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A Comparison of Completion Times Between a 1.5-Mile Run on an Indoor Track and Treadmill in Physically Active Individuals

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A Comparison of Completion Times Between a 1.5-Mile Run on an Indoor Track and Treadmill in Physically Active Individuals

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

Introduction

Cardiorespiratory endurance is one of the primary components of physical fitness and is the ability of an individual to sustain continuous physical activity for an extended amount of time (Nieman, 2003). An adequate level of cardiorespiratory endurance is essential for successfully performing basic physical tasks of everyday living. Maximal oxygen consumption (VO_{2max}) is the standard used to measure the capacity of the cardiovascular system and is the maximum rate at which oxygen can be taken up and used by the body during exercise (Brooks, Fahey, & Baldwin, 2005). Additionally, the importance of cardiorespiratory endurance cannot be overstated as low levels have been associated with an increased risk of death from all causes, specifically cardiovascular disease (ACSM, 2006).

Directly measuring VO_{2max} in a laboratory is considered the most accurate method of assessing an individual's cardiorespiratory fitness, however, this method is often times impractical due to a variety of reasons including expense, time-constraints, need for highly trained personnel, and inability to test a large number of individuals simultaneously (Kline et al., 1987; George, Vehrs, Allsen, Fellingham, & Fisher, 1993b). As a result of these limitations, several indirect tests that estimate VO_{2max} have been developed and validated including several tests that can be performed in a field setting. In many situations, field testing has been suggested to provide several advantages in comparison to laboratory testing. Larsen, Alexander, Fellingham, Aldana, and Parcell (2002) emphasized field testing, when compared to laboratory testing, is easier to administer; allows testing of multiple individuals concurrently; is less costly; and is more time effective. Furthermore, Nummela, Hamalainen, and Rusko stress that field tests may better follow the principle of specificity compared to laboratory tests.

One of the most commonly referenced field tests to estimate cardiovascular fitness is the 1.5-mile run test (Jackson, Dishman, La Croix, Patton, & Weinberg, 1981; Kline et al., 1987; Mello, Murphy, & Vogel, 1988; Anderson, 1992; George et al., 1993a; Grant, Joseph, & Campagna, 1999; Williford, Duey, Olson, Howard, & Wang, 1999; Larsen et al. 2002). The 1.5-mile run test is typically administered outdoors on a track or flat course and requires an individual to complete 1.5 miles as fast as possible while timed with a stopwatch. Based on the amount of time it takes to complete the test, a prediction of the individual's cardiorespiratory endurance can be quantified through the use of several criterion-referenced standards or prediction equations. An equation used by the American College of Sports Medicine (2006) to estimate cardiorespiratory endurance from a 1.5-mile run is VO_{2max} (ml•kg^{-1}•min^{-1}) = 3.5 + [(483 / time in minutes)]. This equation provides a simple method for estimating VO_{2max} using an individual's completion time from a 1.5-mile run.

Conducting a 1.5-mile run is not possible or feasible in many circumstances. Inclement weather (e.g., wind, rain, ice, snow, heat, and humidity) and the absence of either a track or adequate running area present genuine challenges for practitioners conducting 1.5-mile runs outdoors. One promising solution to account for situations such as those mentioned previously would be to administer the 1.5-mile run test on a treadmill indoors instead of in a typical field setting. Administering the 1.5-mile run test on the treadmill eliminates weather and conditions that are likely to increase the chance of injury and distress to the individual performing the test. While a number of studies have examined the relationship between the 1.5-mile run and cardiorespiratory endurance (Cooper, 1968; Daniels, Kowal, Vogel, & Stauffer, 1979; Jackson et al., 1992; Williford et al., 1999; Grant et al., 1999; Hall, Figueroa, Fernhall, & Kanaley, 2004), no studies have investigated the validity of performing the 1.5-mile run test on a treadmill in an indoor setting. This is an area that necessitates further study and, therefore, will be explored in this investigation.

Significance of the Study

Many studies comparing the validity of field testing to accurately assess cardiorespiratory endurance have been conducted by a number of researchers (Cooper, 1968; Jackson et al., 1981; Mechelen, Hlobil, & Kemper, 1986; Kline et al., 1987; Mello et al., 1988; Jackson, Weduwe, Schick, & Sanchez, 1990; Anderson, 1992; Weller, Thomas, Corey, & Cox, 1992; George et al., 1993b; Berthou, Fellmann, Bedu, Beaune, Dabonneville, & Coudert, 1996; Williford et al., 1999; Grant et al., 1999; O'Gorman, Hunter, McDonnacha, & Kirwan, 2000; Larsen et al., 2002; Hall et al., 2004). Furthermore, several studies have been conducted comparing the differences between track and treadmill running (Pugh, 1970; Lehmann, Berg, Kapp, Wessinghage, & Keul, 1983; Bassett, Giese, Nagle, Ward, Raab, & Balke, 1985; Ceci & Hassman, 1991; Nigg, De Boer, & Fisher, 1995; Crouter, Foster, Esten, Brice, & Porcari, 2001; Meyer, Welter, Scharhag, & Kindermann, 2003; Nummela et al., 2007). Research involving the performance of the 1.5-mile run test using a treadmill is lacking, yet the potential implications would be beneficial when the traditional protocol is not possible. More research in this area is needed to determine if a 1.5-mile run test performed on a treadmill is a comparable means of estimating cardiorespiratory endurance based on the same

VO_{2max} prediction equation for a 1.5-mile run conducted on a track.

Statement of the Problem

This study was intended to compare completion times of a 1.5-mile run test performed on a track to the completion times of a 1.5-mile run test performed on a treadmill in one group of physically active individuals 19 to 30 years of age with tests conducted on two separate occasions.

Hypothesis

No significant difference will be found in completion times between the 1.5-mile run performed on an indoor track versus the 1.5-mile run performed on a treadmill in those individuals participating in the study.

Limitations

1. Differences in motivation level of the participants in this study could have affected the outcomes since the tests require maximum effort.
2. The age range of the participants in this study was eleven years.
3. Participants in this study performed the tests at different times during the day.
4. The number of days between the tests performed by each subject varied.
5. This study assumes that participants were familiar with track and/or treadmill running.
6. Subject physical activity classification was based on a self-reported questionnaire.

Delimitations

1. Participants in this study were classified as physically active.
2. The indoor track used was 18 laps per 1.5 miles. Consequently, the inside lane

turns were quite sharp and could negatively impact performance.

3. Thirty subjects were recruited from the University of Central Oklahoma.
4. Participants did not experience any significant improvements in cardiorespiratory endurance between tests.
5. All subjects were at a moderately active physical activity level.
6. Testing equipment was properly calibrated prior to testing.

Assumptions

1. Participants in this study performed each test to the best of their ability.
2. Participants in this study abstained from exercise on the day they were tested.
3. All participants had no known diseases and were physically active.
4. Participants completing the test in less time had higher levels of cardiorespiratory endurance.
5. Data collection, methodology, data management, or instrumentation utilized did not contribute to statistical error.

Definitions of Terms

The following definitions were used in this study:

Maximal oxygen consumption (VO_{2max}) is the standard used to measure the capacity of the cardiovascular system and is the maximum rate at which oxygen can be taken up and used by the body during exercise (Brooks et al., 2005).

Estimated maximal oxygen consumption is a prediction of maximal oxygen consumption based on regression equations that have been developed by researchers (Nieman, 2003).

Field tests are used to estimate cardiorespiratory fitness and endurance performance and require little equipment, may be performed in different locations, and involve common forms of exercise such as walking or jogging (McArdle, Katch, & Katch, 2000).

The *1.5-mile run test* is a running field test which requires the individual being tested to run 1.5 miles in the shortest possible period of time (Nieman, 2003).

A *Maximal exercise test* is an exercise test that requires an individual to exercise to the point of volitional fatigue and is usually conducted under medical supervision (Nieman, 2003).

A *Submaximal exercise test* is used when a maximal exercise test is not feasible and involves using the heart rate response to different work rates in order to predict VO_{2max} (ACSM, 2006).

Physically active individuals are those individuals meeting the U.S. Surgeon General's minimal physical activity recommendations, which consist of accumulating 30 minutes of moderate-intensity (e.g., 64-76% of a an individual's age-predicted maximal heart rate) physical activity most days of the week (ACSM, 2006).

CHAPTER TWO

Review of Literature

Many different field tests have been developed to estimate VO_{2max} (Cooper, 1968, 1977; Jackson et al., 1981; Kline et al., 1987; Mello et al., 1988; Weller et al., 1992; George et al., 1993a; Berthou et al., 1996; Larsen et al., 2002; Knapik et al., 2006). One particular field test, the 1.5-mile run test, has been used in a variety of settings to assess cardiorespiratory endurance among individuals, groups, and populations (Cooper, 1968; Daniels et al., 1979; Jackson et al., 1981; Anderson, 1992; McNaughton, Hall, & Cooley, 1998; Grant et al., 1999; Williford et al., 1999; Hall et al., 2004). According to Adams, the 1.5-mile test is routinely used by many organizations including the U.S. Navy, U.S. Air Force, and the American Alliance of Health, Physical Education, Recreation, and Dance (AAHPERD).

One of the most frequently cited studies in the literature involving field testing is Cooper's 1968 study comparing a 12-minute run test to a VO_{2max} treadmill test. The subjects in this study consisted of 115, physically active U.S. Air Force males (M age = 22 years). The subjects were required to perform a 12-minute run on a flat, one mile hard-surface course and were instructed to cover as much distance as possible in 12 minutes. There was a very high correlation (r = .90) between the subject's distance covered and VO_{2max}. Based on these findings, Cooper concluded that field testing provides a valuable assessment of VO_{2max} in young, well-trained subjects, however, the accuracy of this assertion was related to the motivation level of subjects being tested. Additionally, several advantages of field testing were noted by Cooper including the fact that the mode of exercise (walking or running) is well-known, testing costs are minimal, large groups can be tested simultaneously, and trained personnel are not required.

A more recent study by Jackson et al. (1981) investigated other variables involved in the 1.5-mile run test not accounted for in Cooper's original study. The researchers evaluated pacing strategies, heart rates, and rating of perceived exertion (RPE) at various performance intervals in a group of 67 males (*M* age = 21.3 years, *M* weight = 74.4 kg). Subjects performed a 1.5-mile run on an outdoor track with varying wind conditions (5-15 mph) and were required to report an RPE level at 50-m intervals until 1.5 miles was completed. In addition, each subject's heart rate was measured by telemetry and recorded at each 50-m interval. The subjects completed six laps on the outdoor track, which was equivalent to 1.5 miles. On average, the subjects completed the first lap the fastest (*M* time = 1.51 min) while the times for laps 2-5 were progressively slower (*M* time = 1.69, 1.78, 1.81, and 1.83 min, respectively) until lap 6 (*M* time = 1.64 min). The mean RPE of the subjects increased from 9.5 during the first lap to 17.6 during the sixth lap. The mean heart rate of the subjects increased from 163.4 beats per minute (b•min^{-1}) during the first lap to 193.1 b•min^{-1} during the sixth lap. Major findings from this study were that the 1.5-mile run test consists of three common pacing characteristics: initial speed, stable slower speed, and final speed. Furthermore, the researchers highlighted that RPE appeared to increase with distance as opposed to performance time or heart rate.

