPC, and .80 for the composite PSE scale). The scale was significantly related to the Tennessee Self-Concept Scale, lending support to its convergent validity. The PSE scale was also shown to have concurrent validity, as the individuals demonstrating strong self-efficacy tended to exhibit higher levels of self esteem, be less self-conscious, to be more sensation-seeking, and to feel more in control in varying situations. The scale has shown predictive validity in that subjects with a more positive perception of physical skill performed better than subjects with poor self regard on three physical tasks (these tasks however, tended to be more concentrated on reaction time and motor coordination which relate closely to skills-related physical fitness, but less closely with health-related physical fitness). Students who perceived themselves as physically competent tended to have a more extensive experience, as well as current involvement in sports. This also supports the predictive validity of the scale. In all cases, the PPA subscale tended to be more predictive than the PSPC, as far as performance and sports participation is concerned. Further research by Ryckman, Robbins, Thornton and Kaczor (1983) showed that for men and for women, the PPA was related to exercise intensity of work-outs, while the PSPC scores were not.

Even though the PPA subscale focuses more on physical ability, it has been shown to correlate positively with aerobic capacity, flexibility, body composition, muscle endurance and it was inversely related to percentage of body fat (Thornton, Ryckman, Robbins, Donolli, & Biser, 1987). The PPA was not related to muscle strength.

Godin and Shephard (1985) found that there is a gender effect in perceived physical self-efficacy: men showed greater self-efficacy than women. There seemed to be no age effect on physical self-efficacy.

McAuley and Gill (1983) stated that the PSE appears to be a good general predictor of physical self-efficacy in terms of both validity and reliability after testing 52 female collegiate gymnasts. The PSE was less successful however in predicting performance of sport-specific skills.

The PPA subscale scores of the PSE have not been shown to influence exercise behavior, meaning participation in some form of vigorous exercise (Valois, Shephard, & Godin, 1986). The explanation given by the authors is that while sports require specific skills (which the PPA focuses on), there are many types of physical conditioning which do not require a great deal of skill. Thus the PPA might be less effective at predicting such behavior.

Physical Estimation and Attraction Scales

A second type of scale that evaluates self-perception more closely to perceived fitness is the Physical Estimation and Attraction Scales [PEAS] (Sonstroem, 1974). These were designed as an action model for physical activity. Sonstroem's model is based on the hypothesis:

"... that for a person to participate in physical activity, the person must be interested in or attracted to physical activity (Attraction). Also, this person must believe himself capable of achieveing a measure of success at the activity (Estimation)" (p.97, Sonstroem, 1978).

The Estimation items were meant to relate more directly to physical activity than body image. The model proposed by Sonstroem goes on to explain that:

"...physical activity produces physical ability which in turn leads to higher levels of self-esteem. Because the person high in self-esteem has pride in his or her body, exercise behavior persists, fitness is increased or maintained, and the cycle continues" (p.100, Sonstroem, 1978).

The construct validity of the PEAS scale has been demonstrated as the scale has shown significant relationships with other measures of self-esteem (Neale, Sonstroem, & Metz, 1969; Sonstroem, 1974). Research with the scale has failed to show a significant relationship between physical fitness and general self-esteem (Neale et al., 1969; Sonstroem, 1974, 1976). Since fitness seems to be unrelated to self-esteem, it has been suggested that it is not how fit you truly are that matters but how fit you perceive yourself to be that leads to security and self-esteem (Corbin, 1981; Heaps, 1972, 1978; Riley, 1983; Sonstroem, 1976, 1978). From this, Sonstroem posits that "Estimation rather than physical fitness or self-esteem influences one's attraction to or interest in physical activity" (p.101, Sonstroem, 1978).

Self-esteem is seen by theorists as being affected by objective feedback from outside the individual. If self perception of physical ability (Estimation) is to be a valid subdivision of self-esteem, it must have some relationship to actual physical performance. Neale, Sonstroem, and Metz (1969) found that high fit adolescent boys tended to have significantly higher estimates of physical ability and greater attraction to physical activity than low fit boys. Dishman (1978) also reported that estimation of physical ability was significantly related to actual physical fitness in both males and females.

Criterion validity and test-retest reliability of the PEAS also are satisfactory (Sonstroem, 1976, 1978). The scale is reportedly sensitive to attempts to "fake bad" but insensitive to "fake good" attempts as far as response distortion is concerned (Dishman, 1980). It has been noted that the accuracy of self perceptions on this test may be affected by one's defensiveness and not wanting to admit that they do not possess a certain skill or attribute, especially in adolescents (Sonstroem, 1976). The original scales were developed for junior and senior high school boys (Sonstroem, 1974) but a modified version is available for use with adult males and females (Morgan, 1977) and it seems to be valid.

The PEAS seems to be an effective tool for gauging physical self-estimation and somewhat less effective in measuring attitude towards physical activity (Safrit, Wood, & Dishman, 1985). The PEAS involves estimation items which are applicable across various types of sports as well as being sport-specific. The items tend to focus more on physical ability in sports however, instead of estimation of physical fitness.

Other related research has shown estimation of physical fitness to have a significant positive relationship to two physical performance tests: the 600 yard run and the situp test (Young, 1985).

Perceived physical fitness has been shown to be significantly related to exercise participation in men, but not in women (Netz, 1987). Moderate correlations have been noted between perceived and actual physical competence in children (Lintunen, 1987).

Perceived and actual fitness

Little research has actually documented the relationship between actual and perceived levels of physical fitness. Leonardson and Gargiulo (1978) noted a moderate correlation between perceived and actual fitness in 15 students. The only fitness measure used was the

Cooper 12 Minute Run and they designed their own survey. They failed to show a change in perceived fitness with training.

Heaps (1972, 1978) also found little relationship between actual and perceived levels of fitness in 56 male volunteers. Again the fitness measure utilized in this investigation was Cooper's 12 minute run and they designed their own survey. However Heaps did note that perceived fitness will change based on the objective information that a person is given regarding his/her physical state.

One such study investigated 78 nursing students and the accuracy of their self rating of fitness. Based on the answer to one perception question and the results of the Canadian Home Fitness Test, the subjects were not accurate judges of their fitness levels relative to other students (Booth, Richards, Sabina, & Orban, 1986).

Brandon and Evans (1988) have been the only investigators to consider nearly all aspects of health - related physical fitness and to compare these to perceived levels of fitness. Their sample consisted of 20 physical education instructors. They used skinfolds (body composition), situp tests (muscle endurance), a sit-and-reach test (flexibility) and the 6 minute Astrand-Rhyming bicycle test (cardiorespiratory endurance). They did not measure muscle strength. The authors designed their own survey to use in the measurement of perceived fitness. The majority of subjects felt that they were in good physical condition and that they presented a good example of fitness to students. The overall actual fitness levels of the instructors were below average, suggesting a discrepancy in the actual versus perceived levels of fitness, at least in physical educators.

Measurement of Physical Fitness

Total physical fitness has been defined by the American Alliance for Health, Physical Education, Recreation, and Dance (1984) to include: muscle strength, muscle endurance, cardiorespiratory endurance, flexibility and body composition. The definition and measurement of each of these attributes of physical fitness will now be addressed.

Cardiorespiratory Endurance

Cardiorespiratory endurance depends on the coordinated efforts of many systems which are collectively designated the oxygen transport system. If oxygen is to reach the muscles it must go through a series of steps:

1. Oxygen delivery from the atmosphere to the alveoli to the blood.

2. Transport of the oxygen through the cardiovascular system from the heart to the muscles.

3. Exchange of the oxygen at the muscle-blood interface.

4. Transfer and utilization of the oxygen within the muscle cell. (AAPHERD, 1984; Knuttgen, 1969).

It is the concerted actions of the cardiovascular, pulmonary, and muscle systems that determine one's functional capacity or ability to perform endurance exercise. The maximum capacity of the body to consume oxygen is what is defined as cardiorespiratory endurance (VO_2 max).

If the pulmonary system is functioning properly, the capacity of the body to transport oxygen is limited primarily by cardiac output and the arterial-venous (A-V) oxygen difference (Mitchell, Sproule, & Chapman, 1958). These two measures would thus be the optimal measures of the oxygen transport system. The complex methodology required for collecting these data make such a measurement impractical in most settings. Both cardiac output and A-V oxygen difference relate very closely to maximum oxygen uptake [VO_2 max] (Astrand, & Rodahl, 1977; Mitchell et al., 1958). Since VO_2 max is representative of both central and peripheral limitations, it is considered to be the best practical measure of the oxygen transport system. VO_2 max is generally the conventional measurement of cardiorespiratory fitness. The coefficient of reliability for this test is reported to be .95, with S.E. measurement ± 2.4% for treadmill tests (Taylor, Buskirk, & Henschel, 1955).

There are several methods and types of equipment for measuring VO_2 max, including treadmills, cycle ergometers, step tests and arm ergometers. In a national survey that included 1,400 exercise testing laboratories in the U.S., the treadmill was favored by 71% as the most commonly used mode for testing, while the cycle ergometer received votes from 17% and 12% lent support for the step test (Stuart and Ellestad, 1980).

Direct measurement of VO_2 max.

The treadmill is often the method of choice because the machine is what sets the pace, rather than the subject. It involves an action that people are familiar and comfortable with (walking or jogging). The maximum oxygen consumption value that is achieved is usually representative of a centralized oxygen delivery limitation (Shephard, 1984). Disadvantages include the fact that the machines are very costly; they tend to be large and noisy; there is a slight chance that people can fall off while exercising and it is often difficult to obtain additional measurements at the same time (blood pressure or drawing blood samples).

Bicycle ergometers are favored because they are less expensive, produce less noise, are more portable and the subject remains somewhat stationery, allowing more access for ancillary measurements.

One of the major disadvantages of using the cycle ergometer is that many Americans are not familiar with bicycle riding, in contrast with the Europeans, on whom the test was standardized. Indeed Astrand (1952) was unable to demonstrate a difference between VO_2 max values obtained on the treadmill and on the bicycle. He has stated (Astrand, 1967) that the difference in the values obtained from the 2 measures is not too great, and that the advantages of the bicycle justify its use.

Others however, report that the VO_2 max value obtained with the use of a bicycle ergometer is approximately 7-8% less than that obtained with a treadmill (Boileau, Bonen, Heyward, & Massey, 1977; Bouchard et al., 1973; Glassford, Baycroft, Sedgwick, & Macnab, 1965; Hermansen, & Saltin, 1969; Kamon, & Pandolf, 1972; McArdle, Katch, & Pechar, 1973; McArdle, & Magel, 1970; Miyamura, Kitamura, Yamada, & Matsui, 1978; Moody, Kollias, & Buskirk, 1969; Saltin and Astrand, 1967; Shephard, 1982; Shephard et al, 1968; Taguchi, Raven and Horvath, 1971; Wyndham, Strydom, Leary, & Williams, 1966).

During the bicycle exercise, a great deal of the power is generated by the quadriceps muscle (Kay, & Shephard, 1969). The exertion required by such an exercise is large in relation to the power of the muscle. This tends to restrict circulation in the quadriceps (Davies, Tuxworth, & Young, 1970; Glassford et al., 1965; Katch, Girandola, & Katch, 1971; Lind, & Williams, 1979; Moody et al., 1969; Wyndham, Strydom, Leary, & Williams, 1966).

