QUALITY OF LIFE AND STRESS IN ACTIVE AND SEDENTARY UNIVERSITY MALES

by

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Bachelor of Science, 2014
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Pittsburgh, PA

Submitted to the Graduate Faculty of
Harris College of Nursing and Health Sciences
Texas Christian University
in partial fulfillment of the requirement
for the degree

MASTER OF SCIENCE

In

Kinesiology

(Sport Psychology)

June

2018

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A Thesis for the Degree of

Master of Science in Kinesiology

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June 2018

ACKNOWLEDGMENTS

There are several individuals I would like to acknowledge and thank for their contributions to my completion of this thesis. First, my advisor, Dr. Debbie Rhea, for her guidance, review, and support throughout the process, from inception to completion. Second, my committee, Dr. Debbie Rhea, Dr. Joel Mitchell, and Dr. Stephanie Jevas, for their guidance, review, expertise, and support throughout the process and especially during my proposal and defense. Third, my lab partner, Mr. Andreas Kreutzer, who helped me find the correct assay for this project and worked with me to complete the assays during the analysis. Fourth, the TCU Kinesiology Department and staff for their support, thoughtful review, and collegial setting during my time at TCU. Finally, I'd like to thank my family, my friends, and my peers, for their support, thoughtful review, and the challenge to push to the finish, especially Ron and Tracy Wadle, Brian Franklin, Michael Wood, and Alec Pickett.

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ABSTRACT

This study explored the impact of exercise levels on stress, psychological and physiological components, and quality of life in university males. A total of 51 students (age: 20.31±2.01) were recruited and participated in three trials over the course of the semester. Participants were divided into active and sedentary groups based on a physical activity level survey. Each trial consisted of a urine sample measuring cortisol for physiological stress and the completion of the quality of life and psychological surveys. A one-way repeated measures ANOVA across time showed no significant difference in cortisol levels by group. Pearson product correlations showed significant negative relationships (-0.334 to -0.710, $p<0.05$) at each time point between perceived stress and quality of life, but no relationship was found between perceived stress or quality of life and cortisol levels. The results indicate male students may have difficulty assessing their physiological stress levels. The lack of difference in stress, quality of life, or cortisol levels between the groups indicates exercise may not be an attenuating factor for university males. More psychophysiological research on this population should be completed to explore other stress and quality of life factors.

CHAPTER 1. INTRODUCTION

College is often thought of as the "best times" of one's life, an experience to be treasured and a "party" for four years. College has become part of the fast-paced, performance driven machine the world is today. This can result in an increased level of stress and pressure on students, who are inundated with work in and out of the classroom. Attending class, social gatherings, personal and work commitments, and dedicating hours to studying and learning material for exams and future use: the student life. The stress can become very impactful to these students' performance in the academic, social, and health/exercise areas, likely influencing their quality of life (Carodine, Almond, & Gratto, 2001; Miller & Kerr, 2002; Stilger, Etzel, & Lantz, 2001).

Similar to the multi-area impact stress can have on individuals, stress is multifaceted. First, a person can feel a positive (eustress) or negative (distress) stress state. There are two components, physiological and psychological, which interact to produce a positive or negative stress state (Lazarus, 1966). These components are highlighted in the holistic definition of stress, which "is the inability to cope with a perceived (real or imagined) threat to one's mental, physical, emotional, and spiritual well-being, which results in a series of physiological responses and adaptations" (Seward, 2012, p.6). When a eustress response is elicited, it is considered healthy and gives one a feeling of fulfilment or other positive feelings. When a distress response is elicited because an event is perceived as a threat, potential adaptations to cope with the stressor are needed. In the General Adaptation Syndrome (GAS), an alarm response occurs immediately in wake of the stressor. A resistance stage is ideally reached to cope with and adapt to the stressor. If the resistance stage fails, then an exhaustion state is reached, and the stress state is maintained until the threat is gone (Selye, 1936, 1950, 1951). The endured stress state is also known as chronic stress. In general, chronic stress is the result of sustained distress. Distress and stress are recognized synonymously in the American culture, therefore the word stress will be used to mean distress throughout this study.

Acute and chronic stress are impactful to the function of an individual in multiple areas of life and multiple body systems. Studies have shown psychological and physiological stress in athletic competition, academic results, and social functioning, as well as physical and psychological health and immune function (Dienstbier, 1989; Hanin, 1995; Kimball & Freysinger, 2003; Lazarus, 1966; McEwen, 1998; Selye, 1936, 1950, 1951; Yerkes & Dodson, 1908). The impact can vary by individual due to their coping ability and or how they perceive the stress. However, an overwhelming amount of stress or a chronic stress state has negative consequences for the individual, including quality of life. The World Health Organization (WHO) defines quality of life as dependent on the self-perception of an individual's satisfaction with their performance or function in multiple areas of their life (1995). The areas of academic, social, and health/exercise performance and function are critical to the perception of a student's, college-aged (18-26 yrs), quality of life. A chronic stress state, physiologically or psychologically, would likely have significant impact on these areas.