Anderson (1992) compared three different field tests, one of which was the 1.5-mile run test. The subjects in this study consisted of 37 male and 26 female college age physical education students. The tests compared were the multistage 20-m shuttle run, the Canadian Aerobic Test of Fitness (CAFT) step test, and the 1.5-mile run. This study found that the type of field test performed influences the predicted VO_{2max} values in college males, however, not in college females. Significant differences between the shuttle run and step test ($p \leq .01$) and the step test and distance run ($p \leq .01$) were found in males, but not females. No significant differences were found between the shuttle run and distance run in males or females. The researchers attributed these differences to higher motivation among the males enabling them to reach their potential on each test, but admit the difficulty of substantiating this statement.

George et al. (1993a) developed a submaximal treadmill jogging test to estimate VO_{2max} in 129 subjects (84 males and 45 females) ages 18 to 29 years. Subjects performed a submaximal treadmill jog at a pace between 4.3 mph (1.9 $m \bullet s^{-1}$) and 7.4 mph (3.3 $m \bullet s^{-1}$) until achieving a steady state heart rate. A steady heart rate was considered heart rates 30 seconds apart differing by less that 3 $b \bullet min^{-1}$ after 3 minutes of jogging. Using a multiple regression analysis, the researchers developed an equation to estimate VO_{2max} in males and females using the submaximal treadmill jogging protocol, which was found to be highly correlated ($r = .84$) with the subjects measured VO_{2max} and, therefore, a valid means of estimating VO_{2max}.

George et al. (1993b) developed a sub-maximal field test as a way to estimate VO_{2max} from a 1-mile track run in a group of males and females. One hundred forty-nine college students ages 18 to 29 years participated in this study, however, 106 subjects performed the 1-mile track jog while 96 performed the 1.5-mile run. Subject's VO_{2max} was determined from a maximal graded exercise test (GXT) performed on a treadmill. The treadmill protocol required the subjects to jog at a self-selected speed with a 2.5% increase in grade every minute until the subject requested to stop. The 1-mile track jog and GXT were performed on the same day, with the 1-mile jog performed first. The 1.5-mile run was performed on a different day to minimize the effects of fatigue. All tests were performed within a two-week period. Adjusted correlation values (r_{adj}) and standard error of estimate (SEE) for relative VO_{2max} for the 1-mile jog were .87 and 3.0 ml•kg^{1}•min^{-1} compared to .90 and 2.8 ml•kg^{-1}•min^{-1} for the 1.5-mile run. The researchers concluded that the 1-mile jog and 1.5-mile run compare favorably in the ability to estimate cardiorespiratory fitness, but that the 1-mile run is probably more appropriate and better tolerated by individuals who are not accustomed to higher exercise intensity.

McNaughton et al. (1998) compared estimated VO_{2max} on four different running field tests (including the 1.5-mile run test) to actual VO_{2max} values obtained via gas analysis on a treadmill in a group of college males. Thirty-two subjects (*M* age = 20.1 years, *M* weight = 73.7 kg, *M* VO_{2max} = 57.9 ml•kg^{-1}• min^{-1}) were randomly tested on a treadmill jogging test, 1.5-mile run, 12-minute run, and a 20-m progressive shuttle test, which were then compared to actual VO_{2max} values. Maximal oxygen consumption was determined when subjects attained a plateau in VO_2 despite an increase in workload or when a respiratory exchange ratio (RER) greater than or equal to 1.1 and an age-predicted maximum heart rate (± 10 b• min^{-1}) were achieved. A submaximal jogging test protocol developed by George et al. (1993a) was used to estimate subject's VO_{2max}. The protocol required subjects to sustain a jogging pace between 4.3 mph (1.9 m•s^{-1}) and 7.4 mph (3.3 m•s^{-1}) until achieving a steady state heart rate (heart rates 30 seconds apart differing by less that 3 b•min^{-1} after 3 minutes of jogging). This study found that the 12-minute run and 1.5-mile run had the highest correlation to measured VO_{2max} (r = .87 for both tests), while the 20-m progressive shuttle run and treadmill jogging test had correlation values of .82 and .50, respectively. The researchers concluded that the 12-minute run, 1.5-mile run, and 20-m progressive shuttle run can and should be used to accurately predict VO_{2max} in young men. The researchers discussed several possible explanations for the low correlation found between the submaximal treadmill jogging test and measured VO_{2max}. In the study conducted by George et al. (1993a) a greater number of subjects were tested (129 vs. 32) leading to the higher correlation (.84 vs. .50) between estimated and measured VO_{2max}. Also, the subjects tested in the study had higher VO_{2max} scores (58.0 $\pm$ 3.1 vs. 51.1 $\pm$ 5.1 ml•kg^{-1}•min^{-1}) compared to the subjects tested by George et al. (1993a). In addition, the submaximal jogging test was shorter in duration and distance compared to the actual VO_{2max} test and, therefore less intense. In summary, the researchers suggested that a submaximal treadmill running test may be more suited for less fit individuals and, therefore, not the best test for estimating VO_{2max} in more fit individuals.

Grant et al. (1999) compared the results of seven, indirect VO_{2max} tests to a direct measurement of VO_{2max} determined using the Poole treadmill protocol. Thirty subjects (15 males and 15 females) between the ages of 18 and 35 years participated in the study. Subjects performed eight tests during six sessions (two different tests were performed during the same session on two of the six sessions), which were at least 48 hours apart to allow for recovery. Directly measured VO_{2max} using the Poole protocol was compared to the following tests: Astrand-Ryhming submaximal cycle ergometry (Astrand); submaximal Bruce treadmill protocol (85% Bruce); maximal Bruce treadmill protocol (Max Bruce); modified version of the submaximal heart rate extrapolation cycle ergometer protocol (mWHO); CAFT; 20 m (21.9 yd) multistage maximal shuttle run test

(MMST); and a 1.5-mile maximal run. Among the men, the correlation values between the seven predictive tests and directly measured VO_{2max} ranged from .20 to .59. In women, however, all predictive tests except, for the CAFT (r = .64), had high correlation values ($r \geq .80$). The researchers explained that the difference between the correlations found among the genders was due to the smaller range of directly measured VO_{2max} values in men (15.0 ml•kg^{-1}•min^{-1}) compared to women (26.3 ml•kg^{-1}•min^{-1}) and that any combination of a smaller range of values results in lower correlations compared to a larger range of values. The researchers inferred that it is more important to consider the inherent error associated with the tests among the men since all of the indirect tests except the CAFT had less than 10% error in predicting cardiorespiratory endurance compared to directly measured values. Furthermore, the researchers stressed that test selection should be based primarily on the mode of training (i.e., running vs. cycling, indoors vs. outdoors) when choosing a predictive cardiorespiratory endurance test.

Williford et al. (1999) evaluated 91 firefighters on various exercise tests, including a 1.5-mile run, to determine which component of physical fitness was most important for effectively performing job-related duties based on the physical performance assessment (PPA). The PPA simulates common firefighting tasks including stair climbing, hoisting, forcible entry, hose advance, and victim rescue. Along with lean body mass and pull-ups, the study found that the best multiple predictor of the PPA was the 1.5-mile run (r = .73, p < .001) and that training programs designed to increase or maintain these areas can directly benefit job performance.

Larsen et al. (2002) developed a submaximal version of the 1.5-mile run test from 112 college students (57 men and 55 women) ages 18 to 26 years. Each participant performed a maximal GXT and two submaximal 1.5-mile run tests. The Borg RPE scale was explained to each participant prior to testing. Participants were instructed to achieve an RPE of 13 ("somewhat hard") and maintain this intensity during each 1.5-mile run. The 1.5-mile runs were performed before the GXT test, which utilized a protocol developed by George et al. (1993b). The protocol consisted of a 6-minute warm-up in which subjects walked on 5% grade at a self-selected speed. After warming up, subjects could either continue walking or jog at a self-selected speed for 3 minutes. This speed was then used for the rest of the test and the grade of the treadmill was increased 1.5% every 3 minutes until subjects reached exhaustion. Heart rate and rating of perceived exertion (RPE) were recorded every 1 minute. Expired minute ventilation was measured using a Ventilation Measurement Module (VMM Series, Alpha Technologies, Bellingham, WA). Oxygen and CO_2 was analyzed using a spectrometer (Model 1100, Margquette, St. Louis, MO) and VO_2 was calculated using Consentius (Sandy, UT). Maximal oxygen consumption was considered the highest average over a minute period near the end of the test. Using the subject's completion time on the submaximal 1.5-mile run, gender, and body mass the researchers developed the following equation to estimate VO_{2max}: VO_{2max} = [65.404 + 7.707 x gender (1 = male; 0 = female) – 0.159 x body mass (lb/2.2) – 0.843 x elapsed exercise time (minutes of walking, jogging, or running)]. This prediction equation showed acceptable validity ($r = .86$, SEE = 3.37 ml•kg^{1}•min^{-1}) similar to field tests developed by Cooper (1968), Kline et al. (1987), and George et al. (1993a). Similar to the maximal 1.5-mile run test, the submaximal 1.5-mile run test was found to accurately predict VO_{2max} while accommodating a broader range of fitness levels.

Several studies (Cooper, 1968; Anderson 1992; Larsen et al., 2002) support the use of the 1.5-mile run test or modified version of the test as a valid method to assess cardiorespiratory fitness. It must be noted, however, that the studies involved subjects of varying fitness levels and that these distinctions are worthy considerations that must be balanced when choosing to use the 1.5-mile run test for assessment purposes.

Additional Field Testing Studies

Mechelen et al. (1986) compared two running field tests in a group of 82 children (41 boys and 41 girls) ages 12 to 14. The researchers attempted to determine the necessity of individuals to run for more than five minutes at a steady pace in order to significantly improve the correlation between VO_{2max} and running performance. Subjects performed a maximal, multistage 20-m shuttle run (20-MST) and a 6 minute endurance run. The correlation coefficient between VO_{2max} and the 20-MST was found to be .76 for both sexes and .63 for both sexes on the six minute endurance run. Based on these findings, the investigators concluded that the 20-MST is a valid tool for predicting VO_{2max} in children and that the practicality of the test is preferred over continuous run tests. The researchers noted that since children were tested, applying the results to a less homogenous population should be done so with discretion.