Step tests are another method for measuring VO_2 max (Kasch, Phillips, Ross, & Cater, 1965; Nagle, Balke, & Naughton, 1965). These are advantageous in that they are much less expensive, they are efficient, very portable and require a well-known form of exercise. VO_2 max as measured by step tests has been as close as 3-4% to values from treadmill tests (Shephard, 1984; Shephard et al, 1968).

The arm ergometer is also used for the testing of VO_2 max (Boles, Porter, & Butts, 1982; Kriska, & Robertson, 1982; Marincec and Valincic, 1977-1978; Sawka, Foley, Pimental, Toner, & Pandolf, 1982; Wicks, Lymburner, Dinsdale, & Jones, 1977-1978; Zwiren, & Bar-Or, 1975). The arm ergometer makes use of a much smaller muscle mass, thus the obtained VO_2 max is 20-30% lower than that from a treadmill (Astrand, & Saltin, 1961; Pollock, Foster, & Hare, 1973; Sawka, Foley, Pimental, Tomer,& Pandolf, 1983). Ancillary measurements are difficult to obtain with this method.

Indirect methods of estimation of VO_2 max

Other techniques have been used in estimating VO_2 max. One of the most well known is Cooper's 12 minute run (Cooper, 1968). Running speed and VO_2 max have been shown to have a coefficient of correlation that is near .90 (Cooper, 1968). Shephard's (1982) review of other pertinent literature revealed correlations ranging anywhere from .04 to .90. High correlations only occurs with subjects who are highly motivated, with previous running and pacing experience and are willing to participate in an all-out effort. Obviously, this technique is not for everyone.

Another estimation technique is the Canadian Home Fitness Test (Shephard, 1980). The test involves stepping up and down to a set rate on a record and measuring heart rate at the end of exercise as well as total exercise time. It has been shown to have a .90 correlation with VO_2 max also (Jette, Campbell, Mongeon, & Routhier, 1976; Shephard, 1982).

Because maximal oxygen uptake tests are so demanding of subjects and require a great deal of motivation as well as sophisticated equipment, experienced technicians and many hours, several attempts have been made to develop a submaximal test from which VO_2 max can be predicted.

There have been a few who made use of respiratory data in trying to predict VO_2 max, but they found little relationship between the two (deVries, & Klafs, 1965; Issekutz, Birkhead, & Rodahl, 1962; Rowell, Taylor, & Wang, 1964; Shephard, 1975). Most submaximal tests center around a linear relationship that exists between heart rate and oxygen consumption or heart rate and work load (Astrand, 1960; Dolgener, 1978; Margaria, Aghemo, & Rowell,1965; Maritz, Morrison, Peter, Strydom, & Wyndham, 1961; Shephard et al., 1968; Sjostrand, 1960; von Dobeln, Astrand, & Dolgener, 1967; Wahlund, 1948).

In these tests, measurement at submaximal work loads are extrapolated to predict a maximum value (such as heart rate to predict VO_2 max). In doing so, there are three implicit assumptions: 1) there is a direct linear relationship between heart rate and oxygen consumption, 2) the maximum heart rate is ascertained, and 3) that efficiency is constant across the population (Shephard, 1984; Wyndham, 1967).

It does appear that heart rate and oxygen consumption are linear at submaximal workloads, but near the maximum, the lines asymptote and the relationship is broken (Davies, 1967; Wyndham et al., 1966).

Interindividual variation in maximum heart rate appears to be small (Astrand, 1960; Astrand, & Rhyming, 1954; Davies, 1968, Shephard, 1984; Wyndham, 1967). This variation will be increased with training (Davies, 1967; Wright, Sidney, & Shephard, 1977), altitude changes (Goddard, 1967; Shephard, 1974) and increasing age (Asmussen, & Molbech, 1959; Astrand, 1960; Lester, Sheffield, Trammell, & Reeves, 1968; Sidney, & Shephard, 1977).

Variations may also occur at submaximal work loads which further confounds the relationships. These changes may occur because of emotion and excitement , training, meal times, the amount of hemoglobin in the blood supply (Rowell et al., 1964), hydration of the subject (Astrand, & Rhyming, 1954), ambient temperature (Asmussen, & Molbech, 1959; Astrand, & Rhyming, 1954) and posture (Rowell et al., 1964).

Mechanical efficiency also varies among individuals and types of exercise. There can be differences of up to 4-5% in efficiency when on the bicycle ergometer, 7% while using a step bench and up to 10% on the treadmill (Shephard et al., 1968). Due to all of these variations, the final prediction of VO_2 max may show an error ranging from 10% (Astrand, & Rodahl, 1977; deVries , & Klafs, 1965; Fox, 1973; Shephard, 1984) to 15 or even 20%

(Davies, 1968; Glassford, Baycroft, Sedgwick, & Macnab,1965; Hermiston, & Faulkner, 1971; Rowell et al., 1964).

Despite large variations in some of these methods, the submaximal tests are generally accepted as a valid indication of cardiorespiratory endurance. Such predictions can be made more accurate if measurements are made closer to the maximum value or if two measurements are made at two different submaximal workloads.

Those techniques making use of the heart rate versus oxygen consumption relationship include bicycle ergometer tests which predict VO_2 max by extrapolation using a nomogram (Astrand, & Rhyming, 1954; Margaria, et al., 1965; Maritz et al., 1961). Sjostrand (1947) used the bicycle for the development of a physical working capacity test which operates on the same premises as the others.

Step bench tests are used for predictions of VO_2 max also (Kannel, McGee, & Gordon, 1976; Kurucz, Fox, & Matthews. 1969; McArdle, Katch, Pechar, Jacobson, & Ruck, 1972; Skubic, & Hodgkins, 1963; Witten, 1973). These tests are advantageous in that several people can be tested at one time in field situations, unlike the bicycle ergometer.

The principle behind these stepping tests is that given the same work load, the individual that is in better condition will exhibit a lower heart rate and thus have a higher predicted VO_2 max. Skubic and Hodgkins (1963) designed the Harvard Step Test for women and girls. Their test measured the heart rate in the recovery period after exercise. Astrand and Rhyming (1954) suggested that recovery heart rate is not a very valid measure of stress placed on the heart during exercise. Because of this, McArdle et al. (1972) formulated a three minute step bench test, called the Queens College Test, where the heart rate is counted for 15 seconds immediately following the end of exercise. This test is easier to administer than others (Johnson, & Siegel, 1981). The predicted VO_2 max from this test was shown to have a correlation coefficient of r=.76 with actual VO_2 max values (McArdle et al., 1972). Prediction values were within 8% of the actual values. It is because of these reasons that this step test was chosen for this research project. The regression equations for predicting VO_2 max, in ml/kg/min are:

Men: VO_2 max = 111.33 - (0.42 x heart rate, in bpm)

Women: VO_2 max = 65.81 - (0.1847 x heart rate, in bpm)

(McArdle et al., 1972; p.181, Pollock, Wilmore, & Fox, 1984).

When using these tests and heart rate is measured by the palpation technique, especially in untrained (in taking pulse rates) subjects, some inaccuracy is inherent. McArdle, Zwiren, and Magel (1969) noted a 6-14% difference in heart rate with manual measurement. Witten (1973) reported that the correlation coefficient between palpation and ECG measurement was .95. Gregory (1979) found that there was no significant difference in heart rate as measured by palpation and by telemetry. Greer and Katch (1982) however found a larger discrepancy in that the correlation was .59 for palpation and telemetry, and errors in measurement ranged from 6-11%, causing underestimation of 8% in VO_2 max values. They suggest that the palpation technique tends to be less accurate, and some form of ECG measurement lends much more precision to such predictions. For this reason, heart rate monitors were used to measure heart rate in this study.

Body Composition

Obesity has been associated with greater risk for many serious diseases and conditions including coronary heart disease, hypertension, hypercholesterolemia, diabetes, and cancer (National Institute of Health, 1985). The measurement of obesity by body weight alone is not very definitive. It seems that the percentage of body fat is more relevant to obesity.

The most basic method for determining ideal body weight or body composition has been the use of weight relative to height tables (Baecke, Burema, & Durenbdrg, 1982; Billewicz, Kemsley, & Thompson, 1962; Forbes & Arimhakimi, 1970; Lohman, Boileau, & Massey, 1975; Roche, Siervogel, Chumlea, & Webb, 1981; Rolland-Cachera, et al., 1982; Seltzer, Goldman, & Mayer, 1965; Shephard, Jones, Ishii, Kaneko, & Albrecht, 1969). Several researchers have noted that these height/weight indices are not an accurate predictor of body fat due to the very low correlation that the height/weight index has to body fat (Benn, 1971; Frisancho & Flegel, 1982; Garn & Pesick, 1982; Lee, Kolonel, & Hinds, 1987; Norgan & Ferro-Luzzi, 1982; Roche, 1984; Rosenbaum & Skinner, 1985). Investigators have relied on other indirect measurements for estimating body density to establish a more valid predictor of body composition. These methods include hydrostatic weighing (Behnke, 1942; Wilmore, 1983), measurement of fat soluble gases (Behnke, Thomson, & Shaw, 1935; Lesser & Deutsch, 1967; Lesser, Deutsch, & Markofsky, 1971; Lesser, Peri, & Steele, 1960), creatinine excretion (Boileau, Horstman, Buskirk, & Mendez, 1972; Forbes & Bruining, 1976; Grant, Custer, & Thurrlaw, 1981; Heymsfield, Artega, McManus, Smith, & Moffitt, 1983), the excretion of the amino acid

3-methylhistidine (Lukaski, Mendez, Buskirk, & Cohn, 1981b; Mendez, Lukaski, & Buskirk, 1984), anthropometric measurements (Brozek & Keys, 1951;Forsyth & Sinning, 1973; Katch, Behnke, & Katch, 1979;Katch & McArdle, 1973; Lohman, 1981;), measurement of total body nitrogen from neutron activation analysis (Lukaski, Mendez, Buskirk, & Cohn, 1981a), and measurement of total body potassium (Burkinshaw, 1978; Burkinshaw, Morgan, Silverton, & Thomas, 1981; Cohn, Dombrowski,& Pate, 1969; Cohn & Dombrowski, 1970). Other methods include body impedance analyzers (Kushner & Schoeller, 1986; Lukaski, Johnson, Bolonchuk, & Lykken, 1985), and total body electrical conductivity (Presta, Harrison, Bjorntorp, Harker, & Van Itallie, 1983) to estimate total body water. All of these methods are indirect measurements of body composition. The truest measures of body composition are direct methods which chemically analyze animal carcasses (Jones et al., 1964; Mickelsen & Andersen, 1959; Oscai, Spirakis, Wolff, & Beck, 1972; Oscai, Babirak, Dubach, McGarr, & Spirakis, 1974) and human cadavers (Clarys, Martin, & Drinkwater, 1984; Forbes, Cooper, & Mitchell, 1953; Mitchell, Hamilton, Steggerda, & Bean, 1945; Pawan & Clode, 1960; Thomas, 1962; Widdowson, McCance, & Spray, 1951). Most of these techniques require a great deal of time, specialized equipment, a laboratory setting and skilled technicians, making them rather impractical for testing a large number of people.