Physiological and psychological measures of stress have been used to evaluate stress independently and concurrently. These measures have shown to be correlated in several populations (Baum & Posluszny, 1999; Chrousos & Gold, 1992; Dienstbier, 1989; Dos Santos, Kuczynski, Machado, Osiecki, & Stefanello, 2014; Juster, McEwen, & Lupien, 2010; Rafidah et al., 2009; Selye, 1973; Stilger et al., 2001; Teixeira et al., 2015). Additionally, each independently has been shown to be correlated to a performance measure and/or quality of life (Blouin, Deaton, Richard, & Buza, 2014; Boudreau, Johnson, & Herman, 2011; Filaire, Lac, &

Pequignot, 2003; Kausar, 2010; Marshall, Allison, Nykamp, & Lanke, 2008; Matheny et al., 2002; Orem, Petrac, & Bedwell, 2008; Rafidah et al., 2009; Stilger et al., 2001; Surujlal, Van Zyl, & Nolan, 2013). Students are often convenient samples in psychological studies and student-athletes/exercisers are often convenient samples for physiological studies and experiments. It remains to be seen if a student population accurately assesses their stress and how the perceptions of stress and physiological stress varies over the course of a semester. The association between quality of life and stress is known, but this population has not experienced much exposure at this point.

Statement of Purpose

The overall purpose of this study was to examine the relationship between actual and perceived stress levels of college males. A secondary purpose was to examine actual and perceived stress level differences between sedentary and active college males at pre and post time periods. Finally, the study examined the relationship between actual and perceived stress levels and the student's quality of life by year in school.

Significance

This study explored a gap in the literature regarding stress levels of collegiate students related to their quality of life and exercise habits. This aids researchers in evaluating time periods where stress levels may be higher or quality of life may be lower in a semester and what impact exercise has on those variables. It may also help institutions be more aware of when students struggle, during a semester and during their career, and where to direct aid. This study also explored whether physical stress levels and perceived stress levels are consistent with each other. The consistency could potentially add to the support for the psychophysiological stress relationship and suggest ways students can accurately assess their own stress levels.

CHAPTER 2. REVIEW OF LITERATURE

Stress can be positive or negative, and chronic stress, considered negative, can be problematic for anyone experiencing it. The extent of the influence stress has on an individual is based on the psychological perception and physiological response to the stressor. Research has examined the impact of perceived stress on performance in academic and athletic settings and the impact of physiological stress on cognitive and physical performance. Together these expose more about an individual's stress state and quality of life.

Exploring the relationship between these stress types and their relationship with performance over the course of a semester and a collegiate career may reveal more about the students' quality of life. In order to pursue this endeavor, it is necessary to understand the stress response research, psychological and physiological, in relation to performance in health/exercise, social, and academic areas, and ultimately its effect on quality of life. This review includes the following topics: (a) the physiology of stress, (b) stress theories, (c) stress and health research, (d) stress and performance, (e) quality of life as performance, (f) stress and collegiate students, (g) stress over the course of a season/semester, and (i) stress impairing quality of life.

The Physiology of Stress

In order to understand the theories of stress and how psychological and physiological systems interact to produce a stress response, a knowledge of the physiological pathways involved is helpful. Stress, known as distress and was defined previously as, "the inability to cope with a perceived (real or imagined) threat to one's mental, physical, emotional, and spiritual well-being, which results in a series of physiological responses and adaptations" (Seward, 2012, p.6). The physiological responses associated with these threats differ based on the severity and duration of the threat.

The stress response is often referred to as the "fight or flight" or "tend and befriend" response for males and females, respectively (Cannon, 1932; Taylor et al., 2000). However, these are stress reactions, or initial behaviors due to a perceived threat both genders will experience. The stress responses occur in multiple systems within the human body to prepare the body for action and maintain a homeostatic state. The autonomic nervous system and the endocrine system will be focused on for the purposes of this review.

The Autonomic Nervous System. The autonomic nervous system is made up of the sympathetic and parasympathetic nervous systems. The sympathetic nervous system is most associated with the "fight or flight" reaction to stress. This system releases epinephrine and norepinephrine throughout the nervous system at sympathetic junctures to stimulate metabolic activity to provide energy for cognitive and physical functioning. Epinephrine and norepinephrine are produced by the adrenal medulla via the sympathetic adrenal medullary axis (Padgett & Glaser, 2003). This axis serves as the connection between the perceived threat and the stress reaction.