Kline et al. (1987) explored a 1-mile walk test to estimate VO_{2max} that could be better applied to a broader population compared to the 1.5-mile run test. Subjects (183 males and 207 females) in this study ranged from 30 to 69 years of age and were required to perform the one-mile walk test and the maximal graded treadmill test on separate days to reduce the likelihood of fatigue affecting the outcome of the test. Heart rate was monitored during each minute of the walk test. From the data collected among the subjects, the researchers developed and validated six equations for estimating VO_{2max} in adults ages 30 to 69 years using age, gender, weight, heart rate and time from a one-mile walk. Moreover, based on their findings, the researchers concluded that the one-mile walk test offers several advantages over running field tests particularly in older or sedentary individuals.

Mello et al. (1988) examined the relationship between a two-mile run for time and VO_{2max}. Subjects consisted of 44 males and 17 females ages 20 to 51 years. One third of the subjects were sedentary and two thirds were classified as recreational joggers. Subjects performed a two-mile time run test on a paved, outdoor course and a maximal treadmill test that directly measured VO_{2max}. Both tests were performed within 15 days of each other. The results from the study found a strong relationship between a laboratory determination of VO_{2max} and field testing as supported by previous studies. The researchers developed separate VO_{2max} prediction equations for males and females based on two-mile run time with a SEE of approximately 3.0 $ml \bullet kg^{-1} \bullet min^{-1}$ for both equations (3.31 $ml \bullet kg^{-1} \bullet min^{-1}$ for the male equation and 2.78 $ml \bullet kg^{-1} \bullet min^{-1}$ for the female equation). The researchers concluded that field testing is very useful to those routinely using timed runs as a physical conditioning reference or for institutions lacking the resources to directly measure VO_{2max}.

Jackson et al. (1990) developed a three-mile running field test as a means to estimate aerobic capacity. The researcher's justification for choosing this distance was that the duration of the test for most individuals is equal to the minimum duration required to improve cardiorespiratory endurance and, therefore, exceeds shorter distance field tests. One hundred nine male subjects (*M* age = 21.7 years, *M* weight = 71.8 kg) performed a treadmill test using the Bruce protocol and a three-mile run within seven days of each other. The three-mile run was performed on a quarter mile track in temperatures greater than 80º F and winds < 15 mph. A concurrent validity coefficient of -.58 indicated that the three-mile run is only a moderately valid field test and that there is no advantage over field tests of shorter duration.

Weller et al. (1992) attempted to validate a submaximal step test prediction equation against a maximal step and treadmill test. One hundred twenty-nine subjects (58 males and 71 females) between the ages of 15 and 69 were recruited for this study. Subjects performed a maximal step test, maximal treadmill test, and the modified CAFT. The protocol for the maximal step test required the subject to step at 30 steps•min^{-1} on a step set at a height of 40% of the subject's leg length. Step frequency was increased two steps per minute every two minutes until a maximum of 36 steps•min^{-1} was attained. Additionally, the subject wore a vest with pockets and two kilogram weights were added to the vest every two minutes until the subject reached volitional fatigue or could not maintain the stepping frequency. The protocol for the maximal treadmill test consisted of the modified World Health Organization (WHO) protocol in which the speed of the treadmill was held at 2 mph and grade of the treadmill was increased 2% every two minutes until an 8% grade was attained. After this, the grade was increased 1% every two minutes until the either a oxygen consumption failed to increase (< 2 ml•kg^{-1}•min^{-1}), a RER of 1.15 or greater was recorded, or an age-predicted maximum heart rate or greater was achieved despite an increase in workload. Subjects performed the modified CAFT prior to either the maximal step test or maximal treadmill, depending on which one they had been randomly assigned. The subjects were tested again on another day and performed the modified CAFT before performing the maximal test they did not perform during the first day. It was found that the maximal treadmill test resulted in higher values compared to the maximal step test for peak VO_{2max} (43 vs. 37 ml•kg^{-1}•min^{-1}), peak ventilation (97 vs. 86 L•min^{-1}), peak heart rate (183 vs. 179 b•min^{-1}) and peak respiratory exchange ratios (RER) (1.15 vs. 1.08). Age-predicted maximum heart rate was reached in 35% and 55% of subjects on the step test and treadmill test, respectively. A peak respiratory exchange ratio (RER) of 1.15 was reached in 22% and 53% of subjects on the step test and treadmill test, respectively. The researchers used the peak oxygen consumption obtained from subjects tested on the treadmill to develop a new prediction equation for the CAFT to be used to estimate VO_{2max}.

In order to evaluate the validity of field tests to predict endurance in competitive sports participants, O'Gorman et al. (2000) assessed 15 competitive male athletes (*M* age = 20.3 years) on the 20-m shuttle test (MST) and 12-minute and 3,000 m (1.86 mi) run tests. Both the 12-minute and 3,000 m (1.86 mi) run were significantly ($p < .05$) related to VO_{2max}. The mean distance covered by the subjects for the 12-minute run was 1.91 $\pm$ .028 miles and the mean time for the subjects complete the 3,000 m (1.86 mi) run was 11.71 $\pm$ .24 minutes. This study found that the 12-minute run and the 3,000 m (1.86 mi) run are equally valid measures of endurance capacity, and when compared to VO_{2max}, "event specific field tests may provide a better indication of performance capabilities" (2000, p. 65).

Gamelin et al. (2006) compared critical velocity (CV) calculated from five CV estimation models developed by Housh, Cramer, Bull, Johnson, and Housh (2001) to determine which model correlates highest with a one-hour run and which model best predicts performance on a one-hour run. Twelve well-trained males (*M* age = 29 years) participated in the study. Subjects performed three constant duration tests (6, 9, and 12 minutes) on an indoor track and a maximal running velocity test. The maximal running velocity test used to estimate CV required the subjects to perform a 30-m run following a 20-m run-up. The subjects performed the three constant duration tests at least 24 hours apart and the maximal running velocity test was added randomly to one of the three constant duration tests. Subjects also performed a one-hour track test (to determine actual performance) which was compared to the estimated performance calculated from each of the five models developed by Housh et al. While the researchers found that all five CV estimation models were correlated with the one-hour track test ($.85 < r < .99$, $p < .01$) and with CV performance ($.80 < r < .93$, $p < .01$), none of the five models could be used to sufficiently predict one-hour running performance. The researchers concluded that while estimating CV allows coaches to rank a runner’s ability to perform well on long-distance events, it should not be used as basis to develop training programs.

Track versus Treadmill Running

The previous discussion focused on studies utilizing field tests involving different populations, modalities, and protocols. Another integral matter of relevance to this investigation involves a discussion on the inherent differences between track and treadmill running. Various studies comparing track and treadmill exist that are of importance in the present study.

Pugh (1970) compared track and treadmill running and the effects of air resistance in a group of nine, male runners (*M* age = 28 years). On the track run, the runners performed a series of two to five runs at various speeds while expired gas was collected in a 300 liter bag by a tester who was driven in a vehicle alongside the runner. Expired gas was also collected on the treadmill in a similar fashion, except that the tester remained off to the side of the subject. Additionally, one subject performed a running treadmill test in a climatic chamber to determine the effects of wind resistance. The subject running in the climatic chamber ran at a constant speed of 9.9 mph against winds of varying velocities (0, 26.2, 22.4, and 40.9 mph). Pugh (1970) reported that VO_2 values at high speeds for track running are slightly greater compared to treadmill running (VO_2 at 13.4 mph was 6.3 $ml{\bullet}kg^{-1}{\bullet}min^{-1}$ higher on the track compared to the same speed on the treadmill), but that the reason for this is due to air resistance and not differences in the mechanics of locomotion. According to Pugh's findings, air resistance accounts for about 8% of the total energy cost of track running at 13.4 mph and 16% of the total energy cost of track running at 22.4 mph.

Van Ingen Schenau (1980) demonstrated that there are no mechanical differences between overground and treadmill running when different coordinate systems are used to calculate the energy costs of both types of running. A fixed coordinate was used for calculating the energy costs of overground running and a moving coordinate system was used for calculating the energy cost of treadmill running. The moving coordinate system used for treadmill running consisted of the coordinate system moving with the belt of the treadmill. By using different coordinate systems for overground and treadmill running, van Ingen Schenau determined that the same change in potential energy relative to the frame of reference existed and, consequently, the energy costs of both types of running were equal. While this study showed that there are no differences between treadmill and overground running from a mechanical point of view based on calculations, it did not necessarily prove the equality of both types of running in a real-world setting. Furthermore, several criteria were given in order for the results of this study to order for this finding to be valid: the treadmill belt must be moving at a constant velocity; the treadmill motor must be able to absorb the maximal load opposing the treadmill belt velocity; and the treadmill belt and surface that the belt moves over should provide a fast enough feedback mechanism to the person using it to prevent velocity changes due to changes in the load of the belt.

Lehmann et al. (1983) investigated the predictive significance of laboratory data such as oxygen intake, catecholamine responses, and lactate behavior in relation to endurance performance in eleven highly trained male marathoners (VO_{2max} = 66.4 $\pm$ 1.7 ml•kg^{-1}•min^{-1}). The researchers evaluated the significance of catecholamines and of the product of catecholamines and lactate measurement in comparison to VO_2 at different exercise levels. The subjects first performed a graded treadmill test which started them at a speed of 4.97 mph and increased 1.24 mph every three minutes until exhaustion. Several days later, the subjects performed an 18.6 mile (11.6 km) cross-country run on a flat course as fast as possible. The researchers found positive correlations between the field run and minimum lactate equivalent (r = .69), submaximum lactate levels (r = .52), submaximum catecholamine responses (r = .69), and submaximum lactate-catacholamine product. Inverse correlations were found between the field run and VO_2 at individual lactate threshold (r = -.68), 4 mmol lactate threshold (r = -.76), VO_{2max} (r = -.71), and submaximal noradrenaline-lactate product (r = .79). The researchers concluded that submaximal noradrenaline-lactate is a good performance index and has a higher correlation with field running compared to lactate noradrenaline levels alone.