Hydrostatic weighing

In the 1930's, the United States Navy spurred an interest in the design of a technique for measuring the body composition of divers. This led to the method known as hydrostatic weighing which makes use of body density to estimate body fat. This technique became the standard against which all other methods of body compostion are tested (Roche, 1987; Wilmore, 1983). In the practical day-to-day methods that are often used, body fat is predicted from body density with indirect methods.

Hydrostatic weighing makes use of Archimedes' principle of displacement to predict body density. The protocol requires measurement of weight both underwater and on land. The density of lean body mass is greater than water, and fat has a density that is less than the density of water. Because of these differences, a person with greater lean body mass for the same total body weight will have a greater weight in water and a greater body density and thus a lower percentage of body fat (AAPHERD, 1984).

Volume of the body can be calculated using this equation:

$$BV = (Ma - Mw / Dw) - (LV + 0.1)$$

Where: BV = Body Volume

Ma = body mass in air

Mw = body mass in water

Dw = density of water

LV = volume of air held in lungs when weighed underwater

Density is then calculated with the formula: density = mass / volume. And from body density, percent body fat may be found by using either of these two formulas:

Percent Fat = [(4.950 / body density) - 4.500] 100 (Siri, 1961)

Percent Fat = [(4.570 / body density) - 4.142] 100 (Brozek, Grande, Anderson, & Keys, 1963). Both of these equations are based on the assumption that body components are constant in nature. Both are correlated closely and give similar mean numbers (Behnke & Wilmore, 1974). Unfortunately, these equations were not based on a representative sample of the population and they may not be valid for use with children or the elderly (Lohman, 1982), as well as the black population (Schutte, et al., 1984) and athletes (Forsyth & Sinning, 1973; Lohman, 1984; Wilmore, 1983).

There are two major sources of error in the hydrostatic weighing procedure (Katch & Katch, 1980; Lohman, 1981). One source is biological in nature due to intrasubject variation (such as state of hydration, general overall health status, etc.). The other source is from technical errors arising from measurement of the lung volume and measurement of underwater weight. Despite these errors, hydrostatic weighing is still the most effective indirect technique for estimating body composition.

Anthropometric measurement

Anthropometric measurements are much more practical for testing large groups and they are closely correlated with hydrostatic weighing. The technique is less expensive, needs little space or complicated equipment, and one can acquire the necessary measures quickly and with ease (Jackson & Pollock, 1980).

Skinfold calipers are often the measurement of choice to predict body fat. The technique involves the measurement of the thickness of a double fold of skin and compressed adipose tissue. In this method, the assumption is that the uncompressed double layer of adipose tissue is represented by the compressed double layer of skin and adipose tissue. Such a measurement indicated what the total adiposity is beneath the skin. This adiposity is then converted to body fat by calculation, and the internal fat must be included (Clarys, Martin, & Drinkwater, 1984; Martin, Ross, Drinkwater, & Clarys, 1985).

Clarys and co-workers (1984) dissected actual measured fat from male and female cadavers, which was compared to percent body fat as predicted from skinfold measurements. From the results of this comparison, the authors report that various samples exhibited a mean compressibility ranging from 16% to 51%. They noted age, sex, sites and state of hydration as suggestions for the variability seen in the experiment. Other results included the observation that the same skinfold values can mean a great discrepancy in the actual thickness of adipose tissue. They reported that skin usually does not account for much of the total skinfold thickness, but it can cause significant errors, especially when the subjects are very lean. The fat content of adipose tissue tends to increase as adiposity increases, so one cannot assume that the fat content of adipose tissue is constant.

Brozek and Keys (1951) were the first to develop regression equations to predict body composition from skinfolds in young men and those of middle-age in 1951. Then Sloan, Burt, and Blyth (1962), Young (1964), and Young, Martin, Tensuan, and Blondin (1962) published equations based on skinfolds for women in the 1960's. During the late 1960's and the 1970's, many more equations were developed for men and women, in the hopes of designing equations that would be more accurate. These equations often included circumference and bone diameter measurements, in addition to skinfolds. The development of computer technology during this time enhanced researchers' abilities to design stepwise multiple regression programs. This permitted the analysis of several variables and the selection of the most predictive combinations of variables. Investigators found that those equations which took into account skinfolds, circumferences and diameters tended to have greater accuracy than those equations based solely on skinfolds, especially in females and males that were middle-aged (Pollock et al., 1976; Sloan, 1967).

Body density has been shown to vary greatly with age and sex. This was noted as research efforts migrated towards population-specific equations. The difference in body density between males and females is basically because of variation in the amount of essential fat (Behnke & Wilmore, 1974). Males and females also differ in the deposition of subcutaneous fat (Parizkova, 1977). In addition, bone density changes may be associated with aging. It seems that bone density increases up to age 20 and tends to be reduced after age 50 (Lohman, 1981; Cureton, 1947). Because of these differences, equations that are designed from one group tend to be biased if applied to subjects differing from the original group in age, sex or fatness (Lohman, 1981). If prediction equations are developed on a younger population, they will underestimate the body density in subjects who are older. In addition, using equations that are specific to one gender will produce a constant prediction error of 0.025 g/ml (11% fat) if used on the opposite sex (Lohman, 1981).

There is another error that is inherent in the use of population specific equations. These equations are based on the assumption that there is a linear relationship between skinfold fat and body density, as determined by hydrostatic weighing. This is not the case however, as the relationship is curvilinear, not linear (Jackson & Pollock, 1978). Such a relationship means that the population-specific equations were most accurate for those subjects who were at the mean of the population on whom the equations was tested. As individuals stray from the mean though, there is a significant increase in measurement error (Jackson & Pollock, 1976).

More recently, there has been an increase in the interest of developing generalized equations, rather than those that are population-specific. These generalized equations are valid and representative of the defined populations (Pollock et al., 1984). Durnin and Womersley (1974) were the first investigators to consider the generalized equations. Results from their research indicated correlation coefficients for the sums of two or more skinfolds and body density to range from -0.70 to -0.90. They further noted that accuracy increases as the complexity of the equation increases, but that this increase is minimal. The most recent generalized equations were developed by Jackson and Pollock for adult males (1978) and females (1980). Their research continued the trend that began with Durnin and Womersley, and they generated equations in the hopes of overcoming the errors that prevailed with population-specific equations. Jackson and Pollock included age in the actual equation to adjust for possible changes that might occur in body density and in the ratio of internal to external fat (Jackson & Pollock, 1982).

In order to develop the equation for males, Jackson and Pollock (1978) studied 403 men that ranged in age from 18-61 years. They were able to find equations that correlated with hydrostatic weighing as closely as r=.918.

When studying the 331 adult women aged 18-55 (Jackson, Pollock, & Ward, 1980), the authors noted that the sum of skinfolds showed the highest correlations with hydrostatic weighing, whereas correlations were lower with the single skinfold values. Indeed the correlation of the sum of three skinfold measures as correlated with hydrostatic weighing is greater than 0.97 (Jackson & Pollock, 1976, 1978, 1982; Pollock, Schmidt, & Jackson, 1980). If circumference values were added into the equation, there was little effect on the correlation.

The quadratic equations that took into account age and the curvilinear relationship between body density and skinfold fat did not elevate the correlations significantly above the linear equations. What they did , however, was to reduce the prediction errors that were present at extremes of the distribution of body density (Pollock, Wilmore, & Fox, 1984).

One must realize that error is still inherent in these methods. Hydrostatic weighing has been noted to have a standard error of 2.5-2.7% body fat (Lohman, 1981). It seems that the generalized equations only add approximately 1% more to this standard error if the measurement technique is accurate. This means that percent body fat as measured by skinfolds will range in accuracy from 3.5 to 3.9% body fat (Jackson & Pollock, 1982). One other possible source of error is that of inter-tester reliability. However, many studies have shown that there is high intertester reliability, especially if the testers are very experienced (Chumlea & Roche, 1986; Jackson, Pollock, & Gettman, 1978; Keys & Brozek, 1953; Munro, Joffe, Ward, Syndham, & Fleming, 1966; Pollock et al., 1976; Tanner & Weiner, 1949). Despite the source of error in this method, it seems that the prediction equations are very appropriate for ranking individuals as to their body composition (Katch & McArdle, 1975).

Muscular Strength

It is easy to see that maintaining a certain level of muscular strength and muscular endurance would be important to health in that they both allow one to be more efficient in every-day activities. Muscular strength includes both static and dynamic contractions. Methods for testing strength have included weights; dynamometers; cable tensiometers; computer-assisted, electromechanical and isokinetic devices; and elaborate force transducers and recorders (McArdle, Katch & Katch, 1981; Pollock, Wilmore & Fox, 1984; Wilmore, 1982)

Cable tensiometers have long been used in strength measurement. This test makes use of an adapted and calibrated tensiometer originally designed for measuring the tension of aircraft cables. This instrument is used to determine the amount of tension that an individual can apply to a cable that is placed in specific positions for differing movements (Clarke, 1948, 1950; Clarke, Bailey & Shay, 1952). This tool can measure the pulling force of a muscle where there is almost no change in the external length of a muscle. The tensiometer is easily transported, easily maneuvered and it holds up well over time. It is also advantageous in that one can make measurements at many angles within the range of motion for each joint. Fitness batteries have been designed to measure the static contraction of muscles that move the neck, shoulders, trunk, elbows, forearms, wrists, thumbs, hips, knees, and ankles (Clarke, 1948, 1950; Clarke, Bailey & Shay, 1952). These tests are especially useful with rehabilitation from an injury or disease because one can isolate and test the specific muscles that have been weakened (McArdle, Katch, & Katch, 1981). Test-retest reliability for the tensiometer has been noted to be between 0.91 and 0.97 for the various test batteries (Clarke, 1948).

Another method that is commonly used involves either hand-grip or back-lift dynamometers. Both of these instruments operate on the compression concept. If a subject exerts a force that is applied to the dynamometer, a steel spring is compressed, which causes a pointer to move a certain distance. From the movement of the pointer, and knowing what amount of force is needed to move the pointer, one can measure how much external force was applied to the device (McArdle, Katch, & Katch, 1981). Test-retest reliability for the hand-grip dynamometer has been estimated to range from 0.84 to 0.99 (Bohannon, 1986).

More sophisticated equipment can be very expensive, as well as time consuming, and the accuracy gained from such equipment may not be that much greater than the accuracy of field tests (McArdle, Katch, & Katch, 1981). Strength can be easily measured with the one-repetition maximum test [1-RM] (Berger, 1963, 1982; McArdle, Katch, & Katch, 1981; Pollock, Wilmore, & Fox, 1984). A specific muscle or a group of muscles is selected to be measured and then each subject is given trials to find the greatest amount of weight that can be lifted only once. Such a test is administered on a trial-and-error basis where the subjects start out at a weight that they can lift comfortably, and then weight is added in 1,2, or 5 kilogram increments until maximum capacity is achieved (Jackson, 1986; Pollock, Wilmore, & Fox, 1984). A true 1-RM means that the weight can not be lifted correctly more than once by an individual.

