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California State University Systemwide Student Research Competition

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Normative Values of College-Aged Men and Women for the 1.5-Mile Test on a Treadmill for Cardiorespiratory Fitness

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Introduction

University years are a formative time for young adults. Students invest time gaining knowledge in fields of interest, exploring arts and sports, joining clubs, and participating in many other extracurricular activities. It is not surprising that at such a busy time, students do not always take care of their health. In a meta-analysis done by Keating et al. they found that 50% of university students did not meet the American College of Sports Medicine's (ACSM) guidelines for physical activity (Keating et al., 2005). Furthermore, in a review by López-Valenciano et al., the authors found that physical activity levels of university students around the world decreased during the covid pandemic (López-Valenciano et al., 2021). The repercussions of a sedentary lifestyle are far-reaching. Physical activity has been shown to positively affect brain function and cognition (Kramer & Erickson, 2007). A negative correlation has been found between cardiorespiratory fitness and depression, suicide attempts, and self-harm (Grasdalsmoen et al., 2020). In addition to mental health, physical activity affects bodily functioning. Physical activity is one of the chief methods for improving and maintaining cardiorespiratory fitness (CRF). CRF is the ability of the respiratory and circulatory systems to supply oxygen to working muscles (Kenney et al., 2019). Poor CRF has been associated with many diseases from diabetes to heart disease (Al-Mallah et al., 2018). Many of these diseases are among the top ailments that affect people globally (World Health Organization, 2021). Physical activity therefore must be a part of students' weekly routine to help them tackle the difficulty of gaining higher education and maintaining their health at the same time.

With CRF playing such an important role in human health, it is necessary to be able to effectively determine an individual's CRF and whether it meets current recommendation guidelines. Maximal aerobic capacity (VO2 max) is the maximal consumption, distribution, and utilization of oxygen during exhaustive exercise and is the gold standard for categorizing an individual's CRF (Kenney et al., 2019). While VO2 max can be measured by a trained technician using laboratory equipment, most people do not have access to such tests on a regular basis and an easier method for determining their CRF is necessary. Fortunately, many field tests have been developed to allow people to estimate their CRF with little more than a stopwatch and a track to run on. The 1.5-mile test has been reported as one of the most accurate and reliable tests to estimate a person's VO2 max (Mayorga-Vega et al., 2016, ACSM 2013). Using an established equation, the weight and gender of the testee, and run time for the 1.5-mile test, an accurate VO2 max estimate can be produced (Larsen et al., 2002). Furthermore, in an unpublished thesis, Jackson found that 1.5-mile times did not differ significantly (p = .122) for either men or women when performed on a track versus a treadmill (Jackson, 2008). To determine a person's level of CRF, an individual can compare their VO2 max score to normative data for their age and gender (ACSM, 2013). Normative data come from cross-sectional studies in which a large group of subjects from a population takes a test. The results of each subject are used to determine percentile ranks that indicate the range of scores within the population. Thus, normative data provide a quick and simple way to assess performance and examine how an individual's score compares to a population (Hoffman, 2006).

The ACSM reports normative data for the 1.5 mile run test, however, this data was not established by sampling a population in a formal study but rather calculated using an adjusted 12-minute run test equation (S. Farrell, personal communication, February 20th, 2021). The ACSM's calculated normative data lack demographic parameters and the generalizability of the data is uncertain. The first purpose of this study is to fill the gap by establishing normative data for the 1.5-mile run test for moderately active university-aged adults. Due to the ease of use, all the 1.5 mile run tests will be performed on treadmills. Secondarily, this study aims to examine any differences between male and female subjects. We hypothesize that male participants will have a lower run time at any given percentile rank than female participants.

Methods

The normative data collected was obtained from a sample of 175 subjects (75 women; 100 men) between 19 and 29 years of age who were recruited for participation in this research. All 1.5-mile run tests were completed on a motorized treadmill (Platinum Club Series Treadmill, Life Fitness, Rosemont, IL). A running distance of 1.5 miles was used to compare results to the normative data as this distance has been previously identified as the minimum distance necessary to estimate cardiorespiratory fitness (Vickers, 2001). In addition, previous research has shown that the 1.5-mile run test had a positive correlation with V O2 max (Gleason et al., 2014, Larsen et al., 2002). Subjects were instructed to run until reaching 1.5-mile with their self-selected stride frequency. The University Institutional Review Board (IRB) approved this study, and each subject signed a written consent form before participating in the study.