Bassett et al. (1985) also compared the oxygen demands of track (overground running) and treadmill running on both level and inclined running. Seven, highly-trained males (*M* age = 26.5 years) participated in the study. Subjects performed an outdoor run on a level track and inclined run on a county road. The Douglas bag technique was used to collect expired gas over the last 150-m of the 950-m run. Subjects also performed a level and inclined run on a treadmill with the speed set at the level used for the individual's overground run. The same technique used to collect expired gas on the overground runs was also used for the treadmill runs. No statistical difference in the energy requirements between overground and treadmill running were found in this study, which differed from common prediction formulas that indicate overground running is more costly than treadmill running (ACSM, 1980). Bassett et al. (1985) argued against the claim that the energy cost of treadmill running is less costly compared to overground running due to the treadmill belt moving under the feet since it does consider the frame of reference, which was previously pointed out by van Ingen Schenau previously. Bassett et al. (1985) identified several differences between overground and treadmill running (i.e., wind resistance, higher perceived exertion on the treadmill, and belt speed variations due to the impact of the foot), but concluded that the energy requirements for treadmill and overground running are the same based on the expired air measurements obtained from the subjects.

Ceci and Hassman (1991) compared rating of perceived exertion (RPE) between track and treadmill running in a group of 11 male subjects ages 33 to 65 years. The subjects were randomly assigned to perform either a treadmill or field run for the first session. For the treadmill run, the subjects adjusted the speed until they reached an RPE level of 11 by the end of the first 3-minute interval. The subjects then rested for 1-2 minutes and repeated the process in exactly the same way. The subjects then adjusted the speed until they reached an RPE level of 13 by the end of an 11 minute interval. Exactly like the 3 minute interval, the subjects were allowed to rest for 1 to 2 minutes and then repeated the process in exactly the same way. The final intensity level required the subjects to run at an RPE level of 15 that was achieved within 5 minutes. The subjects again rested for 1 to 2 minutes and then repeated. The field test was conducted the same way as the treadmill except that they ran on a 500-m outdoor track. Significant differences between track and treadmill running were found for velocity ($p < .001$), heart rate ($p < .001$), and blood lactate ($p < .05$). These differences led the researchers to conclude that when using RPE to monitor training intensities in most individuals, the RPE scale should be kept at or below RPE 13 in the field and RPE 15 on the treadmill since the values obtained for the measured variables (i.e., velocity, heart rate, and blood lactate) for field running were all significantly higher than for treadmill running.

Nigg, De Boer, and Fisher (1995) investigated the validity of using a treadmill to simulate the kinematics of human locomotion during overground running situations. Twenty-two subjects (11 runners and 11 non-runners) performed an overground run, run on a large treadmill, run on a midsize treadmill, and run on a small treadmill at various running speeds. Differences were found between all four runs and categorized into either systematic or subject dependent components. For instance, subjects were found to systematically plant their feet in a flatter position on the treadmill compared to overground running, while most lower extremity kinematic variables were inconsistent and depended on factors such as running style, running speed, and shoe/treadmill situation. Based on the findings the authors concluded that difference in track and treadmill running kinematics are substantial and that, "it is not yet understood how the human locomoter system adapts to a particular treadmill running situation" (1995, p. 98).

Berthou et al. (1996) tested the hypothesis that the most suitable duration for measuring maximal aerobic velocity (v_{amax}) by a field test is five minutes since running performance is not just measured by VO_{2max}, Other factors such as running economy, fractional utilization of VO_{2max}, and maximal aerobic velocity have also been found to explain running performance (Peronnet & Thibault, 1989). A group of 51 men (*M* age = 27.9 years) of varying fitness levels participated in this study. Maximal oxygen consumption and V_{amax} were determined from both a both a track and treadmill. Additionally, VO_{2max} and V_{amax} were also calculated using an equation proposed by Lacour, Padilla, Chatard, Arsac, and Barthelemy (1991). On the treadmill run, VO_{2max} was measured directly during a graded continuous treadmill test in which a constant gradient of 1% was used throughout the test in order for subjects to maintain running posture easier and to compensate for wind resistance. Maximal aerobic velocity was calculated using an equation proposed by Kuipers, Verstappen, Keize, Guerten, and Van Kranenburg (1985). On the track run, University of Montreal Track Test (UMTT) was utilized to estimate VO_{2max}. Maximal aerobic velocity was determined by multiplying the maximal distance run by the subject in five minutes by 12 (V_{amax} = km run in 5 min. x 12). Maximal oxygen consumption using the Lacour et al. (1991) equation and from the UMMT was significantly higher compared to the direct, treadmill method (+0.87 mph ($p < .001$) and +0.19 $km \cdot hr^{-1}$ ($p < .001$), respectively). Based on these findings, the researchers concluded that the 5-minute test correlated very highly ($r = .90$) with treadmill results and track performances and that it could also be used to predict VO_{2max}.

A more recent study by Crouter et al. (2001) compared maximal incremental treadmill running to a maximal one-mile indoor track run in ten male and five female collegiate cross-country runners. The researchers found no significant differences between track and treadmill running for several physiological variables including, peak oxygen consumption (VO_{2peak}), peak ventilation (VE_{peak}), peak heart rate (HR_{peak}), and peak oxygen pulse ($VO_{2peak} \bullet HR^{-1}_{peak}$). A significant difference ($p < .05$) was found, however, in peak blood lactate (BLa_{peak}). On the incremental treadmill test, subjects ran at a constant 1% grade throughout the entirety of the test. The initial speed of the treadmill was set at 7.4 mph for men and 6.3 mph for women. Speed was increased every two minutes by 1.3 mph in men and 0.89 mph in women until volitional fatigue. On the 1-mile indoor track test, the subjects completed the distance as fast as possible as intermediate times were called to subjects to help with pacing. Mean values (track vs. treadmill) for VO_{2peak} (63.0 ± 7.4 vs. 61.9 ± 7.2 $ml \bullet kg^{-1} \bullet min^{-1}$), VE_{peak} (147 ± 37 vs. 144 ± 30 $L \bullet min^{-1}$), HR_{peak} (188 ± 5 vs. 189 ± 7 $b \bullet min^{-1}$), and $VO_{2peak} \bullet HR^{-1}_{peak}$ (22.1 ± 4.4 vs. 21.5 ± 4.5) did not differ significantly. However, the mean values between track and treadmill running for BLa_{peak} (14.4 ± 3.3 vs. 11.7 ± 3.0 $mmol \bullet L^{-1}$) were significant, which the researchers attributed to the longer higher intensities sustained by the subjects during the treadmill run. The researchers emphasized that the insignificant differences found among all the variables besides BLa_{peak} support the suggestion that VO_{2peak} during an incremental test is not always the greatest VO_2 an individual can attain. Futhermore, the researchers conclude that the VO_{2max} during incremental exercise may be dependent on the protocol utilized.

Meyer et al. (2003) investigated whether track running results in higher VO_{2max} measurements compared to treadmill running in eighteen male subjects (*M* age = 28 years, *M* weight = 73 kg). The researchers measured ambulatory gas exchange on the treadmill and indoor track run using a MetaMax II (Cortex, Leipzig, Germany), which was fixed to the subject's back. Both runs were incremental runs to exhaustion and were conducted in randomized order. The subjects were allowed a day of rest between tests and were required to wear the same running shoes both times. The treadmill run was conducted on a Woodway treadmill (Weil and Rhein, Germany) and a ramp protocol was used in which the speed was increased by 0.15 or 0.2 $m \cdot s^{-1}$ every 30 seconds. The grade of the treadmill was set at 0.5%. Maximal oxygen consumption (VO_{2max}) was considered the highest VO_2 obtained over 30 seconds and exhaustion was considered when a subject could no longer stay on the front half of the treadmill. The indoor track run was performed on a tartan surface, 200-m indoor track. A flashing light system (Sim Rabbitt, Gumbel, Ludwigshafen, Germany) was used on the indoor track run that was exactly matched to the treadmill velocity. The flashing lights emitted by the system allowed the subjects to stay on pace. Exhaustion was considered when the subjects could not remain within 5 seconds of the flashing lights. No significant differences ($p = .71$) were found in VO_{2max} between the treadmill run (63.5 $ml \cdot kg^{-1} \cdot min^{-1}$) and indoor track run (63.3 $ml \cdot kg^{-1} \cdot min^{-1}$), however, significant differences ($p < .001$) were found in submaximal VO_2. There was also a significant difference ($p < .001$) between the duration of the two tests. It took the subjects about 5% longer to complete the indoor track run compared to the treadmill run (12.12 min vs. 11.52 min, respectively). Based on the results, the researchers concluded that treadmill and field running are identical in terms of VO_{2max}, but that due to higher submaximal VO_2 measurements attained on the treadmill and the longer duration achieved on the indoor track run in the group of subjects tested, track running is more economical than treadmill running.

Hall et al. (2004) found no differences in energy expenditures between track and treadmill running in 28 subjects (15 males and 13 females) ages 18-30. In addition, the researchers found no significant differences between the actual energy expenditure and estimated energy expenditure calculated using the ACSM (2006) prediction equation. The subjects performed a 1600 m (1 mi) run on a track and treadmill with at least 24 hours of recovery between the two tests. Energy expenditure was measured using the Cosmed K4 B^2 metabolic analyzer (Rome, Italy) and the result on each test was compared with the ACSM (2006) running predicted energy expenditure. The findings from this study were in agreement with the researcher's hypothesis that there were no energy expenditure differences between track and treadmill running when factors such as wind influence were controlled.

Slawinski and Billat (2005) hypothesized modifications of internal mechanical cost of running (C_{int}) and whether any changes were related an increase in the energy cost of running (C_r), which usually occurs at the end of a supralactate threshold (i.e., maximal) run. Fourteen subjects (11 males and 3 females) performed an incremental track run to volitional fatigue as well as a track run 95% at velocity associated with VO_{2max} (*v*VO2max) to volitional fatigue. The researchers found that during track running, C_r increased during the third and last minute. These results were contrary to findings from the results found in treadmill running by Borrani et al. (2003) and the differences found were attributed to the differences between the two methods of running.

Nummela et al. (2007) compared maximal running velocity on a treadmill to that of running on a track. Fourteen male and eight female subjects highly trained sprint and distance runners participated in this study. Maximal velocity on the track run was found to be significantly higher than the treadmill run in males and females (16.9 $\pm$ 1.8 mph vs. 15.9 mph $\pm$ 1.7 mph). The researchers attributed this result to a number of differences including the determination of maximal velocity, duration of the runs, the incline of the running surface, and the familiarity of the track. The difference in determining maximal velocity was that subjects were required to run the last 150 m at a predetermined, constant velocity during the treadmill run. For the track run, subjects began running at maximal effort and gradually decreased velocity towards the end of the run. The duration of the run was constant on the treadmill (20 s) compared to the track, which ranged from 19 s to 38 s for women and 17 s to 32 s for men. The incline on the treadmill was set at 3º compared to 0º on the track. Finally, the subjects performed the majority of their training on a track.

Conclusions

While several advantages of utilizing the 1.5-mile run test exist, the fact that the test was developed to be performed as a field test potentially poses several challenges to conducting the test on a treadmill. Furthermore, the inherent differences between track and treadmill running may or may not affect the ability of the prediction equation for the 1.5-mile run test to estimate VO_{2max}. In order to realize the potential benefits gained from establishing the legitimacy of performing the 1.5-mile run test on a treadmill, further investigation is merited and will be explored in this study.

