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Introduction

Cardiovascular disease (CVD) is the leading cause of death in the United States (US) and worldwide. According to the World Health Organization, an estimated 17.9 million people died from CVDs in 2019, representing 32% of all global deaths.[1] The American Heart Association (AHA) reports that the incidence of CVD in US men and women is about 40% from 40–59 years old.[2] Recent evidence reveals individuals becoming exposed to CVD risks at younger ages. Furthermore, cardiopulmonary fitness, an indicator of cardiovascular risk, is starting to show clearer peaks in males during their late 20s and 30s, whereas females may reach their peak even slightly earlier.[3] Carenthon et al. reported that the incidence of CVD, during a 15-year period, either maintained constant or increased in younger adults from the age range of 18-50 years old.[4] Among older adults, sudden deaths are often due to atherosclerotic coronary artery disease and terminal ventricular fibrillation.[5] Each year there are 300,000 such deaths in this country. [6] In contrast, sudden deaths from cardiac causes in young people are few but have numerous causes.[6] Healthy lifestyle behaviors during young adulthood strongly influenced CVD risk profile in later years[7], but risk factors such as hypertension, smoking, abdominal obesity, and diabetes mellitus are slowly increasing and affecting young adults. In some adolescents and young adults, the development of subclinical atherosclerosis is accelerated by identifiable risk factors; a steady decline in physical activity levels later in adulthood are significantly and independently associated with premature CVD events before age 60. [8]

One of the many factors that contribute to the likelihood of obtaining a CVD is increased time constraints placed on young adults when going through the transition phase into graduate school.[9] Graduate students will begin to shift their focus to their studies which takes up most of their time and energy, preventing them from being able to participate in regular exercise programs (health promoting behaviors of PT students). Students strive to meet the demands of the graduate program but must adjust

lifestyle behaviors to gain academic success within their program. Three healthy behaviors began to decline from the beginning to the end of the school curriculum: decreased moderate to vigorous exercise, decreased strength training and inadequate sleep. [10] However, Racette et al deduces that more frequent participation within moderate to vigorous exercise is correlated with an overall better cardiometabolic health status instead of just maintaining a sedentary lifestyle. [10]

Practice of unhealthy behaviors during young adulthood can jeopardize future health status later in life. Young people, especially those who become health care professionals that advocate towards health-promoting behaviors, should take responsibility for their own overall personal health status. As physical therapy programs have a rigorous curriculum, students tend to find themselves lacking time and motivation to promote healthy behaviors and instead devote their time to academic activities. [11] As graduate students age and decrease their activity level, the prevalence of obtaining a CVD will continue to increase. Therefore, it is important to recognize unhealthy habits in graduate students to decrease the incidence of CVD at a young age. The purpose of the present study is to determine the long-term effects of UTEP's Doctor of Physical Therapy program on students' health outcomes within their first year of the curriculum. This 1-year longitudinal study aims to: 1) determine aerobic fitness capacity (measured via VO 2 max), 2) determine the variation in body composition (body fat mass measured via DEXA), 3) determine the differences in vascular function (measured via pulse wave analysis [PWA] and pulse wave velocity [PWV]), and 4) to determine the differences in stress levels between the students' first year of the program.

Methods

Participants

Inclusion criteria included apparently healthy, young (18-40 years) UTEP Doctor of Physical Therapy students from the 2025 graduating cohort. The DPT program is a graduate program; therefore,

we expected to have participants older than 18 years of age. Exclusion criteria included known cardiovascular or cardiac disease and any physical limitation that prevented exercising. A pre-survey was administered to determine if the participant met eligibility requirements. If subjects are taking over-the-counter painkillers, such as NSAIDs or aspirin, or nutritional supplements containing antioxidants, we advised them to abstain from their use for 12 hours before their visits. The study was approved by the Institutional Review Board of UTEP, and all individual participants included in the study signed the informed consent before beginning testing.

Study Design

This longitudinal study following the UTEP DPT class of 2025 required annual visits to the laboratory (one at the beginning of the first year of PT education and once more at the beginning of the second year); each visit lasted approximately 2 hours (total time ~ 4 hours). Demographic data including date of birth, race/ethnicity, height and weight were collected during the first visit and served as a baseline measurement for comparison to visits 2. During each visit, participants completed testing at three stations: 1) Body composition station (DEXA scan), 2) Survey station (stress and fear), and 3) Cardiovascular station (vascular function and cardiorespiratory fitness). The first data point was collected in July 2022 and second visit was recorded in April 2023. Participants were recruited via an in-class presentation and emails.