The axis follows a pathway from the neural cortex of the brain to the adrenal gland. First a threat is perceived by the neural cortex and a message is sent to the subcortical amygdala, thought to be the primary structure in activating the stress response. The amygdala then activates the hypothalamus, specifically the lateral hypothalamus which controls the sympathetic nervous system. The lateral hypothalamus sends a message to the adrenal medulla, which then produces and releases epinephrine and norepinephrine (Chrousos & Gold, 1992; Padgett & Glaser, 2003). This release causes several physiological responses immediately, including, increased heart rate, vasodilation of arteries to working muscles, vasoconstriction of arteries to non-working muscles, dilation of pupils and bronchi, increased ventilation, decreased digestive activity, increased glucose release from the liver, and other functions to prepare the body for the reaction (Selye, 1936, 1950, 1951).

Epinephrine and norepinephrine are fast-acting neurotransmitters and signal the body's systems for a high level of energy expenditure over a short period of time. The response generated is short-lived and functional for acute stressors, like a "fight or flight" situation. There are exceptions where sympathetic activity will be maintained for longer than minutes, but it will not last for days on end. A different system produces this response. After an acute stress response, the dissipation of epinephrine and norepinephrine in the body reduces the physiological responses and returns the body to its homeostatic state. However, as the stress response becomes chronic, the endocrine system is activated and becomes the main response system.

The Endocrine System. The endocrine system is comprised of a network of glands, including the adrenal gland, which release hormones into circulation to act on target organs or other glands to produce physiological changes. The endocrine system is contributory to the "fight or flight" reaction through the adrenal gland to produce epinephrine and norepinephrine but also to produce cortisol. Cortisol is active in an acute stress response but has long-lasting responses as well. Cortisol, a glucocorticoid, is produced in the adrenal cortex of the adrenal gland and is activated via the hypothalamic-pituitary-adrenocortical axis (Chrousos & Gold, 1992).

This axis is a pathway from the perceived threat to the adrenal cortex, via hormonal signaling. Initially, the neural cortex sends a message to the amygdala, which activates the hypothalamus, similar to the sympathetic adrenal medullar axis. However, the paraventricular nucleus of the hypothalamus is activated in this axis and corticotropin releasing hormone (CRH) is released. CRH stimulates the pituitary gland causing the release of adrenocorticotropin releasing hormone. This hormone acts on the adrenal cortex to release cortisol (Padgett & Glaser, 2003). The immediate process cortisol aids in is lipolysis, the breaking down of fat, for further energy production. In the long term, cortisol can perpetuate the stress response and compromise other systems in the body.

The stress response can become chronic through the presence of cortisol and glucocorticoids. If a stress state is maintained after epinephrine and norepinephrine are reduced and cortisol is not reduced, then the locus coeruleus is activated to release further norepinephrine. This signals the amygdala, which leads to the production of more corticotropin releasing hormone and the hypothalamic-pituitary-adrenocortical axis is reactivated (Sapolsky, 2003). The maintenance of cortisol and glucocorticoid levels induce a chronic stress state, which can be cyclical. The chronic stress state is linked to immune system suppression (cortisol activity), physical and cognitive dysfunction, and disease. The dysfunction is a result of the physiological systems not returning to a homeostatic state.

Stress Theories

Stress has been studied and discussed for hundreds of years. It was not until recently the research community began to understand what impact stress has on individuals. Physiological, psychophysiological, health-related, and psychological theories of stress responses and effects will be explained. It is important to understand how these overlap and interact to produce an understanding of stress, stress responses, and the effects of stress. This will aid in comprehending the existing research providing evidence for the current study.

Physiological Theories. Hans Selye (1936) observed stress responses while working with rats and noticed significant and similar changes in physiological functions over time. He proposed a three-stage model, the General Adaptation Syndrome (GAS), humans go through physiologically to handle a stress state until the threat is resolved. First, the stressor is encountered, and an initial response occurs, the “alarm reaction”. Second, an adaptation to the stressor occurs to return the individual to homeostasis or the stressor is removed, “resistance”. Third, if no adaptation occurs or the stressor is not removed, “exhaustion” is reached and the individual is vulnerable and often gets sick or may even die (Selye, 1936, 1950).

GAS proposes multiple pathways in defense of “alarm reactions”. The two main pathways are the sympathetic adrenal medullary axis and the hypothalamic-pituitary-adrenocortical axis, which correspond to the release of catecholamines (epinephrine and norepineprhine) and cortisol, respectively (Selye, 1950, 1951). These produce the “resistance” to the “alarm reactions” and help the individual adapt to the stressor. However, if the defense is ineffective or perpetuates itself into a cycle, the stress becomes chronic and leads to the exhaustion stage, rather than an adaptation.