CHAPTER THREE

Methods

This study was designed to compare the 1.5-mile run test performed on an indoor track to the 1.5-mile run test performed on a treadmill in a group of physically active adults. The study compared completion times on both tests, which were conducted within a two-week period at least seven days apart. A total of 30 subjects (n = 30) consisting of males (n = 15) and females (n = 15) between 19 and 30 years of ages considered physically active participated in this study. All participants in this study were volunteers and were recruited by two methods. The first method to recruit subjects was through flyers posted in the UCO Kinesiology and Health Studies building and the UCO Wellness Center (Study Announcement, Appendix B). The recruiting flyer included a brief description of the study, benefits of the study to participants, and the phone number and email of the Principal Investigator (PI). The second method used to recruit subjects was through announcements made in various Healthy Life Skills classes (Healthy Life Skills Approval, Appendix C). The PI met with several course instructors to explain the purpose and benefit of the study to potential subjects. The course instructors that attended this meeting agreed to announce the study during a class period as well as distribute a flyer that included further study details and how to contact the PI.

Subjects

A total of 30 (n = 30) students (15 male, 15 female) at the University of Central Oklahoma (UCO) participated in this study. The study consisted of the subjects performing a 1.5-mile run on a track and a 1.5-mile run on a treadmill on two separate occasions. The track run served as the control group in this study (C = 30) and the treadmill run served as the experimental group (E = 30). All participants were volunteers and only eligible to participate if they completed a Physical Activity Readiness Questionnaire (PAR-Q) (Appendix E) and were determined able to participate in physical activity without the need for physician consent.

Preliminary Procedures

A study proposal was submitted and approved by the UCO Internal Review Board (IRB) (Appendix A). Participants in the study were required to complete a Physical Activity Readiness Questionnaire (PAR-Q) (Appendix E), informed consent form (Appendix D), and exercise history form (Appendix F) prior to any testing. The purpose of this was to ensure all participants did not have any pre-existing medical conditions, were currently physically active, and that the participants fully understood the purpose and requirements involved in the study. Participants returned all preliminary paperwork to the PI. After determining the participant was eligible for the study, a testing date and time were coordinated between the participant and the PI.

Equipment and Testing Procedures

Participants met the PI at the UCO Wellness Center on the specified date and time. Participants were reviewed on the purpose of the study and on the testing procedures that was previously explained in the preliminary procedures. The order of the test was randomly assigned by the researchers in order to control for a learning effect. A minimum of seven days within a two-week period was required between each test to ensure adequate recovery between runs. The track run was held on the indoor track located on the second floor of the UCO Wellness Center. Eighteen laps on the inside lane of the track was equivalent to 1.5 miles. The treadmill run was conducted at the UCO

Wellness Center on a Woodway Mercury S treadmill (Waukesha, WI). The same treadmill was used to test all subjects and the belt speed was checked prior to each day of testing by the PI to ensure that the speed of the treadmill belt was consistent on each test. A Sportline Eventimer 250 stopwatch was used to time all tests in this study.

The indoor track test was conducted on the indoor running track at the UCO Wellness Center. Subjects warmed up for five minutes by walking or running on the track at an RPE level of 3 on the category-ratio scale of 0 to 10. After warming up, the subject completed 1.5 miles (18 laps on the inside lane) as fast as possible on the indoor running track. Time was measured with a stop watch and each lap was recorded by the PI. The subjects were told their ¼ mile time (3 laps around the track) to help them with pacing. Upon completion of the test, the participant's final time was recorded by the PI. The subject performed a 5-minute walk to cool down.

For the treadmill test, subjects were instructed to walk or run for five minutes on the treadmill for five minutes at a 0% grade at a RPE level of 3 on the category-ratio scale of 0 to 10. After this warm-up period, participants completed a 1.5-mile run on the treadmill, which remained set at 0% grade throughout the entirety of the test. Time was measured by the PI with a stopwatch. The PI called out the subject's time every quarter mile to help with pacing. Participants were responsible for selecting the speed on the treadmill and covering the required distance in as short of time as possible. Participants were allowed to increase or decrease their speed at any point during the test. Upon completion of the test, the participant's final time was recorded by the PI and the subject performed a 5-minute walk to cool down.

Statistical Analysis

Data was analyzed using SAS (version 9.1). Differences between independent means (means for age, track completion time, and treadmill completion time between males and females) were compared by two-tailed t-tests. Differences between dependent means (means between track and treadmill completion times for all subjects, males, and females) were compared by two-tailed paired t-tests. Differences between proportions (responses for each question on the subject's self-reported exercise history) were compared by two-tailed Fisher's exact tests. Correlation between two variables (track and treadmill completion times for all subjects, males, and females as well as between all possible combinations for questions on the subject's self-reported exercise history) was determined using Pearson's coefficient (one continuous variable and one categorical variable) or the phi coefficient or Fisher's exact test (two categorical variables).

CHAPTER FOUR

Results

Thirty subjects participated in the study. The mean age of the subjects was 25 years and ranged from 19 to 30 years. The mean completion time for the track run was 12.5 minutes (range = 9.1 – 17.9) compared to 12.8 minutes (range = 9.2 – 19.0) for the treadmill run (Table 1).

Table 1

Demographic Characteristics (n = 30)

	M	*SD*	Range
Age	25.03	3.24	19 - 30
Track	12.45	2.26	9.08 - 17.92
Treadmill	12.81	2.61	9.21 - 18.95

The mean age of both males and females was 25 years. There was no significant difference (p = .784) between mean ages for males and females. There was a significant difference in mean completion times between males and females for the track run (p = .026) and a near significant difference for the treadmill run (p = .064) (Table 2).

Table 2

Track and Treadmill Comparison Between Males and Females

	Males (*n* = 15)			Females (*n* = 15)			
	M	*SD*	Range	*M*	*SD*	Range	p-value
Age	25.20	3.05	20 - 29	24.87	3.52	19 - 30	.784
Track	11.55	2.37	9.08 - 17.92	13.35	1.80	10.44 - 16.90	.026
Treadmill	11.93	2.66	9.21 - 17.64	13.69	2.32	10.02 - 18.95	.064

As reported in Table 3, the mean completion time among males for the track run was slightly better than for the treadmill run (track = 11.6 minutes, treadmill = 11.9 minutes, $p = .329$). Similarly, the mean completion time among females for the track run was slightly better than for the treadmill run (track = 13.4 minutes, treadmill = 13.7 minutes, $p = .223$).

Table 3

Track versus Treadmill Running by Both Genders, Males, and Females

	Track				Treadmill				
	n	*M*	*SD*	Range	*n*	*M*	*SD*	Range	p-value
Both	30	12.45	2.26	9.08 - 17.92	30	12.81	2.61	9.21 - 18.95	.122
Males	15	11.55	2.37	9.08 - 17.92	15	11.93	2.66	9.21 - 17.64	.329
Females	15	13.35	1.80	10.44 - 16.90	15	13.69	2.32	10.02 - 18.95	.223

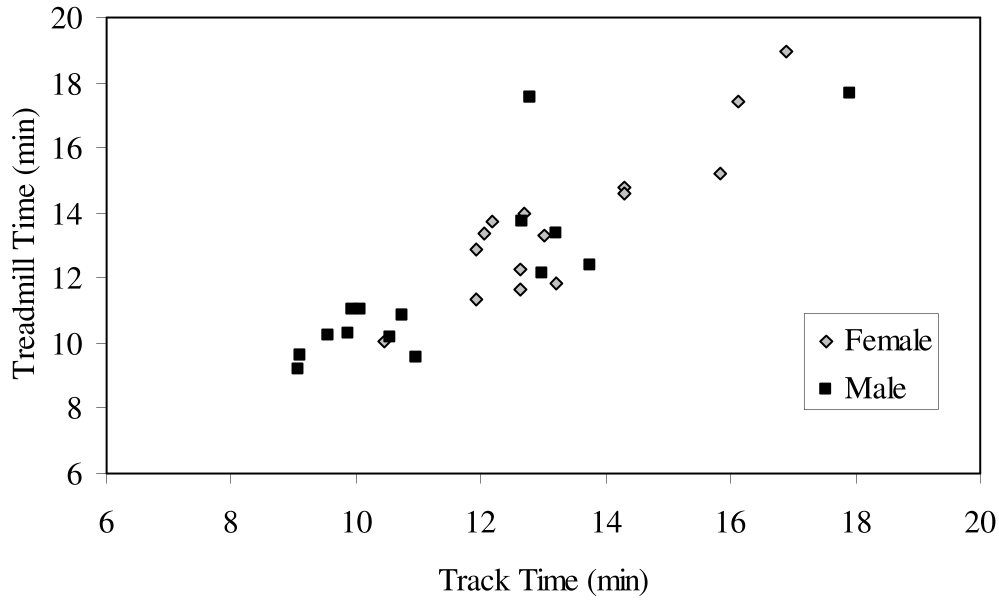
Track and treadmill completion times were highly correlated (r = .881, $p < .001$) (Table 4). Subject completion times are presented in Figure 1.

Table 4

Pearson's Correlation Coefficient for Track and Treadmill Time

Both	.881 ($p < .0001$)
Males	.840 ($p < .0001$)
Females	.904 ($p < .0001$)

Figure 1



1.5-mile Completion Times for Males and Females

Based on subject responses to the exercise history questionnaire, approximately 80% of subjects reported having an above average fitness level. Eighty percent of subjects reported that they exercised regularly and 70% of the subjects reported that they exercised four or more days per week. In addition, 87% of subjects reported that they walk, run, or perform some other type of aerobic exercise on a regular basis at least three days per week (males = 80%, females = 93%). Among subjects reporting that they walk, run, or participate in another type of aerobic activity on a regular basis, 58% of males and 71% of females reported that they primarily used a treadmill. All subjects reported having had treadmill experience with nearly 70% (46% of males and 85% of females) reporting they had used a treadmill within one week prior to participating in the study. Sixty percent of subjects (males = 73%, females = 47%) reported that they lifted weights on a regular basis (Table 5).