If a single test is to be used, the 1-RM bench press is usually used. Berger (1963, 1982) noted that there are moderately high intercorrelations among bench press, standing military press, curl-exercises, back hyperextension, squats, sit-ups and rowing. He studied 174 college men and determined that bench press (r = 0.84) and standing military press (r = 0.87) were the 2 best isolated methods for predicting total strength (Berger, 1963). Because of safety and the ease of administration, the 1-RM bench press is most often selected for use (Pollock, Wilmore, & Fox, 1984).

Muscular Endurance

There have been many different methods used to assess muscular endurance (the ability of the muscles to exert force repetitively). These methods include the sit-up test (greatest number performed within one minute) or the greatest number of continuous pull-ups, push-ups or bar dips that can be done by an individual, without a set time limit (Baumgartner & Jackson, 1982; Berger, 1982; Golding, Myers,

& Sinning, 1982; Pollock, Wilmore, & Fox, 1984). These tests however, tend to discriminate against those with short arms, long legs or a great deal of body weight. Because of this, some researchers have suggested that the test consist of using a fixed percentage of a subject's body weight for the resistance. Then the subject would keep lifting until reaching a state of fatigue (Berger, 1982). No definite guidelines have been set as to exactly how much of an individual's body weight should be used. It has been suggested that such a test depends greatly on muscle strength, therefore the test battery should be designed on the basis of individual muscle strength. This would help to isolate this test as a pure determination of endurance and reduce the dependence on strength for such a measurement (Pollock, Wilmore, & Fox, 1984). Unfortunately, no norms or standards have been established for specific populations to allow evaluation.

The two traditional muscular endurance tests are the push-ups to measure the upper body, including the triceps, anterior deltoids, and pectoralis major and the sit-ups to measure the abdomen (AAPHERD, 1984; Baumgartner & Jackson, 1982; Golding et al., 1982).

The sit-up test tends to be chosen most often due to the ease in administration and its relation to low back pain, which is becoming an increasingly larger health problem in this country (AAPHERD, 1984). This usually involves a bent-knee sit-up with the individuals in a back-lying position and performing as many correct sit-ups within 60 seconds as possible (Pollock, Wilmore, & Fox, 1984). Indeed, this test is valid in that the abdominals are active during this exercise and hyperextension of the lower back is diminished (Flint, 1965; Godfrey, Kindig, & Windell, 1977; Kendall, 1965; Robertson & Magnusdottir, 1987; Walters & Partridge, 1957) although some would argue about the role of the lower back plays in this movement (Robertson & Magnusdottir, 1987). There are not a great deal of data available on the reliability of this test, but estimates range from 0.68 to 0.94 (AAPHERD, 1984). Based on these numbers, it would seem to be an acceptable test of muscular endurance. The interpretive error of this test is due essentially to the subject's inability or failure to execute the movement correctly (AAPHERD, 1984).

Flexibility

Flexibility involves the range of motion or freedom of movement of a joint. The degree of flexibility depends upon the actual structure of the joint, as well as the elasticity and the extensibility of muscles and ligaments. A lack of flexibility may be associated with poor posture and low back pain. Attaining a high level of flexibility may improve one's sport performance, as well as help to decrease the incidence of muscle injury and soreness from physical activity (Corbin & Noble, 1980).

Flexibility can be assessed with many instruments. These include: simple tape measures, rulers, and calipers; arthrometers (for measuring joints); fleximeters (to measure the degree of bending); and goniometers (to measure angles), ranging from the simple Leighton (1955) flexometer to more complex and sophisticated electrogoniometers (electric), photogoniometers, and radiogoniometers (Corbin & Noble, 1980).

The Leighton (1955) flexometer has long been used as a tool for measuring flexibility. Its test-retest reliability coefficients range from .913 to .966 (Leighton, 1955). This is the measure against which many other techniques are compared to to establish validity. Measuring flexibility does not involve making one simple measurement with a flexonometer however. It seems that flexibility is highly joint specific, rather than being an attribute that is common throughout all body joints (Clarke, 1975; Corbin & Noble, 1980; Cotten, 1972; Fieldman, 1968; Harris, 1969; Hupprich & Sigerseth, 1950; Munroe & Romance, 1975). Thus to get a true measurement of an individual's flexibility, one would need to take many measurements and a great deal of time. Not many of the other more sophisticated types of equipment are readily available, so one turns to the single field tests in measuring large groups during a short period of time.

It is acknowledged that reliance upon a measurement at isolated joints will not be as accurate or valid as if measuring all of the body joints. Because the emphasis of the other tests considered in this health-related physical fitness test battery pertain to overall health and well-being, lower back flexibility becomes the main target of flexibility assessment.

It is estimated that 80% of all people in the United States suffer from some type of lower back pain at some point in their lives (Amundsen, 1973, Liemohn, 1988). Clinical observation has noted that those experiencing low back problems tend to have a lack of flexibility in the back of the legs (hamstrings), hips and lower back (AAPHERD, 1984; Corbin & Noble, 1980; Kraus, 1970). To measure this capability, field tests have been developed which test trunk, hip, and back flexibility.

One of the first tests was the Scott and French (1950) test. Subjects would stand on a bench or chair, and bob downward, reaching down with their fingertips, without bending the knees. Apparently this having to bend downward led to feelings of apprehension and insecurity for some students, so that they were unable to put forth a maximum effort.

Another common test was the Kraus-Weber test for flexibility, which involved trying to touch the floor with the fingertips from a standing position, without bending the knees (Kraus & Hirschland, 1954). Cureton (1973) also devised such tests. One was similar to the Kraus-Weber test. Another involved sitting on the floor with legs stretched out in front and bending forward at the trunk. A third had subjects lie on their stomachs and bend backwards from the trunk.

The Wells and Dillon (1952) Sit and Reach Test is very often used for this purpose. The test requires that individuals sit down with legs extended and stretch forward as far as possible with the palms along a scale, extending the hamstring and low back muscles (Cotten, 1972; Jackson & Baker, 1986; Wells & Dillon, 1952). If a subject is unable to stretch forward in this manner, it is usually indicative of a lack of flexibility in these muscles. The validity of this test is based solely on logic.

Reliability estimates for the test range from 0.64 (Jackson & Baker, 1986) to more commonly reported values of 0.84 to 0.98 (AAPHERD, 1984; Wells & Dillon, 1952). Of all such tests, the sit and reach test tends to correlate most highly with the Leighton Flexometer (Cotten, 1972; Matthews, Shaw, & Bohnen, 1957). The test seems to be a good impartial test in that leg length is not a factor, nor is the ratio of trunk and arm length to leg length (Cotten, 1972). It is also not related to standing reach, lower limb length, or standing height according to Matthews, Shaw, & Bohnen (1957). Those individuals with extreme anthropometric lengths, poor postures or lack of flexibility in the upper back muscles (rhomboid & trapezius) however, may invalidate the results (AAPHERD, 1984). Many norms and standards are available for this test.

CHAPTER 3

METHODOLOGY

Introduction

The purpose of this research project was to determine the relationship between perceived and actual fitness levels of college students. The description of the subjects, the experimental methodology and collection of data are explained in this chapter.

Subjects

One hundred and one subjects, 35 males and 66 females, participated in this study. The individuals were all enrolled in the Health Studies 1200 class for the spring semester of 1989 at Eastern Illinois University. Males ranged in age from 18 to 38 and females ranged in age from 18 to 22 years. The mean age for all subjects was 19. The physical characteristics of the subjects are depicted in Table 1.

Design of Questionnaire

The survey used to measure perceived physical fitness was developed specifically for this study. The 20 question instrument contained questions which were related to

Table 1

Means and SD of physical characteristics

	Age	Weight(lbs)	Height(inches)
Male (N = 35)			
Mean	19.5	163.6	69.1
SD	3.4	28.3	3.0
Female (N = 66)			
Mean	18.4	133.3	64.5
SD	0.9	18.6	2.4
All subjects (N=101)			
Mean	18.8	143.8	66.1
SD	2.2	26.6	3.4

overall fitness level as well as sub-categories of questions that dealt with the five components of health related physical fitness: body composition, cardiorespiratory endurance, muscular strength, muscular endurance, and flexibility. A few of the questions were based on items in the Physical Self-Efficacy Scale (Ryckman et al., 1982), which is a reliable and valid instrument. A Likert scale was used to measure students' responses to the perception of physical fitness statements. They were asked to circle a number from one to four, one indicating that they strongly disagreed and four indicating that they strongly agreed. A few of the statements were reversed to prevent response set from contributing to self perceptions of fitness (subjects from answering the questions in a set pattern, independent of statment content).

The instrument was pretested in a pilot study with 12 students at Eastern Illinois University. A few minor changes were made based upon their suggestions. The survey was also examined by experts in the field of questionnaire construction and exercise physiology to test for readability and content validity. A copy of the survey is included in Appendix A.

Surveys were administered to the students in the second week of class, prior to the units on physical fitness. A cover letter was distributed along with the surveys that explained the purpose of the survey and that results would be kept confidential. Students were allowed time to complete the surveys in class and then the surveys were collected. A total of 128 surveys were completed.

Assessment of Actual Physical Fitness

All testing was conducted in the Human Performance Lab and in the Student Fitness Center. All investigators received written standardized instructions and were briefed prior to the assessment so that testing methodology remained consistent across time. Each subject underwent 5 fitness tests in a random order. Subjects received verbal standardized instructions for all of the tests. Time was allowed for questioning and to ensure that subjects understood the nature of the tests. Time was also given to permit stretching and a warmup period, where subjects practiced the movements. All tests were carefully supervised to prevent injury. All testing was done within a week and a half of the completion of the survey. All data were recorded on standardized results sheets, which are shown in Appendix B (male) and Appendix C (female). The subjects received a written record of their performance on the physical fitness tests for class instruction purposes. A total of 101 students were tested for actual physical fitness, reducing the final number of subjects to 101.

Cardiorespiratory endurance

The Queens College Submaximal Bench Stepping Test (McArdle, 1972) was used to measure cardiorespiratory endurance. The test involved stepping up and down on a bench that was 16.25 inches high. The male subjects worked at a rate of 24 steps/minute and female subjects at 22 steps/minute for a total exercise time of three minutes. A tape recording was utilized to keep a steady uniform rate for all groups. At the end of the three minutes, subjects remained standing. All heart rates were measured using Vantage heart rate monitors. Heart rates were counted for 15 seconds after stopping the test. The 15 second heart rates were multiplied by 4 to get beats per minute. VO_2 max (in ml/kg) was then calculated using the following regression equations:

Men: VO_2 max = 111.33 - (0.42 x heart rate, in bpm)

Women: VO_2 max = 65.81 - (0.1847 x heart rate, in bpm) (McArdle et al., 1972; p. 181, Pollock, Wilmore, & Fox, 1984).

Body composition

Weight was measured to the nearest ½ pound, on a balance beam scale (Physician's) with the subjects in minimal clothing. Height was measured to the nearest 1/4 inch with a standard ruler device. Measurements were taken from the crown of the head with subjects looking straight ahead and standing with shoulders back and shoes removed.