Psychophysiological Theories. This general response to stress can be elicited through psychological stress as well as physiological stress. Research has demonstrated the type of stimuli is more non-specific than Selye originally proposed (Lazarus, 1966). The stressor can be experienced, felt, real or imagined. If the individual perceives it as threatening, then it can become a stressor. This corresponds to physical stress and psychological stress causing the same physiological response. Lazarus proposed a cognitive-transactional model, which describes stress as a transactional process (Folkman & Lazarus, 1985; Lazarus, 1998). The transaction is between an individual and the environment, specifically the individual’s cognitions and their perceptions of the environment, resulting in a stressful interpretation. This model is limited due to the lack of connection to physiological processes occurring in a stress response (Dishman & Jackson, 2000). Other proposed models include the psychological and physiological processes.

One such model is the physiological toughness model. This model suggests peripheral arousal from exercise reduces stress responses at basal status and enhances the response to a stressor regardless of the source of the stress (Dienstbier, 1989). These are physiological adaptations occurring to enhance psychological and physiological coping, as well as potentially encourage positive performance in complex tasks. This model is psychophysiological, meaning it accounts for the interaction of how stress is perceived and the responses following the perception. Dienstbier (1989) also suggests perception and the response are more intricately linked. A positive perception (challenge) leads to a mainly catecholamine response, where a negative perception (threat) leads to a cortisol heavy response, and these perceptions and responses reinforce each other in a cyclical way (Dienstbier, 1989). Though this model includes an interaction interpretation, it addresses an exerciser population and does not account for how other stressors may adapt the responses.

General adaptation syndrome (GAS), cognitive-transaction, and physiological toughness are each models of stress responses. GAS, with the understanding that responses and adaptations can occur due to physical or psychological stressors, provides the most flexible conceptual basis. It also addresses the issue of what happens when systems fail or overcompensate in the exhaustion stage. Chronic stress' association with dysfunction and disease has led to further research and theories to explain the association more accurately.

Health-related Theories. One line of research in the association between chronic stress and disease has introduced a model of allostatic load. An individual seeks homeostasis, stability in the internal environment despite changes in the external environment, to function normally.

This concept refers to an optimal function range to occur but does not explain changes outside of the range. Allostasis is the process of achieving stability through adaptation or change in a wider range of functioning (McEwen, 1998; McEwen & Wingfield, 2010). The measure of the requirement to adapt or change is called allostatic load (McEwen, 1998). This load occurs when the sympathetic adrenal medullary or hypothalamic-pituitary-adrenocortical axes are overstimulated or performing ineptly and can lead to disease over extended periods of time. There are three types of allostatic load: frequent activation of stress systems, failure to stop functioning after the stress has been removed, or an inadequate response of one system leading to an overcompensating activity of another, usually counter-regulated, system (McEwen, 1998). McEwen does note individual differences are present and individual perceptions of stress can alter the responses. Cortisol, epinephrine, and norepinephrine levels are among the measures reported in the allostatic load battery (McEwen & Wingfield, 2010). This provides a significant expansion to general adaptation syndrome and addresses how dysfunction occurs and can be measured.

Another model, proposed by Borysenko (1987), coincides with general adaptation syndrome and allostatic load. This model explains the stress response hormones can cause a number of physiological dysfunctions, called autonomic dysfunctions in the model, when chronically or over-produced. However, this overlooks the immune dysregulation being caused by the same hormones. Cortisol specifically suppresses white blood cell function and limit the body's ability to identify and fight infection. The model proposes immune function, during homeostasis, is regulated precisely. However, when a chronic stress state occurs, and the immune system is compromised, over-reactions or under-reactions from the immune system are common and cause disease, both internally and externally generated (Borysenko, 1987).

Internally elicited diseases can range from arthritis to cancer, while externally created diseases can vary from allergies to viral infections; these depend on the over- or under-reaction of the immune system. A return to homeostasis in the immune system is necessary but limited by the chronic stress state. Also of note, Borysenko supports the idea psychological stress is a vital component of this immune dysregulation, but the connection between perception and immune system integrity is still being researched (1987).

Psychological Theories. Several psychological theories connect stress and its effect on performance (Hull, 1943; Lazarus, Deese, & Osler, 1952; Yerkes-Dodson, 1908). These theories are mostly based in the sport psychology literature and describe stress as arousal or anxiety. Anxiety is a negative interpretation of arousal, or a “threat” perception, and leads to poor performance generally. Anxiety is related to distress in the understanding of stress. Arousal is considered a positive energy state usually conducive to performance. Arousal corresponds with eustress in the concept of stress. There are psychological and physiological components to each of the theories to be discussed.