Table 5

Subject's Self-Reported Exercise History

No.	Question[a] *Response/Choice*	Both *n* (%)	Male *n* (%)	Female *n* (%)	p-value
1	Fitness Level				
	Not Very	2 (6.7)	1 (3.3)	1 (3.3)	0.495
	Somewhat	4 (13.3)	1 (3.3)	3 (20.0)	
	Above Avg.	19 (63.3)	9 (60.0)	10 (66.7)	
	Very	5 (16.7)	4 (26.7)	1 (3.3)	
2	Thirty Minutes				
	Yes	26 (86.7)	13 (86.7)	13 (86.7)	1.000
	No	4 (13.3)	2 (13.3)	2 (13.3)	
3	Currently Exercise				
	Yes	24 (80)	11 (73.3)	13 (86.7)	0.651
	No	6 (20)	4 (26.7)	2 (13.3)	
4	Exercise Frequency				
	0-1	3 (10.0)	2 (13.3)	1 (6.7)	0.634
	2-3	6 (20.0)	3 (20.0)	3 (20.0)	
	4-5	14 (46.7)	8 (53.3)	6 (40.0)	
	>5	7 (23.3)	2 (13.3)	5 (33.3)	

[a]See Appendix D for full questions.

Table 5 (continued)

Subject Self-Reported Exercise History

No.	Question[a] *Response/Choice*	Both *n (%)*	Male *n (%)*	Female *n (%)*	p-value
5	Walk/Run/Aerobics				
	Yes	26 (86.7)	12 (80)	14 (93.3)	0.598
	No	4 (13.3)	3 (20)	1 (6.7)	
	Time per Week				
	<3	-	-	-	0.692
	3	11 (42.3)	6 (50.0)	5 (35.7)	
	>3	15 (57.7)	6 (50.0)	9 (64.3)	
	Duration (min)				
	<30	1 (3.9)	1 (8.3)	-	0.483
	30-60	23 (88.5)	11 (91.7)	12 (85.7)	
	>60	2 (7.7)	-	2 (14.3)	
	Intensity Level				
	Light	2 (7.7)	1 (8.3)	1 (7.1)	0.138
	Moderate	16 (61.5)	5 (41.7)	11 (78.6)	
	Vigorous	8 (30.8)	6 (50)	2 (14.3)	
	Method				
	Treadmill	17 (65.4)	7 (58.3)	10 (71.4)	0.269
	Outdoors	5 (19.2)	4 (33.3)	1 (7.1)	
	Both	4 (15.4)	1 (8.3)	3 (21.4)	

[a]See Appendix D for full questions.

Table 5 (continued)

Subject Self-Reported Exercise History

No.	Question[a] *Response/Choice*	Both *n (%)*	Male *n (%)*	Female *n (%)*	p-value
6	*Weights*	18 (60.0)	11 (73.3)	7 (46.7)	0.122
	Stretching	3 (10.0)	-	3 (20.0)	
	Biking	1 (3.3)	1 (6.7)	-	
	Sports	5 (16.7)	3 (20.0)	2 (13.3)	
	Other	2 (6.7)	-	2 (13.3)	
	None	1 (3.3)	-	1 (6.7)	
	Times per Week				
	<3	5 (17.2)	2 (13.3)	3 (21.4)	1.000
	3	17 (58.6)	9 (60.0)	8 (57.1)	
	>3	7 (24.1)	4 (26.7)	3 (21.4)	
	Duration (min.)				
	<30	6 (20.7)	2 (13.3)	4 (28.6)	0.655
	30-60	19 (65.5)	11 (73.3)	8 (57.1)	
	>60	4 (13.8)	2 (13.3)	2 (14.3)	
	Intensity Level				
	Light	2 (6.9)	1 (6.7)	1 (7.1)	0.710
	Moderate	16 (55.2)	7 (46.7)	9 (64.3)	
	Vigorous	11 (37.9)	7 (46.7)	4 (28.6)	
7	Experience				
	Yes	30 (100)	15 (50)	15 (50)	1.000
	No	-	-	-	
	Last Treadmill Use				
	≤ 1 week	17 (65.4)	6 (46.2)	11 (84.6)	0.177
	≤ 1 month	4 (15.4)	3 (23.1)	1 (7.7)	
	> 1 month	5 (19.2)	4 (30.8)	1 (7.7)	

[a]See Appendix D for full questions.

In addition, age, gender, and selected questions from the exercise history questionnaire completed by the subjects (Appendix D) were used in a multivariate analysis to predict treadmill time. Question 1 (self-described fitness level categorized as either not very/somewhat fit or above average/very fit) was significantly correlated to question 2 (30 minutes of activity most days), Question 3 (exercise currently), and Question 4 (exercise frequency). Question 5a (walk, run, or aerobics regularly categorized as yes or no), Question 5e (categorized as using a treadmill or not), Question 6a (categorized as either using weights as other exercise or not), and Question 7b (categorized as last using a treadmill within one week or not) were also selected for inclusion as possible predictors. The best one-variable model selected the use of weights (adjusted R^2 = 37.7%); that is, using weights accounted for 38% of the variability seen in treadmill times. The mean treadmill time for subjects using weights was 11.5 minutes versus 14.8 minutes for subjects not using weights (Table 6). The best two-variable model selected gender and walking, running, or other type of aerobic exercise (Question 5a), which accounted for 44.4% of the variability seen in treadmill times. The mean treadmill times decreased by almost five minutes for males and four minutes for females who reported walking, running, or performing some other type of aerobic exercise on a regular basis (Table 7). The best three-variable model selected gender, using weights (Question 6a), and current treadmill usage (Question 7b), which accounted for 45.6% of the variability seen in treadmill times.

Table 6

Weights as a Predictor of Treadmill Time

	Weights				No Weights				
	n	*M*	*SD*	Range	*n*	*M*	*SD*	Range	p-value
Time	18	11.48	1.53	9.21 - 13.97	12	14.79	2.69	10.25 - 18.95	.001

Table 7

Aerobic Exercise as a Predictor of Treadmill Time

Males

Walk, Run, or Aerobics on a Regular Basis (Question 5a)	*n*	*M*	*SD*	Range
Yes	12	10.94	1.45	9.21 - 13.76
No	3	15.86	3.00	12.40 - 17.64

Females

Walk, Run, or Aerobics on a Regular Basis (Question 5a)	*n*	*M*	*SD*	Range
Yes	14	13.42	2.16	10.02 - 18.95
No	1	17.39	*	*

Hypothesis

There is no significant difference in completion times between a 1.5-mile run performed on an indoor track versus a 1.5-mile run performed on a treadmill among physically active individuals.

Results of Hypothesis

There were no significant differences in completion times on a 1.5-mile run performed on a track versus a treadmill for both genders (p = .122); males only (p = .329); and females only (p = .223). However, differences in track completion times and treadmill completion times for both genders combined (p = .122) could be viewed as approaching significance.

CHAPTER FIVE

Conclusions and Future Implications

Conclusions

Despite the clear health benefits of regular physical activity, the majority of adults in the United States are not physically active at levels determined to promote health (Prevalence of physical activity, 2003, p. 764). Additionally, a number of laboratory- and population-based studies have documented the many health and fitness benefits associated with physical activity and endurance exercise, such as improved physiologic, metabolic, and psychological parameters, as well as decreased risk of many chronic diseases and premature mortality (ACSM, 2006, p. 7). Given that cardiorespiratory endurance is not only a crucial component of physical fitness, but highly indicative of overall good health, determining an individual's level of cardiorespiratory endurance is critical. As a result of the link between cardiorespiratory endurance and health, several assessment methods have been developed over the years. As indicated previously, field testing is often a more practical means of testing cardiorespiratory endurance compared to laboratory methods for a variety of reasons including ease of test administration, allowance of testing multiple individuals concurrently, and cost and time effectiveness (Larsen et al., 2002).

This study was designed to compare subject completion times between a track and treadmill run on the 1.5-mile run test - a valid field test estimating cardiorespiratory endurance in young, fit subjects (Cooper, 1968; Daniels et al., 1979; Jackson et al., 1981; Kline et al., 1987; Mello et al., 1988; Anderson, 1992; George et al., 1993a; McNaughton et al., 1998; Grant et al., 1999; Williford et al., 1999; Larsen et al. 2002; Hall et al., 2004). Thirty subjects (15 males and 15 females) between the ages of 19 and 30 participated in the study. Subjects performed both an indoor track and treadmill run with a minimum of seven days recovery between each run, but no longer than two weeks between tests. Run order was randomly assigned.

Completion time was the dependent variable in this study and a comparison between subject completion times for a 1.5-mile run performed on a track and a 1.5-mile run performed on a treadmill was the focus of the study. An inverse relationship exists between the completion time of a 1.5-mile run and cardiorespiratory endurance, which is measured by maximal oxygen consumption (VO_{2max}). Based on this notion, the less amount of time it takes an individual to complete 1.5-miles, the greater their level of cardiorespiratory endurance, and, therefore, the greater their VO_{2max}. An estimation of the mean VO_{2max} was determined in this study using a prediction equation suggested by the American College of Sports Medicine (ACSM). Mean completion times for both the track and treadmill runs were plugged into the ACSM equation, VO_{2max} ($ml \cdot kg^{-1} \cdot min^{-1}$) = [3.5 + (483 / time in minutes)], in order to estimate mean VO_{2max} for males, females, and both genders combined (Appendix G).

While the research comparing track and treadmill running is abundant (Pugh, 1970; Lehmann et al., 1983; Bassett et al., 1985; Ceci & Hassman, 1991; Nigg et al., 1995; Crouter et al., 2001; Meyer et al., 2003; Nummela et al., 2007), studies comparing the transferability of completion times of running fields test to a treadmill is lacking. The results from this study found that there were no significant differences between completion times on a 1.5-mile run performed on a track versus on a treadmill in a group of physically active males and females.

There were also two other important findings in this study when looking at the exercise history form data (Appendix F). Lifting weights was found to be the single best predictor of treadmill completion times for both males and females. Previous studies have shown that resistance training can improve endurance performance (Hickson, Dvorak, Gorostiaga, Kurowski, & Foster, 1988; Johnston, Quinn, Kertzer, & Vroman, 1997; Millet, Jaouen, Borrani, & Candau, 2002) and in this study subjects lifting weights in addition to regular aerobic training were found to have the lowest completion times. Surprisingly, subjects reporting training primarily on a treadmill (Question 5e) was not a very good predictor of treadmill time as it was not even included among the best two- and three-variable models for predicting treadmill time. In addition, subjects reporting a fitness level categorized as above average/very fit (Question 1) also reported accumulating 30 or more minutes of physical activity most days of the week (Question 2), exercising currently (Question 3), and exercising more frequently (Question 4) when compared to subjects categorizing themselves as having a not very/somewhat fit level of fitness.

Based on the results in this study, using a treadmill to perform a running field test in circumstances where either a track or outdoor setting is not an option is an appropriate method of estimating an individual's cardiorespiratory endurance. In addition, combining weight training with aerobic training may positively effect cardiorespiratory endurance.