Body Composition

The DEXA, or dual-energy x-ray absorptiometry, measures bone mineral density as well as body composition and body fat content with high accuracy.[12,13] The DEXA machine was calibrated each morning of data collection. The participants were instructed to lay supine on the DEXA machine and were positioned carefully within the testing field by the investigators to ensure proper measurements of

both sides of the body. A total body scan, using the default settings, was taken once for each participant, and each scan took approximately 10-15 minutes to complete. The scan produced high estimates of visceral fat, a measure that has predictive value for increased risk of cardiovascular disease. For the purposes of this study, the DEXA scan will be used to produce a general body composition breakdown for each participant to examine body fat and lean tissue data.

Survey

The Perceived Stress Scale (PSS) is a self-report survey that was administered to subjects via QuestionPro. The PSS is a simple 10-item questionnaire with acceptable and established psychometric properties. [14] The PSS measures and reports the degree to which life events or situations are perceived as stressful by the participant. For purposes of this study, the results from the PSS will be evaluated to examine the impact of the UTEP DPT program on the students'/participants' mental health.

Vascular Testing

Three sets of data were collected during vascular testing: Pulse Wave Analysis (PWA) and Pulse Wave Velocity (PWV). The height and weight of each participant were also taken at the beginning of the session.

Central blood pressure was assessed via PWA. Pulse wave analysis (PWA) enables the evaluation of central blood pressure and function. Two PWA measurements were taken on the participants' left arm. PWA is non-invasive and does not need any special preparation from the participants. The XCEL PWA system by SphygmoCor facilitates the non-invasive measurement of pulse wave analysis (PWA) using an oscilloscopic cuff. A laptop computer operates the pressure cuff, functioning similarly to a standard blood pressure measurement device.

Carotid-femoral pulse wave velocity (cfPWV) is considered the gold standard for determining arterial stiffness.[15] PWV was taken in the supine position using the participants' left thigh and left carotid artery unless the right carotid provided a stronger pulse. Length measurements were taken from the strongest point of the carotid artery to the sternal notch, from the sternal notch to the top of the cuff, and from the femoral artery to the top of the cuff. Once the participant achieves hemodynamic stability, a high-fidelity tonometer is positioned atop the carotid artery. Pulse waves from both the carotid and femoral arteries will be recorded simultaneously by the tonometer and the cuff, respectively. Three readings were taken for PWV.

Aerobic Capacity

The VO2max exercise test is one of the most pervasive measurements of aerobic fitness [16] and the measurement of maximal oxygen consumption throughout the body has been recognized as the gold standard in the assessment of cardiorespiratory fitness and health outcome.[17] Aerobic capacity was demonstrated with a VO2max test on a cycle ergometer. For the purposes of this study, the VO2max test will be used to measure the cardiovascular fitness of the participants, and values taken at annual intervals will be compared to assess any changes. The VO2max metabolic cart was calibrated at the beginning of the day and again at mid-day. This measurement, known as VO2max, is conducted using a metabolic cart (gas analyzer) linked to the subject via a mouthpiece and an extended tube. During testing, Borg's rate of perceived exertion (RPE) was used to determine the patient's self-reported effort and fatigue during the test. RPE ratings were recorded near the end of each stage. If RPE levels did not increase for 2-3 stages, resistance was manually raised by the investigator at a faster rate to avoid fatigue before true aerobic capacity was reached. Participants were instructed to give as much effort as they could and were encouraged verbally to continue with the test for as long as possible. Indicators that participants were nearing completion of the test included an RPE of greater than or equal to 17 and a

respiratory exchange ratio (RER) of 1.10. However, the participants were also instructed that they were able to terminate the test whenever they needed it.

Statistical Analysis

A repeated measures ANOVA test and pairwise comparisons for each result will be performed to determine differences in health outcomes within the first year of the DPT curriculum. Significance was set prior at an α level of 0.05 with a confidence level of 95%.