Drive theory is the original model of the effect of stress on performance. It suggests performance and arousal are related in a positive linear fashion (Hull, 1943). This means, as arousal increases so does performance. This theory appeared very early on in the sport psych literature but was not pervasive due to its lack of application. Stress was shown to have a more diverse impact than on motivation alone (Lazarus et al., 1952). Drive theory faded in usage as research led to other theories with more support.

The Inverted-U hypothesis was well supported in the research. The hypothesis postulates as arousal increases, performance will also increase in a curvilinear path, but only to a point. After this point, performance decreases as a result of further increases in arousal. The point at peak performance is considered the optimal arousal for performance (Yerkes & Dodson, 1908). This theory is the foundation of modern performance theories.

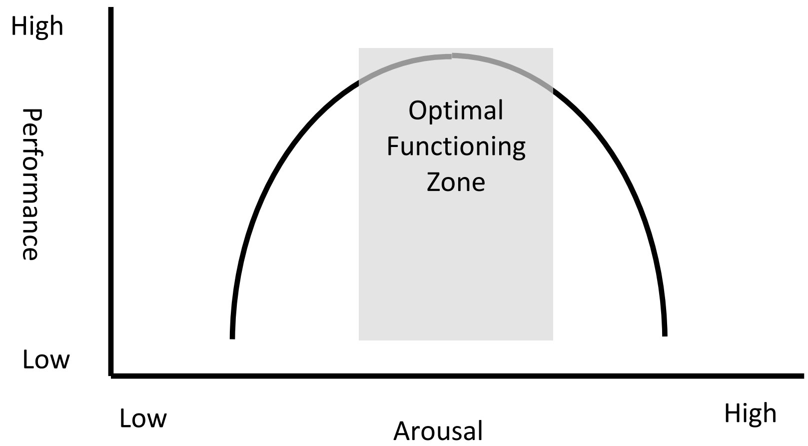


Figure 1. Inverted-U Hypothesis

The Individual Zone of Optimal Functioning (IZOF), as seen in Figure 2, expanded on the Inverted-U hypothesis. It described the arousal level of optimal performance as specific to each individual as it corresponds to perceptions of self and the situation, as well as, the sport in which they are participating (Hanin, 1995). The current IZOF model is multidimensional and applies to various cognitive and somatic components of arousal, i.e. emotion, (Hanin, 2007). The individualistic evidence the IZOF model revealed is important to an understanding of stress, as each individual will experience it differently for each situation. However, this model is limited by its application to sport/high intensity performance and not a wider array of situations.

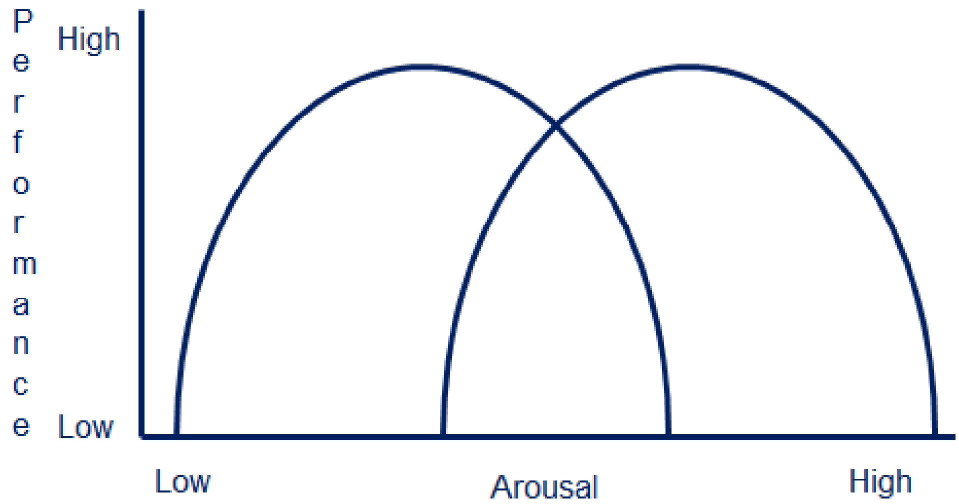


Figure 2. Individual Zone of Optimal Functioning Model

A theory applying to a wider array of situations is the multidimensional anxiety theory. Central to this theory is the concept that anxiety responses are not only individually specific, but situationally specific as well (Martens, 1977). The corresponding model integrates cognitive and somatic state anxiety and self-confidence as influences on performance. Somatic refers to the physical component, while cognitive refers to the mental component of state anxiety. These constructs correspond to different relationships with performance. Cognitive state anxiety has a negative linear relationship with performance, whereas somatic state anxiety has a curvilinear or inverted-U relationship with performance, and self-confidence has a positive linear relationship with performance (Martens, Vealey, & Burton, 1990). There are a number of other variables to be considered to describe these relationships completely. This theory is useful in understanding the complexity of stress and its influence on performance. The complexity can lead to conflicting results in multiple performance settings.