Subjects were recruited and tested from December 2015 until May 2019. Subjects who were thoroughly familiar with treadmill ergometry and laboratory procedures, volunteered to participate in the study. Many subjects participated in a club or recreational sports (57.2% of men and 42.8% of women), but not college varsity sports such as soccer, track and field, etc. All subjects regularly participated in moderate or strenuous exercise for a minimum of 3 days per week for a period of at least 4 weeks prior to participation. Moderate physical activity is defined as any form of activity that takes 3.0-5.9 metabolic equivalent of task (METs) to complete, such as brisk walking, dancing, golf, tennis, and volleyball. Vigorous activity is defined as any activity that requires 6 or more METs to complete, such as jogging and running, bicycling, soccer, swimming, or performing heavy lifting (ACSM, 2013). Subjects were screened for cardiovascular and musculoskeletal disease using a medical history questionnaire, an activity questionnaire, and the Physical Activity Readiness Questionnaire (PAR-Q). Inclusion criteria were (a) classification as "Low Risk" according to ACSM's Cardiovascular Disease Risk Factor Assessment (ACSM, 2013), (b) not currently on any type of restricted diet or on any medication, (c) no musculoskeletal conditions or injuries, and no flu or illness during study, (d) non-smokers for at least the past 6 months, and (e) classification as non-obese (BMI < 30 and waist circumference < 102 cm). Based on inclusion criteria, subjects were considered healthy and active. Subjects participated in two separate sessions as part of the study procedures.

All Testing took place in the Humboldt State University Human Performance Lab (HPL). To avoid inter-rater reliability issues, all anthropometric data was collected by the same proctor. During the first session, all subjects completed a consent form, health history form, and had initial measurements (i.e., weight, height, and anthropometrics) taken. Weight (437 Physician's Scale, Detecto, Webb City, MO) and height (Seca 216, Chino, CA) measurements were taken as part of the subject assessments. Body mass index was calculated from height and weight measurements to determine if subjects met inclusion criterion (e). Body density was determined using the 3-site formula using skinfold (Lange Skinfold Calipers, Beta Technology, Santa Cruz, CA) measures at the triceps, suprailiac, and thigh for women and chest, abdominal, and thigh for men (Jackson et al., 1980); ethnic and sex-specific equations were used to calculate the percentage of body fat from body density. Prior to the data collection days, subjects participated in one familiarization session to help them get accustomed to the testing procedures and protocols (i.e., some practices in pacing). Prior to each experimental session, subjects performed a warm-up running for five minutes at their self-selected speed, followed by a dynamic stretching such as leg swing, high knees, etc. Subjects completed 1.5 miles as fast as possible on a motorized treadmill (Platinum Club Series Treadmill, Life Fitness, Rosemont, IL) with a 0% percent grade of incline. Subjects were instructed to run until reaching 1.5-mile with their self-selected stride frequency. Upon test completion, a mandatory cool-down period was enforced. Subjects walked slowly (80 m/min) for about 5 minutes immediately after the run to prevent venous pooling.

Statistical Analyses

The normal distribution of the data will be verified using a Kolmogorov-Smirnov test. Anthropometric data and completion time will be reported as mean ± standard deviation (SD). All data will be analyzed separately to provide percentile values for men and women. The descriptive statistics will be calculated in mean, standard deviation, minimum, and maximum. A t-test for independent means will be used to verify the differences between men and women. Where possible, the data will be compared with normative data for the general population and divided into categories based on physical fitness. All data will be analyzed using GraphPad Prism 9.0 (GraphPad Software, Inc., San Diego, CA) and Microsoft Office Excel for Windows 2016, and significance for all the statistical tests will be set at an alpha level of 0.01.