A Lange skinfold caliper was used to obtain the skinfold measurements to the nearest millimeter for all sites on the right side of the body. One investigator took all of the skinfold measurements. A minimum of 2 measurements were made at each site, and if the measurement varied by more than one milimeter, a third measurement was made. Skinfold sites on the females were: abdomen, triceps, and suprailium. The skinfold sites measured on the males were the triceps, chest, and subscapular areas.

The Jackson-Pollock equation was used to calculate body density from skinfolds (Jackson & Pollock, 1978; Jackson, Pollock, & Ward, 1980).

$$\text{Male Density of Body} = 1.1125025 - (0.0013125 \times \text{sum of skinfolds}) + [0.0000055 \times (\text{sum of skinfolds})^2] - (0.000244 \times \text{age})$$

$$\text{Female Density of Body} = 1.089733 - (0.0009245 \times \text{sum of skinfolds}) + [0.0000025 \times (\text{sum of skinfolds})^2] - (0.0000979 \times \text{age})$$

Body density was converted to percent body fat using the Siri equation (1961).

$$\%\ \text{Body Fat} = [\ (4.950\ /\ \text{body density}) - 4.500]\ 100$$

Muscular strength

Strength was assessed by the 1-RM bench press test. Each individual underwent a series of trials to determine the greatest amount of weight that could be lifted only once. The subjects began by holding the weight up with their arms extended. The weight was then brought down to the chest, just above the 3rd or 4th rib and lifted back up by the subjects. The test was conducted through a trial-and-error method, where the subjects began with a weight that could be lifted without much difficulty, and then progressed consecutively to higher weights until they could correctly lift the weight only one time (Pollock, Wilmore, & Fox, 1984).

Muscular endurance

Muscular endurance was assesed by the 1 Minute Bent-Knee Sit-up Test. The subjects began by lying down on their backs, with their knees bent. Feet were placed on the floor, and the heels were kept 12 to 18 inches from the buttocks. Hands were held behind the head with fingers interlocked. Partners were used to count the number of sit-ups completed and to hold the subjects' feet firmly to the ground. The subjects completed as many sit-ups as possible within 60 seconds. In the up position, subjects had to touch their knees with their elbows. Then they had to return to a complete down position where the mid-back made contact with the floor, before beginning the next sit-up. The total number of correct sit-ups within 60 seconds was recorded (Pollock, Wilmore, & Fox, 1984).

Flexibility

Flexibility was measured by the Sit and Reach Test. For this test, the subjects sat on the floor after removing their shoes. They extended their knees fully and placed their heels flat against a testing box. A yardstick was attached to this box, with the 15 " mark having been placed at the spot where the feet touched the box. The knees of the subjects were held down by the investigators, while they extended their arms straight forward, one hand on top of the other, with fingertips even. The subjects reached directly forward as far as possible with their palms down along the scale. The farthest distance reached within 3-4 trials was noted on the yardstick and recorded to the nearest 1/4 inch.

Statistical analysis

All five scores on the actual fitness tests were ranked from one to six, according to norms from the Cooper Clinic and Pollock, Wilmore, & Fox (1984), with one being the lowest score and six being the highest score possible. The norms are shown in Appendix D. A total of these rankings was then calculated to determine overall actual fitness (AFIT). For the Perception of Physical Fitness Survey, scores on the questions worded in reverse were converted (for instance, 4 = 1, 3 = 2, etc.) so that a total score of Perceived Physical Fitness (PFIT) could be calculated from the answers to the 20 statements. Sub-categories of questions were also summed to determine perceived general fitness (PGEN); perceived cardiorespiratory endurance (PCEND); perceived body composition or body fat (PBF); perceived muscular strength (PSTR); perceived muscular endurance (PMEND); and perceived flexibility (PFLEX). The statements contained within these components are listed in Appendix D.

Descriptive statistics, including means, standard deviations, and frequency distributions were compiled on all variables and categories. A correlation matrix was calculated using the Pearson Product Moment Correlation for all variables and categories measured in this study. Fischers' Z-tests were calculated to determine whether or not there was a significant difference in the correlations between the high and low fit (top 25% and lower 25%, respectively) groups. A one-way analysis of variance was performed to detect whether differing levels of actual fitness (top 25%, middle 50 %, and bottom 25%) had an effect on perceived fitness. All statistics were done using SPSS.

CHAPTER 4

ANALYSIS OF THE DATA

Introduction

The purpose of this study was to investigate the relationship (correlation) between perceived and actual levels of physical fitness in college students. In addition, a one-way analysis of variance was calculated to determine what the effect of actual fitness level has on perceived fitness means. Fischer's z_r transformation was used to detect the significance of the differences between correlations of actual and perceived fitness in high and low fit groups.

Data Conversion

All five scores on the actual fitness tests were ranked from one to six, one being the lowest score and six being the highest score possible, according to norms from the Cooper Clinic and Pollock, Wilmore, & Fox (1984) The norms are shown in Appendix E. A total of these rankings was then calculated to determine overall actual fitness (AFIT). For the Perception of Physical Fitness Survey, scores on the questions worded in reverse were inverted so that a total score of Perceived Physical Fitness (PFIT) could be calculated from the answers to the 20 statements.

Subcategories of questions were also summed to determine perceived general fitness (PGEN); perceived cardiorespiratory endudrance (PCEND); perceived body composition or body fat (PBF); perceived muscular strength (PSTR); perceived muscular endurance (PMEND); and perceived flexibility (PFLEX). The different perceived fitness components are defined by the statements which were contained within them in Appendix E. The intercorrelations between all of the statements and components are shown in Appendices F and G.

Findings

Relationship Between Actual and Perceived Fitness

Actual physical fitness (AFIT) was found to be moderately, but significantly (at the 0.05 level) correlated with perceived physical fitness (PFIT) [r=.5601; N = 94]. In males this correlation was r=.4448 (N=35), whereas in females the correlation was r=.6361 (N=59). Both of these were significant correlations. Additionally, a post-hoc analysis (Fischer's z_r transformation) revealed that these correlations were not significantly different from each other (z=1.236; $P > 0.05$)). These correlations are shown in Table 2 for the whole group; Table 3 for males and Table 4 for females.

Table 2

Correlations between actual and perceived fitness

for whole group

	AFIT	MEND	CEND	BF	STR	FLEX	PFIT
PFIT	.5601*	.3182*	.2805*	.4775*	.5971*	.0406	
	(94)	(94)	(94)	(94)	(94)	(94)	
PGEN	.4404*	.1617	.2894*	.4010*	.4754*	.0128	.7753*
	(98)	(98)	(98)	(98)	(98)	(98)	(94)
PMEND	.3125*	.4188*					.6268*
	(98)	(98)					(94)
PCEND	.1963*		-.0226				.6447*
	(98)		(98)				(94)
PBF	.3970*			.6592*			.6535*
	(96)			(96)			(94)
PSTR	.3256*				.5762*		.7587*
	(98)				(98)		(94)
PFLEX	.3313*					.4484*	.3708*
	(99)					(99)	(94)

* denotes a significant correlation ($P < 0.05$)

( ) = N of group

Table 3

Correlations between actual and perceived fitness for males

	AFIT	MEND	CEND	BF	STR	FLEX	PFIT
PFIT	.4448*	.3592*	.2285*	.1636	.5792*	.1868	
	(35)	(35)	(35)	(35)	(35)	(35)	
PGEN	.3666*	.1619	.3215*	.2354	.5723*	.0296	.7802*
	(35)	(35)	(35)	(35)	(35)	(35)	(35)
PMEND	.0328	.3764*					.4462*
	(35)	(35)					(35)
PCEND	-.0210		-.2382				.5653*
	(35)		(35)				(35)
PBF	.4228*			.5127*			.6193*
	(35)			(35)			(35)
PSTR	.1937				.6096*		.8122*
	(35)				(35)		(35)
PFLEX	.5474*					.5162*	.6149*
	(35)					(35)	(35)

* denotes a significant correlation ($P < 0.05$)

( ) = N of group

Table 4

Correlations between actual and perceived fitness for females

	AFIT	MEND	CEND	BF	STR	FLEX	PFIT
PFIT	.6361*	.4343*	.3979*	.3409*	.4830*	.1866	
	(59)	(59)	(59)	(59)	(59)	(59)	
PGEN	.4425*	.2274*	.3199*	.2202*	.2552	.2042	.7023*
	(63)	(63)	(63)	(63)	(63)	(63)	(63)
PMEND	.4560*	.4934*					.7061*
	(63)	(63)					(59)
PCEND	.2446*		.0957				.5662*
	(63)		(63)				(59)
PBF	.3071*			.6363*			.5443*
	(61)			(61)			(59)
PSTR	.3846*				.4002*		.6198*
	(63)				(63)		(59)
PFLEX	.1549					.3775*	.3041*
	(64)					(64)	(59)

* denotes a significant correlation ($P < 0.05$)

( ) = N of group

Relationship Between PFIT and AFIT Components

When relating perceived physical fitness (PFIT) to the five components of actual fitness, muscular strength (STR) had the highest correlation with PFIT (r=.5971; N=94). The correlation between body composition (BF) and PFIT was r=.4775 (N=94); muscular endurance (MEND) and PFIT was .3182 (N=94); cardiorespiratory endurance (CEND) and PFIT was .2805; and flexibility (FLEX) and PFIT was .0406 (N=94). All of the components of actual fitness were significantly correlated with PFIT with the exception of flexibility(FLEX).

Relationship Between PFIT and PFIT Components

When looking at the components of PFIT and overall PFIT, perceived muscular strength (PSTR) was found to have the highest correlation with PFIT (r=.7587; N=94). The correlation between perceived cardiorespiratory endurance (CEND) and PFIT was r=.6647 (N=94); perceived body composition (PBF) and PFIT was r=.6535 (N=94); perceived muscular endurance (PMEND) and PFIT was r=.6268 (N=94); and perceived flexibility (PFLEX) and PFIT was r=.3708 (N=94). All of these correlations were significant at the 0.05 level.

Relationship Between AFIT and PFIT Components

When comparing the components of perceived physical fitness (PFIT) and actual physical fitness (AFIT), perceived body composition (PBF) had the highest correlation with AFIT (r=.3970; N=96). The correlation between perceived flexibility (PFLEX) and AFIT was r=.3313 (N=99); perceived muscular strength (PSTR) and AFIT was r=.3256 (N=98); perceived muscular endurance (PMEND) and AFIT was r=.3125 (N=98); perceived cardiorespiratory endurance (PCEND) and AFIT was r=.1963 (N=98). All of these correlations were significant at the 0.05 level.

Relationship Between PGEN and AFIT; PGEN and PFIT

The sum of the 4 questions in the Perceived Physical Fitness Survey that pertained to general overall fitness level (PGEN) was moderately, but significantly correlated with AFIT (r=.4404; N=98). PGEN and PFIT were found to have a stronger and significant correlation of .7753 (N=94).

Relationships Between AFIT Components and PFIT Components

The correlation between actual and perceived body composition (BF and PBF) was the highest of the component relationships (r=.6592; N=96). Muscular strength achieved the second highest relationship between actual and perceived values (STR and PSTR), with an r of .5762 (N=98). Next was flexibility (FLEX and PFLEX) with r=.4484 (N=99);

then muscular endurance (MEND and PMEND) with r=.4188 (N=98). All of these relationships were significant at the 0.05 level. The correlation between actual and perceived cardiorespiratory endurance (CEND and PCEND) had the lowest correlation, with r= -.0226 (P > 0.05;N=98).