Summary. Each of these theories, models, and hypotheses is useful to furthering an understanding of the relationship between stress, stress responses, and the effects of stress on the individual. Overlap between physiological, health, immunological, and psychological theories shows the complexity of the concept of stress. Through the lens of the past research in the area of stress, a significant interaction between psychological and physiological processes is noticed. This interaction and the effects of it have been researched in multiple areas of study, these topics applying to the current research will be discussed in following sections.

Stress and Health Research

Health is an important component of life, good health specifically. Stress can be beneficial to an individual's health, though it often is not. The stress of exercise produces endorphins, provides energy, and aids in immune system function. However, chronic stress has an opposite effect. It is cyclical, reinforcing itself, diminishes energy stores, and causes dysfunction in the immune system. McEwen's (1998) allostatic load model and Borysenko's (1987) dysregulation model provide foundation for investigation into the extent of chronic stress's effect on an individual.

The allostatic load model shows the extent of dysfunction in an individual's systems through a battery of measures. Catecholamine and cortisol are components of the battery as biomarkers of acute and chronic stress. These contribute to the disease risk and eventual disease proliferation in an individual. In a review of chronic stress's impact on health, Juster and colleagues showed the diverse stimulus which can elicit chronic stress and how it can manifest in different ways for each individual (2010). These stimuli range from socioeconomic status to family separation to race to gender even. These were present in children and young adults. As increased age becomes an additional factor, education levels, job demands, and personality contribute more to increased allostatic load. Juster and colleagues suggest the support for disease trajectories begins early in life and carries on throughout life unless the stressor is diminished or removed (2010). Following the general adaptation theory, adaptation to the stress is necessary to produce resilience and success, but maladaptation perpetuates the stress and leads to exhaustion and disease (Selye, 1950, 1951). The stress increasing allostatic load comes from a wide array of sources, but the result is physiological or psychological dysfunction for the individual.

The immune and autonomic dysregulation model provides more concrete outcomes in the research. The source of the chronic stress is non-specific, but the outcomes are more defined. Immune system suppression is linked to chronic stress and the presence of cortisol and glucocorticoids. This suppression makes an individual more vulnerable to disease. White blood cells are especially influenced by cortisol and glucocorticoids, decreasing the number of T-cells and B-cells (hypothesized) (Herberman, 2002). T-cell production sites in the body are affected by hormonal interaction, suggesting emotions and thoughts have a significant impact on function (Rabin, 2002). Natural killer cell activity is reduced by chronic stress leaving an individual susceptible to diseases, internally generated (cancer) or externally (flu) (Herberman, 2002). Any compromise to the immune system, especially those resulting from chronic stress, increases an individual's risk for disease.

The link between chronic stress and disease vulnerability is shown in the research. This impact can be seen in multiple models and shows the diversity of stress sources and outcomes an individual can encounter. Persistent stress has a range of consequences, including biological, cognitive, social, quality of life, and decision making (Baum & Posluszny, 1999). Individual differences will be present, but trends exemplify the connection between stress and health.

Stress and Performance

The link between stress and performance can be seen in physically demanding tasks and cognitively demanding tasks independently, as well as concurrently physically and cognitively demanding tasks. The IZOF theory provides evidence for individual differences in responses to stress to be present regardless of the activity type (Hanin, 1995). As the stress responses vary by individual, the performance will vary by individual as well. These responses will span the spectrum of activities that can be performed.

In physically demanding tasks, the stress and performance will be interpreted based on the physical ability of the individual. Collegiate swimmers showed significant decline in physical performance as training load increased over time, while physical performance improved when training load was reduced. An increase in perceived stress and decreased recovery was reported as training load increased, while perceived stress decreased when training load was reduced (Nagle et al., 2015). The fatigue from the increased training load may have been the factor contributing to the decrease in performance and increase in perceived stress. The connection performance and perceived stress have as a function of time and physiological factors is important to stress having an influence on physical performance.

In cognitively demanding tasks, stress can be externally or internally applied acutely. This stress is perceived immediately and can affect performance. If there is no acute stressor, then the effect of chronic stress on cognitively demanding tasks can be measured. Teixeira et al. showed chronic stress impaired the ability of business executives on cognitive tests and slowed responses to stimuli (2015). Undergraduate students reporting high chronic stress had a significant positive correlation with time to perform a high cognitive functioning task (Orem et al., 2008). The chronically stressed students took significantly longer to complete the cognitive task indicating stress negatively influences cognitive performance. No gender differences were available from the study due to the recruiting process used. Rafidah and colleagues showed academic performance is negatively correlated with perceived stress (2009). The significant correlation occurred at the end of the semester during final exam, the height of cognitive demand for the university student. There is a significant detriment to performance associated with stress and it is not limited to any specific age group. Performance in cognitive tasks and physical tasks are adversely affected by stress. Tasks with both components are affected as well.