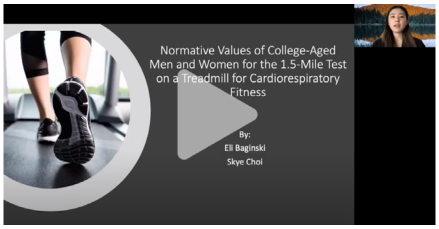
Results

Anthropometric characteristics and 1.5-mile run test outcomes of the study sample separated by sex are shown in Tables 1 and 2. Most variables were significantly higher in males. The average time for 1.5 miles was 11.7 ± 2.3 minutes for males and 13.3 ± 2.5 minutes for females. The average time for females was 113.3% of the average time for males ($p < 0.01$). The average speed for 1.5 miles was 8.0 ± 1.7 mph for males and 7.0 ± 1.2 mph for females. The average speed for females was 87.3% of the average speed for males ($p < 0.01$). Table 3 contains descriptive statistics and percentile norms for the 1.5-mile run test of speeds and times, respectively.

Discussion

The main objective of this study was to establish sex reference values for the 1.5-mile run test among active healthy adults aged 19-29 years and to compare values between sex. Our data in this population also confirms the common finding of faster speed in men compared to women (ACSM, 2013). Overall, these findings provide useful data that can now be used to interpret individual performance on the 1.5-mile run test for the general population. The results of this study provide normative values for both men and women for the 1.5-mile run test that can be used in a commercial or even home gym setting. Previously, there had not been percentile rankings or other normative data for this protocol that were widely available for general use and interpretation. Now coaches, athletes, and fitness enthusiasts who engage in regular physical activity will not only have access to an aerobic capacity (cardiorespiratory fitness) test that can be administered on a treadmill wherever available and used in place of special equipment and that is sports specific to running-type sports, but they can also interpret their results on their own. This study will provide a convenient method for students to assess their CRF. When improvement is desired, an individual can routinely check progress by referencing the normative data chart as they improve their 1.5-mile time.

Presentation



Appendices

Table 1. Characteristics of the study sample by sex. *

Characteristics	All (n = 175)	Men (n = 100)	Women (n = 75)	Difference, p for sex
Age	23 ± 3	23 ±2	23 ± 3	101.2%, p = .015
Body mass (kg)	77 ± 17	84 ± 18	69 ± 10	82.7%, p <. 001
Height (m)	172 ± 10	179 ± 8	168 ± 8	93.8%, p <. 001
Body mass index (kg/m)	25.3 ± 4.6	25.9 ± 5.1	24.5 ± 4.1	94.6%, p <. 001

*Data are shown as mean ± SD *

Table 2. Mean 1.5-mile treadmill run test speed and time for men and women. *

Characteristics	All (n = 175)	Men (n = 100)	Women (n = 75)	Difference, p for sex
Time (minutes)	12.5 ± 2.5	11.7 ± 2.3	13.3 ± 2.5	113.3%, p <. 001
Speed (mph)	7.5 ± 1.5	8.0 ± 1.7	7.0 ± 1.2	87.3%, p <. 001

*Data are shown as mean ± SD *

Table 3. Percentile norms and descriptive statistics for run time and speed for the 1.5-mile treadmill running test for men (n = 100) and women (n = 75).

%ile rank	Speed (mph.) M	Speed (mph.) F	Time (min.) M	Time (min.) F
95	10.7	8.7	08:00	10:17
90	10.0	8.4	08:58	10:45
80	9.1	7.7	09:55	11:43
70	8.8	7.2	10:14	12:31
60	8.1	7.1	11:08	12:39
50	7.9	7.0	11:24	12:43
40	7.5	6.5	12:03	12:49
30	6.9	6.2	13:01	12:52
20	6.4	6.0	14:02	15:05
10	6.0	5.3	15:00	17:00
5	5.9	5.0	15:01	18:02
Mean ± SD	8.0 ± 1.7	7.0 ± 1.2	11:44 ±02:19	13:18 ± 02:28
Minimum	5.8	4.8	15:24	18:42
Maximum	12.1	9.0	07:27	10:02

*Data are shown as mean ± SD