The correlations described previously are displayed in Table 2 for the whole group. The correlation values for males are shown in Table 3 and for females in Table 4.

Effect of actual fitness on PFIT means

In order to determine whether or not actual fitness level had an effect on perceived fitness means, a one-way analysis of variance was performed. The subjects were divided into 3 groups (top 25%, middle 50%, low 25%), based upon the sum of their actual fitness rankings. Group 1 (consisting of AFIT=7-13) had a mean PFIT score of 49.73. Group 2 (consisting of AFIT=14-18) had a mean PFIT score of 53.98. Group 3 (consisting of AFIT=19-26) had a mean PFIT score of 59.96. The results of this one-way analysis of variance are shown in Table 5. The analysis of variance indicated a significant actual fitness effect on perceived fitness(F value = 17.0779; P < 0.05). Tukeys B procedures conducted at the 0.05 level of significance indicated that

Table 5

<u>Analysis of variance summary for effects of actual fitness on perceived fitness</u>

Source of variation	SS	D.F.	MS	F	Significance level
Treatment	1283.3014	2	641.6507	17.0779	$P < 0.05$
Error	3419.0497	91	37.5720		
Total	4702.3511	93			

all three group means were significantly different from one another.

Effect of Actual Fitness on the Strength of Correlations

Correlations between actual and perceived physical fitness were calculated for those who were high fitness (top 25% of AFIT scores [AFIT => 19] N = 23) and for those in the low fitness level (bottom 25% of AFIT scores [AFIT =< 13] N = 26) groups for the purpose of investigating what effect actual fitnes had on the correlations. A Fischer's z_r transformation was used to determine whether or not there were significant differences in the correlations between the high fit and low fit groups.

The correlation coefficient for AFIT and PFIT for the high fit group was r=.4539 and for the low fit group, r was .0503 (z_r = 1.44; $P > 0.05$). The correlation coefficent for AFIT and PGEN for the high fit group was r=.4982 and for the low fit group, r was -.1099 (z_r = 2.15; $P < 0.05$). The correlation coefficient for MEND and PMEND for the high fit group was r= -.0761 and for the low fit group, r was .4066 (z_r = 1.66; $P > 0.05$)). The correlation coefficient for CEND and PCEND for the high fit group was r= -.1365 and for the low fit group, r was .0620 (z_r = .248; $P > 0.05$). The correlation coefficient for BF and PBF for the high fit group was r=.7216 and for the low fit group, r was .6482 (z_r = .15; $P > 0.05$). The correlation coefficient for STR and PSTR for the high fit group was r=.6632 and for the low fit group r was -.0829 (z_r = 2.88; $P < 0.05$). The correlation coefficient for FLEX and PFLEX for the high fit group was r=.0379 and for the low fit group r was .5791 (z_r = 2.04; $P < 0.05$). Only those correlations between PGEN and AFIT; PSTR and STR; and PFLEX and FLEX were significantly different from each other. The correlations for the high fit and the low fit group are shown in Table 6.

Table 6

Correlations between actual and perceived fitness for low and high fit groups

	AFIT	MEND	CEND	BF	STR	FLEX
PFIT	.0503 .4539					
PGEN	-.1099* .4982*					
PMEND		.4066 -.0761				
PCEND			.0620 -.1365			
PBF				.6482 .7216		
PSTR					-.0829* .6632*	
PFLEX						.5971* .0379*

* denotes a significant difference (P < 0.05) in correlations between high fit and low fit groups

Low fit group (AFIT < 13; N = 26) is the top number listed

High fit group (AFIT > 19; N = 23) is the bottom number listed

Relationship between AFIT and AFIT components

A post hoc analysis on the correlation of the components of actual fitness to overall actual fitnessindicated that muscular endurance (r=.6226; N = 101; P < 0.05) was the most closely related to AFIT. Muscular

Table 7
Correlations between actual fitness and the components of actual fitness

	FLEX	STR	MEND	CEND	BF
AFIT	.5198*	.5863*	.6226*	.6170*	.4877*

* denotes significance ($P < 0.05$)

strength ($r=.5863$; $N = 101$; $P < 0.05$), cardiorespiratory endurance ($r=.6170$; $N = 101$; $P < 0.05$), and flexibility ($r=.5198$; $N=101$; $P < 0.05$) were all similar in their relationship to overall AFIT. Body fat showed the weakest correlation ($r=.4877$; $N = 101$; $P < 0.05$) with actual fitness. These results are displayed in Table 7.

Discussion

The purpose of this study was to determine the relationship between actual and perceived physical fitness in college students. One must recognize that self evaluations are not entirely ojective. These self reports of fitness may be influenced by defenses against self-revelation and by desires for approval or social acceptability(Sonstroem, 1976). Because of this, it must be recognized that response style (conscious or unconscious motives to answer the statements in a certain way to portray a certain image of themselves) may have contributed to the PFIT (perception of physical fitness) scores, and that they may not be completely accurate. It is also not known what effect experience or knowledge may have had on the subject's perceptions as reported by the Perception of Physical Fitness Survey in this study.

Another limitation lies in the field tests used for fitness testing. As the time, expense and instrumentation of direct laboratory testing would have been prohibitive for such a large group, indirect field testing was used for testing actual fitnessfor the subjects. Some inaccuracy is inherent in these tests.

Relationship between Actual and Perceived Fitness

A moderate, but significant ($P < 0.05$) relationship was found between these two variables. The correlation coefficient was .5601 (N=94). Nearly one third (31.4%) of the variance in perceived fitness scores can be accounted for by the actual fitness scores ($r^2 = .3137$). This is somewhat in agreement with previous studies. Young (1985) found a significant positive relationship between the estimation of physical fitness as defined by the PEAS and the 600 yard run and sit-up test. Leonardson & Gargiulo noted moderate correlations (r=.50 and .52) between perceived fitness, using their own survey and the Cooper 12 minute run. Heaps (1972, 1978) found little relationship (r=.27) between actual and perceived fitness, based on Cooper's 12 minute run.

Brandon and Evans (1988) have been the only investigators to document perceived and actual total physical fitness of subjects. They included nearly all of the health-related aspects of physical fitness, but their sample consisted of only 20 physical educators. They also did not use any statistical analysis to determine the actual relationship between the two measures. They merely reported a discrepancy betweeen the high levels of perceived fitness and the below average levels of physical fitness in their subjects. Thus our results would seem to be in agreement with the literature, in that there is a slight to moderate relationship between actual and perceived fitness, at least in college students. From the relationship observed in this sample, the data imply that perceived and actual physical fitness are related, and that a self report of fitness could be a marginally valid measure of fitness. This is in agreement with a suggestion of Leonardson (1977), in which performance was found to be moderately related to perceptions of performance. Due to the moderate correlation that was found between these two measures, it would probably not detect specific interindividual differences, but if one desired to compare fitness levels of two or more groups, the self report may be of use as a valid measure of actual fitness. Even though the correlation was a significant one, an investigator would need to be aware that the self-report is still likely to be a less accurate measure of fitness than actual fitness tests.

In males the correlation between actual and perceived physical fitness was r=.4448 (N=35), whereas in females the correlation was r=.6361 (N=59). Both of these correlations were significant, but a post-hoc analysis revealed that these correlations were not significantly different from each other. Little evidence has been presented to date which notes whether there is a gender difference in the relationship of actual to perceived fitness in college students, especially as both measures are defined in this study. Riley (1983) has suggested that gender may have a mediating effect on Estimation (as measured by the PEAS) and its relationship to physical performance in adolescents, although correlations were not performed between Estimation and performance (only between Estimation and self-concept, and between performance and self-concept). Dishman (1978) noted slight differences in the correlations between Estimation and aerobic power (VO_2 max) due to gender. He reported correlation coefficients of .369 and .272 for males, and .326 and .363 for females, all four correlations being significant. Again, differences between these previous studies and the present study include the more comprehensive nature of fitness measured here, as well as the perception survey referring more to health-related physical fitness, rather than fitness that is motor, coordination or skill-related in nature, as the PEAS tends to be. Given that others have noted a gender difference in estimation of themselves (Riley, 1983; Dishman, 1978), it could have been that the disparity in size of the groups between males (N=35) and females (N=66) masked any significant differences due to gender. Perhaps a gender effect would have occurred if sex was equally distributed.

Relationship Between PFIT and AFIT Components

Muscular strength was the component of actual fitness which was most closely correlated with PFIT (r=.5791; N=94). This was followed by body composition, then muscular endurance, cardiorespiratory endurance, and then flexibility. These results are slightly different from the data of Thornton, Ryckman, Robbins, Donolli, and Biser (1987). They used the PSE scale and found that PPA (perceived physical ability) correlated positively with aerobic capacity, flexibility, body composition, and muscle endurance. Muscle strength was shown to have no correlation with PPA. This discrepancy could possibly be explained by the makeup of the perception tests in the two studies. The test used in this study focused specifically on physical fitness, and it is easy to see how muscle strength is important in this area. However, the PPA relates to specific physical abilities, especially those that are skill and coordination related, and the relationship with muscle strength might be less clear in this instance.

Relationship Between PFIT and PFIT Components

It is interesting to note that perceived muscle strength was the most closely related to PFIT of all the components of perceived fitness (r=.7587; N=94), much the same as with actual fitness components. It appears that both perceived and actual muscle strength relate most closely to perceived fitness. Strength is something that is self-tested in daily activity. Other components are more difficult to assess. People may have a more accurate perception of their fitness because of this.

Relationship Between PGEN and AFIT

The sum of the four questions in the Perceived Physical Fitness Survey that pertained to general overall fitness level (PGEN) was moderately, but significantly related to AFIT (r=.4404; N=98). This is less of a relationship than that seen between total perceived fitness (r=.5601), thus it may be that a more comprehensive measure of all components of physical fitness is better than a subscale (PGEN) that consists of a few generalized statements. Perhaps 3 statements were not sufficient enough to elicit accurate responses. Also, the more specific statements may have provided more of a point of reference, giving the students more objective information to base their answers on. The entire survey, that contains more specific statements, appears to be a more useful tool for measuring perception of physical fitness.

Relationship Between AFIT Components and PFIT Components

In breaking down physical fitness into the five components, the correlation between actual and perceived body composition (BF and PBF) was the strongest of all five relationships (r=.6592; N=96). Next was musclular strength, then flexibility, and muscular endurance. A negative correlation was found between actual and perceived cardiorespiratory endurance, where the correlation coefficient was -.0226 (N=98). Thus it appears that the student's perceptions of fitness were most accurate for body composition and least accurate for cardiorespiratory endurance. These differences could be due to subjective interpretation of the statements. With society's emphasis on thinness, students might have received more information regarding what is good and what is bad in terms of body composition. Standards for aerobic capacity are less clear cut, more individualized, and less publicized in popular media. Perhaps another reason for the poor relationship between CEND and PCEND was due to question construction in the Perception of Physical Fitness Survey. One of the questions was rather ambiguous (I would be able to jog for long distances without tiring). Responses to the other two questions may have been due to variation in students' subjective interpretation of the questions.