Recommendations for Future Studies

It was evident from this study that more research is needed in a number of areas involving the differences between track and treadmill running. Although a majority of subjects reported that they trained primarily on a treadmill, mean completion times were faster on the indoor track run compared to the treadmill run in both male and female subjects. While differences in completion times between both track and treadmill were only approaching significance and not technically significant, a number of items should be considered when designing future studies comparing track and treadmill running.

One area that requires future study is how differences in subject's rating of perceived exertion (RPE) between track and treadmill running impacts performance. While subject's RPE was not monitored in this study, it is possible that the treadmill run could have "felt" harder for subjects in comparison to the track run. Previous work from Ceci and Hassman (1991) found that treadmill running elicits higher RPE values compared to track running and that measured variables (i.e., velocity, heart rate, and blood lactate) for field running were significantly higher than for treadmill running at the same RPE level. In the present study, it is quite possible that differences in RPE among the two modes of running accounted for the majority of completion times being faster on the track compared to the treadmill. Subjects may have been able alter their running speed more efficiently during the track run compared to the treadmill run resulting in higher levels of RPE on the treadmill run. On the track run, subjects were able to increase or decrease speed by primarily manipulating their stride length and/or stride frequency. On the treadmill run, however, subjects had to use one of their hands to adjust the speed of the treadmill while continuing to keep up with their running pace. This extra effort may have caused subjects to run at a slightly slower speed in order to refrain from having to constantly increase and decrease the speed to maintain a desired pace. Future studies requiring subjects to self-adjust speed on a maximal treadmill test should incorporate an easier method for subjects to adjust their running speed allowing them to perform at a higher level of effort and help reduce possible differences in RPE between track and treadmill running.

Another area that should be investigated when comparing distance runs performed on a track versus a treadmill is how the testing environment may affect subject's completion times. Foremost among the areas pertaining to testing environment that should be considered in future studies are the number of laps that are equivalent to a specified distance, the shape of the track/course used for testing, and the presence/absence of external distractions. Most running studies utilizing field tests have used a standard, quarter mile (400-m) track (Pugh, 1970; Jackson et al., 1981; Jackson et al., 1990; Hall et al., 2004; Nummela et al., 2007), in which 6 laps around the inside lane of the track were equivalent to 1.5 miles. The present study, however, was conducted on a shorter, indoor track in which 18 laps around the inside lane of the track were equivalent to 1.5 miles. The difference in the number of laps subjects must complete on the 1.5-mile test may be significant. Jackson et al. (1981) found that for a 1.5-mile run test consisting of 6 laps around a track, a specific pacing strategy was observed among most subjects. The first and sixth laps of a 1.5-mile run test conducted on a 6 lap track were found to be performed the fastest. Whether or not this pattern holds true for a 1.5-mile run test performed on a shorter track requiring more laps to be performed remains to be seen. Since in the present study 18 laps was equivalent to 1.5 miles, there may have been a different, common pacing strategy used by the subjects in comparison to a 6 lap, 1.5-mile run test that has been traditionally used for testing.

The shape of the track or course used for conducting a 1.5-mile run may also play a critical role in the results of the test and necessitate further study. In the present study the track run was performed on an oval-shaped track. While a few running field test studies required subjects to complete a 1.5-mile course (Cooper, 1968; Lehmann et al., 1983; Bassett et al., 1985; Mellow et al., 1988), the researchers failed to mention the shape or layout of the course (e.g., straight course, out and back, square shaped, etc.). This could potentially impact how subjects pace themselves compared to running on a track. Theoretically, a straight course could be more difficult (if not impossible) for subjects to determine the distance they have completed when compared to a track where a reference point is easily determined based on the number of laps. Comparing completion times between a course and a track would be helpful in determining whether distance runs are impacted by the ability of subjects to gauge their distance based on some sort of reference point. Additionally, while a track may benefit an individual's ability to reference their distance covered when running, the particular track used in the present study may have also had a negative impact on performance. Since subjects had to run 18 laps in order to complete 1.5 miles, the inside lane turns were quite sharp and may have forced subjects to slow down slightly to avoid hitting the side railing. A track of greater distance may have reduced this and allowed subjects to avoid slowing down turning the turns. Future studies comparing tracks of varying lengths would be useful in determining the impact track distance and curve angle have on running completion times.

There were several external distractions not controlled for in this study that also may have impacted the results of this study. During the track run, subjects shared the track with other exercisers that were not part of the study. While signage was posted around the track notifying exercisers that testing was in progress, many times subjects were forced to swerve outside of the inside lane on the track to avoid colliding with another exerciser. There were also several external distractions that may have positively impacted completion times. For some subjects, having other individuals running on the track while they were testing may have increased their level of motivation or even contributed to them running at a faster pace compared to running by themselves. Other external factors that may have hade a positive effect on track completion times were the changes in surroundings as subjects ran around the track (compared to the treadmill in which subjects stared straight ahead) and background music that could be overheard on the track run only. Finally, the absence of external distractions for the treadmill run in comparison to those mentioned for the track run may have made the treadmill run feel harder and/or longer. The treadmill used for testing was located in an area of the facility with little to no outside interference in comparison to the track run and this may lack of distraction among the subject's may have made the treadmill test effected the subject's ability to push themselves harder.

A number of studies have found no significant differences in VO_{2max} between track and treadmill running (Bassett et al., 1985; Crouter et al., 2001; Meyer et al., 2003; Hall et al., 2004), however, other factors besides VO_{2max} have been found when comparing track and treadmill running. For instance, Meyer et al. (2003) found that track running is more economical than treadmill running due to higher submaximal VO_2 measurements attained by subjects during treadmill running and longer running durations achieved by subjects during track running despite the fact that they found no differences in measured VO_{2max} values between track and treadmill running. In the present study, subject completion times only were used to estimate VO_{2max} using the ACSM (2006) prediction equation (Appendix G). Since VO_{2max} is not the only predictor of running performance (Millet et al., 2002), other factor's relating to running performance, such as lactate threshold and running economy, should be measured when replicating the present study.

Future studies comparing track and treadmill running of similar nature to this study should attempt to account for potential sources of error discussed above. The present student, however, found that a treadmill is a suitable substitute for the track version of the 1.5-mile run test version in a group of young, fit subjects, and, therefore, may be useful in certain situations.

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APPENDIX A

Internal Review Board Approval

UNIVERSITY OF
CENTRAL
OKLAHOMA

Office of Research & Grants
Academic Affairs

March 17, 2008

Mr. Bryan Jackson
Dr. Darla Fent
Dr. Michelle Gray
Dr. Cynthia Murray
Department of Kinesiology and Health Studies
College of Education and Professional Studies
Campus Mail Box 189
University of Central Oklahoma
Edmond, OK 73034

Dear Mr. Jackson, Dr. Fent, Dr. Gray and Dr. Murray:

Re: IRB Application for Research Involving Human Subjects

Thank you for submitting your revised application (UCO IRB# 08072) entitled, *A comparison of completion times between a 1.5–mile run on an indoor track and treadmill in physically active individuals,* to the UCO IRB. The Office of Research & Grants is pleased to inform you of the approval of your application.

Caveat: Please update contact information for our office (see below) on the ICF.

This project is approved for a one year period but please note that any modification to the procedures and/or consent form must be approved prior to its incorporation into the study. A written request is needed to initiate the amendment process. You will be notified in writing prior to the expiration of this approval to determine if a continuing review is needed.

On behalf of the Office of Research & Grants and UCO IRB, I wish you the best of luck with your research project. If our office can be of any further assistance in your pursuit of research, creative & scholarly activities, please do not hesitate to contact us.

Sincerely,

Jill A. Devenport, Ph.D.
Chair, Institutional Review Board
Office of Research & Grants, Academic Affairs
Campus Box 159
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APPENDIX B

Study Announcement

Running Study at UCO

Be part of an important running research study

- Are you between 18 and 30 years of age?
- Do you exercise most days per week?

If you answered YES to these questions, you may be eligible to participate in a running study.

The purpose of this research study is to compare differences in track and treadmill running on 1.5 mile run test. Benefits include an estimation of your aerobic fitness level, also known as your maximal oxygen consumption ($V0_{2max}$).

Adults (18 - 30 years of age) are eligible.

The study is being conducted at UCO's Wellness Center.

Please contact Bryan Jackson at (405) 488-7082 or bryan.jackson@chk.com for more information.

APPENDIX C

Healthy Life Skills Approval

UNIVERSITY OF
CENTRAL
OKLAHOMA

College of Education
Department of Kinesiology
& Health Studies

Bryan Jackson
Living Well Coordinator
Chesapeake Energy Fitness Center

University of Central Oklahoma Graduate Student
Kinesiology & Health Studies Department
University of Central Oklahoma

February 12, 2008

Dear Bryan:

It is with sincere enthusiasm that I provide you with this letter of approval to include the Healthy Life Skills classes in your research on running. As you know, the Healthy Life Skills course at the University of Central Oklahoma focuses on the many dimensions of health, especially highlighting physical components of health. By utilizing research in selected sections of this course, we are able to reiterate to students not only the importance of their health, but the importance of ongoing research as well. Furthermore, because the Healthy Life Skills course is a core course at the University of Central Oklahoma, students in those classes are a broad representation of the campus population.

I welcome this partnership and thank you for including this course in your research design.

Kindest regards,

Sunshine C

J. Sunshine Cowan, MPH, CHES
Coordinator, Healthy Life Skills
Instructor, Community Health Program
Kinesiology & Health Studies Department

Cc:
Donna Cobb, Ed.D., Kinesiology & Health Studies Department Chair
Darla Fent, Ed.D., Thesis Chair, Kinesiology & Health Studies Department

Physical Education/Health • Community Health
Exercise/Fitness Management • Recreation Management
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APPENDIX D

Informed Consent

Informed Consent

TITLE OF PROJECT:	A Comparison Between a 1.5-Mile Run on an Indoor Track and Treadmill in Physically Active Individuals
PRINCIPLE INVESTIGATOR(S):	Bryan Jackson, Graduate Student Darla Fent, Ph.D., Faculty Michelle Gray, Ph.D., Faculty Cynthia Murray, Ph.D., Faculty

Introduction:

This is to certify that I, ________________________________ agree to participate as a volunteer in a study investigating the differences between track and treadmill running for the 1.5-mile run test. Completion time will be the variable measured in this investigation as a means to estimate maximal oxygen consumption. Supervision of testing will be under the direction of Bryan Jackson, Dr. Darla Fent, and Dr. Michelle Gray.

The testing protocol requires that each subject independently run 1.5 miles on an indoor track and a treadmill on separate days. Eighteen (18) laps on the track is equivalent to 1.5 miles.

I understand that at anytime during the test that I feel uncomfortable or feel like I need to stop, I am encouraged to do so. I am not required to run the entire test if it puts me in physical or mental discomfort. I will not be penalized or excluded from the study if I do not run the entire 1.5 miles during testing.