The influence of stress in situations or lifestyles with cognitive and physical demands is negative in nature. Collegiate aviators reporting chronic high stress also reported significantly worse performance than the low and medium stress groups. A strong negative correlation was found between stress level and perceived performance of flight (Blouin et al., 2014). Flying a plane requires cognitive and physical engagement with significant risk and pressure involved. The decrease in overall performance is related to increased stress levels. The same is true for student-athletes in school and sport performance. A significant negative correlation was found between perceived stress and both school and sport performance (Moen, Federici, & Abrahamsen, 2015). The perceived stress of the student-athletes and aviators correlating to negative performances in cognitively and physically demanding tasks, concurrently or independently, shows stress is impactful on performance in college aged individuals. Regardless of the nature of the task, chronic stress impairs the individual's functioning.

Quality of Life and Performance

Performance is often described in quantitative methods such as points or score or GPA. This perspective is limited to individual endeavors without considering their influence on each other. Quality of life provides a holistic perspective for life performance to be described by an individual in relation to several areas of functioning, as well as the impact it may have on their overall well-being. The World Health Organization (WHO), describes quality of life as "individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns" (WHO, 1995, pp. 1405). To interpret this definition, quality of life is an individual's own perception and satisfaction with their life within their own cultural system of living. This concept is subjective, multidimensional and includes both positive and negative dimensions. The domains of quality of life include physical functioning, psychological/cognitive functioning, level of independence, social relationships or functioning, environment, and spirituality, religion or personal beliefs (WHO, 1995). Various measures focus on different domains. The domains of interest for student-athletes are physical functioning, cognitive functioning, and social functioning (Miller & Kerr, 2002). Similar domains are used for non-athlete college-aged individuals in quality of life and life satisfaction (Joseph, Royse, Benitez, & Pekmezi, 2014; Maher, Doerksen, Elavsky, & Conroy, 2014; Marshall et al., 2008; Molina-Garcia, Castillo, & Queralt, 2011; Sigmund, Kvintova, Hrebickova, Safar, & Sigmundova, 2014; VanKim & Nelson, 2013). These domains manifest the performances and interactions of domains in student's lives. These performances and interactions are the influencers of the quality of their lives. Therefore, quality of life is an appropriate assessment of life performance for students.

Stress and Collegiate Students

Students possess a unique set of stressors in contrast to other individuals. The students have added pressures of academic responsibilities, socialization, and financial or employment components for many. The student-athlete spends an additional, extensive amount of time training for competition in their sport, while also attending classes and attempting to function socially and make decisions about their future (Carodine et al., 2001). This is not an exhaustive list of stressors students face, others may include race or gender or stereotypes. This list also applies to the average college student and additional stressors may exist that population. These stressors are impactful to the student and can be found in the research corresponding to physical, psychological and academic performance (Kausar, 2010; Meyer, 1990; Miller & Kerr, 2002; Nguyen-Michel, Unger, Hamilton, & Spruijt-Mertz, 2006; Rafidah et al., 2009; Sigmund et al., 2014; Stigler et al., 2001; VanKim & Nelson, 2013).

The suggestion physical or psychological performance is impaired due to stress being present is not new and is a common view within the world. Teixeira and colleagues showed chronic stress affects business executives adversely and elevates cortisol (2009). This extends to the college students as well. There is limited research identifying all the sources of stress for college students or measuring the stress levels of college students with a biomarker. The presence of stress is determined through biological markers or through psychological tools but is often assumed to exist based on the anecdotes of life. It is important to remember stress responses and interpretations vary individually, and these results are generalized from the data collected.