Effect of Actual Fitness On PFIT Means

The one-way analysis of variance provides evidence for a proposition that actual fitness levels did have a significant effect on the perceived fitness means. For those subjects of a higher fitness level, their perceived fitness means were significantly higher than those who were in a medium fitness category, and those subjects with the poorest levels of fitness. Neale, Sonstroem, and Metz (1969) found that high fit adolescent boys tended to have significantly higher estimates of physical ability and greater attraction to physical activity than low fit boys. Dishman (1978) also reported that estimation of physical ability was significantly related to actual physical fitness in both males and females. Results of the present study are consistent with results of the aforementioned study and suggest that a positive relationship exists between perceived and actual fitness. Other factors, however, affect perception of physical fitness. Further studies are needed to identify these factors, which might include current level of exercise participation or intensity, or possibly age.

Effect of Actual Fitness On the Strength of Correlations

When correlations between actual and perceived fitness were calculated separately for those of high and low levels of actual fitness, the AFIT and PFIT correlation for the highly fit subjects was r=.4539 (N=23), whereas the correlation for the poorly fit subjects was r=.0503 (N=26). While the difference between these two correlations approached significance, they were nof significantly different. However,the high fit correlation was significantly different than 0, whereas the correlation for the low fit group was not significantly different from 0. Three of the component correlations for these two groups did display a significant difference: PGEN and AFIT; PSTR and STR; PFLEX and FLEX. It appears that the level of actual fitness does have some effect on the strength of the correlations between actual and perceived fitness.

Due to the statistical nature of this study (correlational), no definitive conclusions can be made regarding the causal relationship between actual and perceived fitness. From the statistical analysis, it seems that actual fitness levels had some effect on perceived fitness means and the strength of the correlations between actual and perceived fitness.

Sonstroem (1978) suggested that physical ability results from physical activity, which causes increased levels in self-esteem. Because of this, individuals take pride in themselves, and persist in exercise behavior and the cycle continues. Research has failed to show significant relationships between fitness and general self-esteem (Neale et al., 1969; Sonstroem, 1974; 1976). As fitness and self-esteem seem to show a poor relationship, it has been suggested that it is not how fit you are that matters, but how fit you perceive yourself that leads to security (Corbin, 1981; Heaps, 1972; 1978; Riley, 1983; Sonstorem, 1976; 1978). Sonstroem goes on to suggest that "...Estimation rather than physical fitness or self-esteem influences one's attraction to or interest in physical activity" (p.101, Sonstroem, 1978).

It seems that those subjects who were more highly fit could have perceived themselves to be more highly fit because they were more interested in fitness. Heaps (1978) has noted that the similarity between perceived and actual fitness, and thus, the relationship between personality and actual fitness, will vary based on how much objective information a person receives about him/herself. This supports the accordance or discordance between his/her perceived and actual fitness levels. Perhaps this group as a whole has not been exposed to enough objective information about their actual fitnes, and thus the poor congruence between actual and perceived fitness levels. It could be that because the high fit groups are more interested in fitness, that they voluntarily seek out more information and evaluation about personal fitness. If this is in fact true, then more objective tests of physical fitness, such as those used for the students in this Health Studies Class need to be offered, so that the students receive more objective information about their actual levels of fitness. According to Heaps (1978), especially if this information is positive, this should help to improve the relationship between a person's perceived fitness and personal self-attitude.

Relationship Between AFIT and AFIT Components

It seems that muscular endurance was the most closely correlated component of fitness to total overall fitness, although all relationships were significant and moderate. The reason for the closest relationship being muscular endurance could be because the sit-up test is one that many are very familiar with, in comparison to the others. If one was forced to use only one test for fitness, because of time restraints, these results would suggest that the muscular endurance test would relate most closely to overall fitness, but that flexibility, strength, and cardiovascular endurance are all similar in their relationship to overall fitness. A comprehensive test of actual fitness including all five components remains the most useful and informative measurement of fitness.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to investigate the relationship between perceived and actual physical fitness levels in college students. In addition, the effects of actual fitness levels on mean perceived fitness and the strength of correlations was determined.

One hundred and one subjects, 35 males and 66 females, ranging in age from 18 to 22 years were selected for this study. All subjects were students in the Health Studies 1200 class for the spring semester of 1989 at Eastern Illinois University.

The Perception of Physical Fitness Survey was administered to students in class, prior to actual testing or any discussion of fitness in class. Answers to all 20 statements were summed to determine perceived fitness. Five components of actual fitness were then measured for each subject: cardiorespiratory endurance (by submaximal step-bench test), body composition (by skinfolds), muscular strength (by 1-RM bench press), muscular endurance (by one minute sit-up test), and flexibility (by sit and reach test). All testing was done in a random order. The actual fitness values were ranked from one to six, one being the lowest score and six being the highest. The five rankings were then summed to determine an overall actual fitness score.

The Pearson Product Moment correlation method was used to determine the relationships between actual and perceived fitness. A one-way analysis of variance was used to detect the effect of actual fitness on perceived fitness means. A Fischer's z_r transformation was used to test for significant differences between correlations.

Conclusions

Correlation coefficients indicate that there is a moderate, but significant relationship between actual and perceived physical fitness (r = .5601). Gender does not appear to cause a significant difference in the relationship. It seems that a self-report of fitness could be a marginally valid measure of actual fitness for inter-group comparisons.

A one-way analysis of variance indicates that actual fitness level has a significant effect on perceived physical fitness means. Actual fitness did not have a significant effect on the correlation between actual and perceived fitness, although it did affect two intercorrelations between components of actual and perceived fitness. These effects that appear to be caused by actual fitness may occur because those who are more fit, are more interested in fitness or have been exposed to more objective information about their own fitness levels than those subjects who are less fit. If this is indeed the case, more objective information should be offered to students on their personal fitness levels (such as was done for this Health class), thus possibly improving the relationship between perceived fitness and actual fitness.

Muscular endurance was the component of actual fitness most closely related to overall fitness ($r = .6226$). This correlation indicates that muscular endurance would be the sub-test of choice if one had to select only one fitness test, although a more comprehensive battery remains the most objective measure.

Recommendations

The following recommendations are made, based on the results of this study:

1. Replicate this study, using a larger sample and using samples of different ages to determine gender and age effects.

2. Conduct further study on the relationship between actual and perceived fitness before and after a training period to determine training effects, especially on those in the low fit group prior to training.

3. Conduct validity investigations of the Perception of Physical Fitness Survey, noting its relationship to other tests of self-concept (Tennessee Self-Concept Scale) or self-efficacy (PPA of PSE) or Estimation of physical ability (PEAS) to determine convergent validity.

4. Replicate this study and re-administer the perception survey after the students have received feedback on their actual fitness levels to determine whether perceived fitness scores change based on the objective information given to a person regarding his/her fitness state.

5. Conduct reliability studies on the Perception of Physical Fitness Survey.

6. Replicate this study and include records of regular exercise participation and intensity to determine what effects exercise participation and intensity have on actual and perceived fitness, and their relationship.

7. Conduct further studies to determine what other variables affect levels of perceived fitness.

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APPENDIX A

PERCEPTION OF PHYSICAL FITNESS

The purpose of this survey is to gain insight into how you perceive your level of physical fitness. Please answer each question honestly; the results will be kept confidential. Circle the number that best represents your feelings about the statements. Your cooperation is appreciated.

Below, please indicate (by circling) what your social security number is:

1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9
0	0	0	0	0	0	0	0	0

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
1. I would be able to walk long distances without tiring.	1	2	3	4
2. I have very little body fat.	1	2	3	4
3. I would have difficulty doing stretching exercises.	1	2	3	4
4. I would get short of breath by climbing more than one flight of stairs.	1	2	3	4
5. I have good muscle strength.	1	2	3	4
6. I would be able to stand for long periods of time without tiring.	1	2	3	4
7. Overall, I am physically fit.	1	2	3	4
8. I have difficulty lifting heavy objects.	1	2	3	4
9. I would be able to do more than 30 sit-ups in one minute.	1	2	3	4
10. I am fat.	1	2	3	4
11. I cannot walk 5 miles without my legs aching.	1	2	3	4

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
12. I am very flexible.	1	2	3	4
13. I exercise regularly enough to maintain good physical fitness.	1	2	3	4
14. I am within 5 pounds of the ideal weight for my height.	1	2	3	4
15. I have good muscle tone.	1	2	3	4
16. I would be able to jog for long distances without tiring.	1	2	3	4
17. I would be able to touch the floor easily when I bend over.	1	2	3	4
18. I am in good physical condition.	1	2	3	4
19. I need to lose weight.	1	2	3	4
20. I would be able to ride 10 miles on a bicycle without being out of breath.	1	2	3	4

APPENDIX B

Name (please print) ____________________________________

Social Security # ______ - ______ - __________

Age ______ Ht. _______ Wt. ________ Sex Male

Skinfolds: Sit & Reach ______

Chest ______ Max Bench Press ______

Triceps ______ Sit-ups ______

Subscapular ______ Step Test Heart Rate Pre ______

% Body Fat ______ Post ______

Max VO_2 ______

Name ____________________________________

% Body Fat __________ Sit & Reach __________

Sit-ups __________ Bench Press __________

Step Test __________

APPENDIX C

Name (please print) ____

Social Security # _____ - _____ - _________

Age _____ Ht. _______ Wt. ________ Sex Female

Skinfolds: Sit & Reach ______

Abdomen ______ Max Bench Press ______

Triceps ______ Sit-ups ______

Suprailiac _____ Step Test Heart Rate Pre ______

Body Fat ______ Post ______

Max VO_2 _______

Name ____________________________________

% Body Fat ________ Sit & Reach __________

Sit-ups ________ Bench Press __________

Step Test ________

APPENDIX D

Muscle Strength (5,8,15)

I have good muscle strength.
I have good muscle tone.
I have difficulty lifting heavy objects.

Muscle Endurance (1,6,9,11)

I would be able to do more than 30 sit-ups in one minute.
I would be able to stand for long periods of time without tiring.
I would be able to walk long distances without tiring.
I cannot walk 5 miles without my legs aching.

Flexibility (3,12,17)

I am very flexible.
I would have difficulty doing stretching exercises.
I would be able to touch the floor easily when I bend over.

Cardiovascular Endurance (4,16,20)

I would be able to jog for long distances without tiring.
I would get short of breath by climbing more than one flight of stairs.
I would be able to ride 10 miles on a bicycle without being out of breath.

Body Composition (2,10,14,19)

I am fat.
I have very little body fat.
I need to lose weight.
I am within 5 pounds of the ideal weight for my height.

General Fitness Level (7,13,18)

Overall, I am physically fit.
I am in good physical condition.
I exercise regularly enough to maintain good physical fitness.