Purpose:

The primary purpose of this study is to investigate potential differences in completion times on a 1.5-mile run test performed on a track versus a treadmill. Subjects will first perform a 1.5-mile run on an indoor track. Seven days later the subject will perform a 1.5-mile run on a treadmill.

Description of the Study:

The subject will complete a standard Par-Q (Physical Activity Readiness Questionnaire) to ensure they have no disabilities or pre-existing conditions that may prohibit participation in the study, an Exercise History Questionnaire to determine physical activity status, and an Informed Consent form to ensure they understand the study.

1. Prior to subject arrival, all equipment involved in the study will be calibrated to ensure accurate measurements.
2. All Wellness Center staff relevant to the study were reminded of the day's proceedings and appropriate signage will be posted to ensure interference by individuals not involved in the study are minimized.

3. The investigator was responsible for organizing the paperwork filled out by the participants and directing them to the testing area.

4. The principal investigator will explain the testing protocol to the subject and answer any questions the subject may have.

5. The subject will warm-up for 5 minutes by walking or running on the indoor track at UCO Wellness Center at a Rating of Perceived Exertion (RPE) level of 3 on the Borg category-ratio scale of 0 to 10.

6. After warming up, the subject will perform a 1.5 mile run on an indoor track, which is equal to 18 laps on the inside lane of the track. The amount of time it takes the subject to compete the distance will be recorded by the test admininstrator with a stopwatch.

7. The subject will then cool-down by walking at a slow pace.

8. After cooling down, the subject will confirm his or her next testing time with the principal investigator, which will be scheduled seven days later.

9. On the second testing day that will be coordinated between the subject and the PI, the subject will warm-up for 5 minutes by walking or running on the treadmill track at an RPE level of 3 on the Borg category-ratio scale of 0 to 10. The treadmill will be held constant at a 0% grade.

10. After warming up, the subject will complete the 1.5-mile run as fast as possible. The grade of the treadmill will be kept constant at 0%, but the subject will select the speed on the treadmill and perform the required distance.

11. Upon completion of 1.5 miles, the subject will cool-down by walking at a slow pace.

<u>Time Requirements:</u>
The study will require each subject to be tested twice seven days apart. Each testing day will take approximately 30 minutes.

<u>Benefits of the Study:</u>
The benefits of this study are that the use of running field test on a treadmill may be a more practical way to estimate an individual's aerbobic capacity when space is limited to perform the test. Many health facilities do not have an outdoor track or sufficient space to administer a field test and, thus, the use of a field test on a treadmill may be more feasible. In circumstances where a treadmill is preferred over outdoor running, performing a field test on a treadmill is more specific to the training environment. Additionally, problematic conditions associated with outdoor testing (i.e., wind, rain,

lightening) are not factors that affect the performance of the test when performed on a treadmill.

<u>Potential Risks:</u>
The 1.5-mile run test is a maximal field test and is designed to measure how fast an individual can cover the given distance. Due to the nature of the test, there is a possibility that the subject may experience muscle soreness and/or injury during and after testing. The principal investigator is CPR/1st aid certified and will be present during all testing times and available to respond in case of emergency. All equipment available at the UCO Wellness Center will be known by all persons involved in the testing of the subjects in this study. In addition, appropriate signage will be posted in the areas involved in testing to ensure minimal interference from other students, faculty, and staff.

Subject Confidentiality:
Completion times of each subject will be measured and documented in this study. All data will be reported as the aggregate of completion times and held by the principal investigator in a secure location until completion of the study. Only the principal investigator will have access to the date. Upon statistical analysis, all data will be completely discarded.

Injury Compensation:
No compensation will be given to subjects from the University of Central Oklahoma and no other financial aid will be provided for any long-term injuary that may occur during the participation in this study.

Voluntary Participation:
Subjects are voluntarily participating in this research study and may withdrawal at any time for any reason without penalty.

Course Credit / Compensation for Participants:
No course credit will be given to subjects for participation in this research study.

Questions Concerning the Research Study or Research Subject's Rights:
Contact Dr. Darla Fent ((405-974-3599) or Bryan Jackson (405-488-7082) for any questions concerning this research study. Contact the Jackson College of Graduate Studies and Research for questions concerning subject's rights.

Foreseeable Risks:
The requirements of this investigation require the subject to run 1.5 miles around a track and on a treadmill on two separate occasions. The test is a maximal field test and is designed to measure how fast an individual can cover the given distance. Due to the nature of the test, there is a possibility that the subject may experience muscle soreness and/or injury during and after testing. The test administrator is CPR/1st aid certified and will be present during all testing times and available to respond in case of emergency. Equipment available at the UCO Wellness Center will be known by all persons involved in the testing of the subjects in this study.

Subject Confidentiality:
Completion times of each subject will be measured and documented in this study. To ensure subject confidentiality, all data will be held by the principal investigator and stored in a locked location until completion of the study. Data will be reported as the aggregate of completion times for track and treadmill running. The data will stored in a paper file by the primary investigator and will be locked in a secure location until the completion of the study. Only the principal investigator will have access to the data. Data will be kept only for statistical analysis and then destroyed using a paper shredder and then incinerated to ensure the results are fully destroyed.

Research Subject:

Printed Name:______________________________________ Date:___________________

Signature:____ Date:___________________

Witness:____ Date:___________________

APPENDIX E

Physical Activity Readiness Questionnaire (PAR-Q)

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ____

SIGNATURE ____ DATE ________________________

SIGNATURE OF PARENT ________________________________ WITNESS ________________________
or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

Supported by: Health Canada Santé Canada

continued on other side...

APPENDIX F

Exercise History Form

Exercise History Form

ID #:___________ Date of Birth:_____________ Gender:_____ Date:____________

(Please answer the following questions related to your current exercise habits.)

1. How physically fit would you say you are compared to others your same age?

    Not Very   Somewhat   Above Average   Very

2. Do you accumulate 30 minutes or more of moderate physical activity most days of the week through either structured exercise or as part of you job?   Yes / No

3. Are you currently involved in a regular exercise program?   Yes / No

4. How many times a week do you currently exercise?   0-1   2-3   4-5   >5

5a. Do you walk, run, or perform aerobic exercise on a regular basis?   Yes / No

    If you circled YES, please answer the following:

    b) How may times per week?

    c) How long per session?

    d) How would you describe the intensity?   Light / Moderate / Vigorous

    e) Do you primarily perform this activity outside (or track) or on a treadmill?

6a. What other type(s) of exercise do you do participate in on a regular basis?

    b) How many times per week?

    c) How long per session?

    d) How would you describe the intensity?   Light / Moderate / Vigorous

7a. Have you ever used a treadmill before?   Yes / No

    If you circled YES, please answer the following:

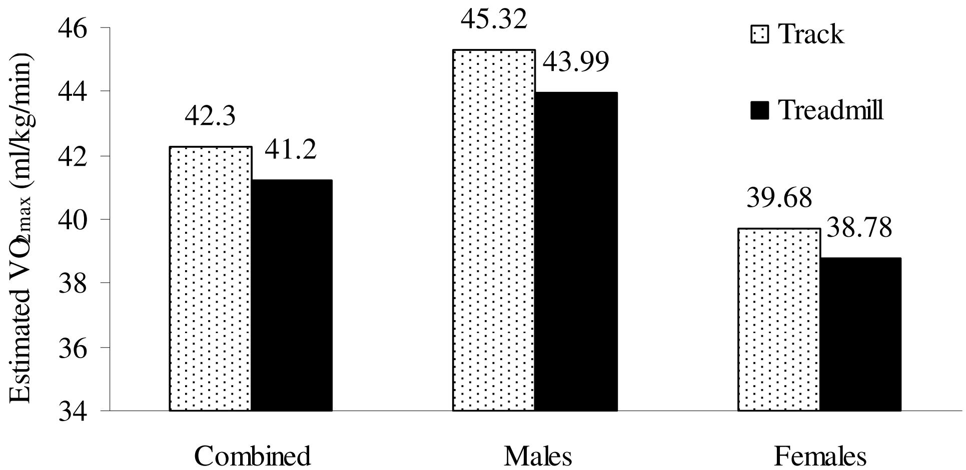
    b) How long ago did you last use a treadmill?

Adapted from Nieman, D.C. (2003). *Exercise Testing and Prescription: A Health-Related Approach*(5th ed.). New York: McGraw-Hill.

APPENDIX G

Estimated Maximal Oxygen Consumption (VO_{2max})

Figure 2



Estimated Maximal Oxygen Consumption (VO_{2max})[a]

[a]Calculated from mean completion times using the ACSM (2006) prediction equation.

APPENDIX H

Abstract

Name: Bryan K. Jackson Date of Degree: August 2008

Institution: University of Central Oklahoma Location: Edmond, Oklahoma

Title of Study:
A Comparison of Completion Times Between a 1.5-Mile Run on an Indoor Track and Treadmill in Physically Active Individuals

Candidate for the Degree of Masters of Science in Wellness Management

Option in Exercise Science

Scope and Method of Study: The purpose of this study was to compare the 1.5-mile run test performed on an indoor track to the 1.5-mile run test performed on a treadmill in a group of physically active adults 19 to 30 years of age. The study compared completion times on both tests, which were conducted within a two-week period at least seven days apart. A total of 30 subjects (*n* = 30) consisting of males (*n* = 15) and females (*n* = 15) participated in this study. On both the indoor track and treadmill runs, subjects completed 1.5 miles as fast as possible and completion times were recorded. Times were called out to subjects every quarter mile during each run. On the indoor track run, 18 laps on the inside lane was equivalent to 1.5 miles. On the treadmill run, subjects were responsible for adjusting their own speed using the treadmill's speed control.

Findings and Conclusions: Data was analyzed using SAS (version 9.1). Differences between independent means were compared by two-tailed t-tests. Differences between dependent means were compared by two-tailed paired t-tests. Differences between proportions were compared by two-tailed Fisher's exact tests. Correlation between two variables was determined using Pearson's coefficient (one continuous variable and one categorical variable) or the phi coefficient or Fisher's exact test (two categorical variables). Multiple regression was used to determine the best-fitting model to predict treadmill times. P-values less than .05 indicated significant differences as well as collinearity. This study found no significant difference in completion times on a 1.5-mile run performed on a track versus a treadmill for both genders (*p* = .122), males only (*p* = .329), and females only (*p* = .223). These findings demonstrate that using a treadmill to conduct a 1.5-mile run test is an appropriate method that can be used to estimate cardiorespiratory endurance in young, physically active adults. Additionally, lifting weights was found to be a better predictor of treadmill completion time compared to both regular aerobic exercise and treadmill experience.