Results

Prior to the start of the study, general descriptive statistics were ran to understand the beginning sample group. The results displayed the average mean, height, weight, body mass index (BMI) and maximal aerobic capacity (VO2max) of the two separate gender groups. The study began with 25 participants from the class of 2025. The male group that began with 7 participants was identified with an average BMI of 24.73 and a VO2max of 40.31 mL/kg/min. The female group with 17 participants exhibited an average of 26.13 BMI and 29.57 mL/kg/min upon VO2max. During the duration of the first year within the participants' curriculum, the study lost three subjects.

The results when comparing the data from prior to starting the doctor of physical therapy program to the end of the first year in the curriculum, the pairwise comparisons were able to signify statistical differences between the sample means of the two groups of males and females. When looking at the male group, the males were able to demonstrate improvements with statistical significance with their brachial systolic pressure (p=0.010) and brachial diastolic pressure (p=0.011) from visit one to visit two. Additionally, the males central systolic pressure (p=0.012) and central diastolic pressure (p=0.021) were able to exhibit statistical differences between the first visit and the second visit. The females only

demonstrated statistical differences with augmented index (p=0.018). Females were able to improve heart rate from the initial visit to the second visit, but did not display statistical significance. The PSS demonstrated evidence that females had statistically higher levels of perceived stress prior to the start of the curriculum (p=0.023) than compared prior to the start of the second year. Males did not find any significant difference upon overall stress levels. Variables such as height, weight, VO2, body fat mass, body lean mass, and PWV did not display any significant differences between males and females during the one year time span between visit 1 and visit 2. The ANOVA defined significance between group differences of males vs females within the variables of height (p=<.001), weight (p=0.012), and VO2 (p=0.007).

Discussion

The purpose of this study was to assess the impact of the University of Texas at El Paso Doctor of Physical Therapy (UTEP DPT) program on the cardiovascular health outcomes of its students. The findings demonstrated interesting disparities between male and female participants, leading to potential factors influencing the study's primary and secondary outcomes.

As the results stated, there were significant differences between male and female students enrolled in the UTEP DPT program. Male participants presented significant improvements in both systolic and diastolic blood pressure compared to females. Additionally, while females demonstrated enhancements in their augmented index, these improvements were overshadowed by the more pronounced gains observed in male blood pressure. Although females displayed a reduction in heart rate from program commencement to the end of the first year, these changes did not reach statistical significance. Moreover, initial stress levels were higher among female students, although these disparities diminished by the end of the first year.

Several factors may contribute to the observed gender disparities in cardiovascular health outcomes among UTEP DPT students. Firstly, the acclimatization process to the demands of the program may have played a role, with students gradually adapting to the rigorous academic and scheduling requirements. Both male and female students likely found ways to integrate physical activity into their schedules, leading to overall improvements in cardiovascular health. However, the more significant improvements among male participants suggest potential gender-specific factors at play.

To further discuss gender-specific influences on cardiovascular health, the differences observed among male and female students could stem from various gender-related factors impacting cardiovascular health. Genetic predispositions, differences in endocrine function, and variations in overall body composition may contribute to different outcomes.[18] Additionally, societal norms and expectations regarding physical activity levels and stress management may influence how male and female students navigate the challenges of the program.

As far as implications and future considerations, understanding gender disparities in cardiovascular health outcomes among DPT students is essential for developing specific interventions and support for students. When implementing these strategies to promote stress management, physical activity, and overall well-being, gender-specific needs should be considered. Future research is needed to look deeper into the underlying mechanisms causing these differences, including genetic and hormonal influences.

In conclusion, the findings of this study emphasize the importance of recognizing gender differences in cardiovascular health outcomes among DPT students. While both male and female participants experienced improvements throughout the program, the magnitude of these changes varied between genders. Moving forward, addressing gender-specific factors and tailoring interventions accordingly can optimize the cardiovascular health and overall well-being of DPT students

Limitations

This study had a few limitations. First, the initial sample size of 25 participants is quite small. It was further decreased after the loss of 3 participants within the 1-year time span. This could increase the risk for a type II error and in turn decrease the power of the study. Second, there were inconsistencies present regarding complete participation on the PSS for visit 2, which may have affected the statistical significance of perceived stress between male and female counterparts within their first year of the curriculum. Examiners should also consider proper calibration of the equipment, especially with the VO2max metabolic cart to increase intrarater reliability. Future studies should consider increasing the sample size, analyze specific physical activity levels, and inquire on nutritional intake to better represent our target population of DPT students nationwide.

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