APPENDIX E

Fitness norms for males aged 20-29

	6 (super)	5 (excel.)	4 (good)	3 (fair)	2 (poor)	1 (very poor)
Sit-Ups (#/min)*						
	> 49	48-43	42-39	38-35	34-31	30-
Sit and Reach (inches)*						
	> 23.5	23.0-21.0	20.5-19.0	18.5-17.5	17.0-15.5	15.0-
Bench Press (% body wt.)*						
	> 1.55	1.54-1.26	1.25-1.09	1.08-0.94	0.93-0.76	0.75-
Step Bench (ml/kg)**						
	> 54.1	54.0-49.0	48.9-45.8	45.7-41.9	41.8-37.7	37.6-
Body Fat (% fat)**						
	< 8.7	8.8-12.9	13.0-16.0	16.1-19.4	19.5-23.6	23.7-

* denotes norms from the Cooper Clinic

** denotes norms from Pollock, Wilmore and Fox (1984)

Fitness norms for females aged 20-29

	6 (super)	5 (excel.)	4 (good)	3 (fair)	2 (poor)	1 (very poor)
Sit-ups (#/min)*						
	> 37	36-31	30-28	27-24	23-20	19-
Sit and Reach (inches)*						
	> 22.0	21.5-19.0	18.5-16.5	16.0-15.0	14.5-13.0	12.5-
Bench Press* (% body wt.)						
	> 1.22	1.21-1.02	1.01-0.90	0.89-0.79	0.78-0.67	0.66-
Step Bench (ml/kg)**						
	> 37.6	37.5-36.1	36.0-35.1	35.0-34.2	34.1-32.4	32.3-
Body Fat (% fat)**						
	< 12.9	13.0-17.8	17.9-21.1	21.2-24.4	24.5-29.0	29.1-

* denotes norms from The Cooper Clinic
** denotes norms from Pollock, Wilmore & Fox

APPENDIX F

Correlations between subcomponents and individual questions

	5	8	15	
PSTR	.8542*	.7628*	.2655*	
	(98)	(98)	(98)	
	1	6	9	11
PMEND	.7681*	.6927*	.4103*	.6451*
	(98)	(98)	(98)	(98)
	3	12	17	
PFLEX	.7608*	.7983*	.8083*	
	(99)	(99)	(99)	
	4	16	20	
PCEND	-.0333	.7587*	.7575*	
	(99)	(98)	(98)	
	2	10	14	19
PBF	.8297*	.8701*	.7189*	.8071*
	(96)	(96)	(96)	(96)
	7	13	18	
PGEN	.8665*	.8711*	.8670*	
	(98)	(98)	(98)	

* denotes significance (P < 0.05)
( ) = N of group

APPENDIX G

Correlations between questions on the survey

	1	2	3	4	5	6	7
1		.1273 (99)	-.0890 (99)	.2523* (99)	.2140* (90)	.4544* (99)	.2493* (98)
2	.1273 (99)		-.1167 (99)	.2976* (99)	.1491 (98)	.1179 (99)	.4413* (98)
3	-.0890 (99)	-.1167 (99)		.1471 (99)	.1867* (98)	-.0455 (99)	.1671 (98)
4	.2523* (99)	.2976* (99)	.1471 (99)		.2008* (98)	.2176* (99)	.2563* (98)
5	.2140* (98)	.1491 (98)	.1867* (98)	.2008* (98)		.2983* (98)	.4191* (997)
6	.4554* (99)	.1179 (99)	-.0455 (99)	.2176* (99)	.2983* (98)		.1769* (98)
7	.2493* (98)	.4413* (98)	.1671 (98)	.2563* (98)	.4191* (97)	.1769* (98)	
8	.2392* (99)	.0381 (99)	.2050* (99)	.3945* (99)	.4822* (98)	.2935* (99)	.2691* (98)
9	.3562* (99)	.2218* (99)	.0319 (99)	.3045 (99)	.3520* (98)	.2999* (99)	.1937* (98)
10	.1386 (96)	.6555* (96)	-.1946* (96)	.3086* (96)	.2153* (95)	.0740 (96)	.2976* (96)
11	.4352* (98)	-.0432 (98)	.0510 (98)	.2240* (98)	.2093* (97)	.2374* (98)	.1171 (97)
12	.1114 (99)	.0777 (99)	.4177* (99)	.1103 (99)	.3427* (98)	.0435 (99)	.2990* (98)
13	.2351* (99)	.4089* (99)	.2080* (99)	.3140* (99)	.4455* (98)	.2523* (99)	.6166* (98)
14	.2133* (99)	.5065* (99)	-.1298 (98)	.1878* (99)	.1467 (98)	.0399 (99)	.2948* (98)

* denotes significance ($P < 0.05$)
( ) = N

	8	9	10	11	12	13	14
1	.2392* (99)	.3562* (99)	.1386 (96)	.4352* (98)	.1114 (99)	.2351* (99)	.2133* (99)
2	.0381 (99)	.2218* (99)	.6555* (96)	-.0432 (98)	.0777 (99)	.4089* (99)	.5065* (99)
3	.2050* (99)	.0319 (99)	-.1946* (96)	.0510 (98)	.4177* (99)	.2080* (99)	-.1298 (98)
4	.3945* (99)	.3045* (99)	.3086* (96)	.2240* (98)	.1103 (99)	.3140* (99)	.1878* (99)
5	.4822* (98)	.3520* (98)	.2153* (95)	.2093* (97)	.3427* (98)	.4455* (98)	.1467 (98)
6	.2955* (99)	.2999* (99)	-.0740 (96)	.2374* (98)	.0435 (99)	.2353* (99)	.0399 (99)
7	.2691* (98)	.1937* (98)	.2976* (96)	.1171 (97)	.2990* (98)	.6166* (98)	.2948* (98)
8		.2871* (100)	.1714* (97)	.2827* (99)	.1414 (100)	.3766* (100)	.1700* (100)
9	.2871* (100)		.2164* (98)	.1603 (100)	.2037* (101)	.2856* (101)	.2992* (101)
10	.1714* (97)	.2164* (98)		0 (97)	-.0470 (98)	.2557* (98)	.5357* (98)
11	.2827* (99)	.1603 (100)	0 (97)		.1723* (100)	.2987* (100)	.1370 (100)
12	.1414 (100)	.2037* (101)	-.0470 (98)	.1723* (100)		.2384* (101)	.0291 (101)
13	.3766* (100)	.2856* (101)	.2557* (98)	.2987* (100)	.2384* (101)		.1981* (101)
14	.1700* (100)	.2992* (101)	.5357* (98)	.1370 (100)	.0291 (101)	.1981* (101)	

* denotes significance ($P < 0.05$)
( ) = N of group

	15	16	17	18	19	20
1	.2183* (99)	.3403* (99)	.0122 (99)	.1701* (99)	.0092 (99)	.2630* (98)
2	.1900* (99)	.1920* (99)	-.0206 (99)	.5123* (99)	.5574* (99)	-.0236 (98)
3	.1826* (99)	.0667 (99)	.4133* (99)	.0559 (99)	-.0039 (99)	-.0170 (98)
4	.2067* (99)	.2599* (99)	-.0522 (99)	.3409* (99)	.2211* (99)	.3156* (98)
5	.5939* (98)	.4459* (98)	.2470* (98)	.3753* (98)	.1700* (98)	.0934 (97)
6	.2921* (99)	.3024* (99)	-.0206 (99)	.1231 (99)	.0151 (99)	-.0770 (98)
7	.4477* (98)	.3210* (98)	.2175* (98)	.6670* (98)	.2477* (98)	.1819* (98)
8	.3247* (100)	.4011* (100)	.1115 (100)	.2889* (100)	.1304 (100)	.3127* (99)
9	.3257* (101)	.3372* (101)	.2268* (101)	.2637* (101)	.2034* (101)	.1255* (101)
10	.2210* (98)	.3167* (98)	-.0637 (98)	.4642* (98)	.5958* (98)	.1153 (98)
11	.3053* (100)	.3233* (100)	-.0313 (100)	.0860 (100)	-.1400 (100)	.3025* (99)
12	.1937* (101)	.0597 (101)	.5127* (101)	.2295* (101)	.0078 (101)	.0078 (100)
13	.5187* (101)	.4314* (101)	.2514* (101)	.6044* (101)	.1872* (101)	.0895 (100)
14	.2434* (101)	.2022* (101)	.1243 (101)	.3753* (101)	.3522* (101)	.1076 (100)

* denotes significance (P < 0.05)
( ) = N of group

	1	2	3	4	5	6	7
15	.2183* (99)	.1900* (99)	.1826* (99)	.2067* (99)	.5939* (98)	.2921* (99)	.4477* (98)
16	.3403* (99)	.1920* (99)	.0667 (99)	.2599* (99)	.4459* (98)	.3024* (99)	.3210* (98)
17	.0122 (99)	-.0206 (99)	.4133* (99)	-.0552 (99)	.2470* (98)	-.0206 (99)	.2175* (98)
18	.1701* (99)	.5123* (99)	.0559 (99)	.3409* (99)	.3753* (98)	.1231 (99)	.6670* (98)
19	.0092 (99)	.5574* (99)	-.0039 (99)	.2211* (99)	.1700* (98)	.0151 (99)	.2477* (98)
20	.2630* (98)	-.0236 (98)	-.0170 (98)	.3156* (98)	.0934 (97)	-.0770 (98)	.1819* (98)

	8	9	10	11	12	13	14
15	.3247* (100)	.3257* (101)	.2210* (98)	.3053* (100)	.1937* (101)	.5187* (101)	.2434* (101)
16	.4011* (100)	.3372* (101)	.3167* (98)	.3223* (100)	.0597 (101)	.4314* (101)	.2022* (101)
17	.1115 (100)	.2268* (101)	-.0637 (98)	-.0313 (100)	.5127* (101)	.2514* (101)	.1243 (101)
18	.2889* (100)	.2637* (101)	.4642* (98)	.0860 (100)	.2295* (101)	.6044 (101)	.3753* (101)
19	.1304 (100)	.2034* (101)	.5958* (98)	-.1400 (100)	.0078 (101)	.1872* (101)	.3572* (101)
20	.3127* (99)	.1255 (100)	.1153 (998)	.3025* (99)	.0078 (100)	.0895 (100)	.1076 (100)

* denotes significance (P < 0.05)
( ) = N of group

APPENDIX H

Means of actual fitness testing

	FLEX (inches)	MEND (# situps)	CEND (ml/kg)	BF (% body fat)	STR (% body weight)
Males					
Mean	18.82 (35)	41.71 (35)	43.16 (35)	14.31 (35)	0.89 (35)
S.D.	3.71	8.11	6.14	5.32	0.18
Females					
Mean	20.49 (66)	33.45 (65)	34.31 (66)	28.52 (66)	0.51 (66)
S.D.	2.22	10.45	2.92	5.52	0.08

( ) = N of group

	15	16	17	18	19	20
15		.4392* (101)	.1863* (101)	.4872* (101)	.1228 (101)	.1693* (100)
16	.4392 (101)		.0756 (101)	.3269* (101)	.2995* (101)	.3904* (100)
17	.1863* (101)	.0756 (101)		.2242* (101)	.0005 (101)	.0154 (100)
18	.4872* (101)	.3269* (101)	.2242* (101)		.3538* (101)	.1933* (100)
19	.1288 (101)	.2995* (101)	.0005 (101)	.3538* (101)		.0568 (100)
20	.1693* (100)	.3904* (100)	.0154 (100)	.1933* (100)	.0568 (100)	

* denotes significance ($P < 0.05$)
( ) = N of group