Significant research has been conducted on youth, college, and professional athletes using biomarkers and psychological tools to measure stress. Youth athletes may seem susceptible to stress more so than elite athletes due to their lack of experience and developmental process still being undertaken, the same could be said for college students being less mature than adults. However, stress responses in all athletes are relatively similar. Cortisol levels were elevated after performance in all athletes, specifically in overload, high-intensity training, or competition situations (Dos Santos et al., 2014; Freitas et al., 2014; Iellamo et al., 2003; Moreira, Arsati, Lima-Arsati, Simoes, & de Araujo, 2010; Robazza et al., 2012). Some discrepancies did exist between studies. Dos Santos and colleagues discovered significantly lower cortisol levels during regular training in comparison with rest and competition levels in youth soccer players

(2014). It was also shown these youth players did not perceive much stress in training or competition and recovered quickly from any high stress state achieved. This recovery ability could be connected to their fitness levels and ages (McEwen, 2010). However, lower cortisol levels at rest, elevated cortisol levels after all activity and a positive relationship was found between elevated cortisol levels and symptoms and sources of stress in youth and adult athletes in different sports (Freitas et al., 2014; Moreira et al., 2010). Iellamo and colleagues determined cortisol was heightened in elite athletes during competition, but heart rate did not vary between training and competition settings (2003). Another physical stressor for athletes is injury. It has been shown psychological stress and stress sources are predictors of injury in both youth and professional soccer players (Ivarsson, Johnson, & Podlog, 2013; Johnson & Ivarsson, 2011). The interaction of psychological and physical stress is made more apparent in this evidence. These findings contribute to the individualistic nature of stress and stress responses and provide evidence for a relationship between stress biomarkers and physical and psychological demands. Due to the limited research of biomarkers in college students, it can be reasoned college students may respond similarly as these athletes and the interaction of psychological and physical stress exists for them as well.

The relationship between perceived stress related to academics and academic performance has limited research, but a significant negative relationship has been described between perceived stress and academic performance at the end of the semester (Rafidah et al., 2009). This relationship is accompanied by an over moderate level of stress being reported by students and a significant increase in perceived stress from the beginning of the semester to the middle of the semester, which is maintained to the end of the semester (Rafidah et al., 2009). This fluctuation in perceived stress is reinforced by a study of athletic training students. These students reported higher stress levels at midterm and at the end of the semester with females reporting higher levels of stress, though not significantly (Stilger et al., 2001). These results indicate a connection between perceived stress and academic performance and it manifests differently between genders and over time in the semester.

Stress Over a Period of Time

As there was a difference in perceived stress and academic performance at various times in the semester, it was also found that psychophysiological stress manifests itself over the course of the season. There is agreement stress biomarkers and psychological states are related, but there are some discrepancies about what the relationship is exactly (Filaire et al., 2003; Filaire, Ferreira, Oliveira, & Massart, 2013; Handziski et al., 2006; Kraemer et al., 2004; Robazza et al., 2012; Rouveix, Duclos, Gouarne, Beauvieux, & Filaire, 2006).

Nagle and colleagues showed a significant increase in perceived stress as a function of time over the course of a swim season (2015). The collegiate athletes reported decreased recovery as well. These corresponded to an increase in training load, which also corresponding to a decreased physical performance. Though only psychological stress was measured, it is important to note perceived stress is related to physical performance and training load and increases as the season progresses. The academic load college students have can be substituted for the training and may show a similar trend of decreased recovery and limited performance output.

Filaire and colleagues suggested combined psychological and physiological evaluations of stress were necessary to monitor performance in a team sport (2003). This was based on cortisol and uric acid levels being increased over the course of high intensity training period and decreased performance aligning with changes in the mood state of the team. This increase in cortisol is supported in the research of professional soccer players and it is notable cortisol levels will vary with training and competition intensity. This means rest periods will allow cortisol levels to recover, but continuous stress will lead to further increases (Handziski et al., 2006). Robazza and colleagues provided support as well, concluding cortisol and other salivary hormone elevation can have a perceived psychological effect on an upcoming performance through psychobiosocial states in professional basketball players (2012). These results show cortisol as an effective measure of stress over the course of a season and support the connection between psychological and physiological stressors. Similar themes may apply to the college student given the academic load and shifts in load throughout the semester. This notion is supported by perceived stress measured in college students (Radifah et al., 2009; Stigler et al., 2001).

The connection to physical performance over the course of the season is also present in the research and further supports Filaire and colleagues' (2003) holistic evaluation. Kraemer and colleagues determined male collegiate soccer players had significant performance decrements from the beginning of the season to the end in speed, strength, and power exercises, as well as, cortisol being elevated throughout the season (2004). This study also showed starters performance decrements were greater than those of non-starters. A study of young female tennis players over a periodized training and playing schedule showed cortisol to be significantly elevated by training and increased with training intensity (Rouveix et al., 2006). These increases corresponded with fatigue and anger mood states increasing and vigor decreasing over time, which were correlated to the lowest win percentage and highest training load (Rouveix et al., 2006). These studies support a holistic approach to stress evaluation and connect elevations in hormones to decreased physiological performance.

Some recent studies have provided contradicting evidence to cortisol being elevated as the season progresses. Filaire and colleagues showed an increase in salivary alpha amylase (sAA) and sAA/C ratio over 16 weeks of training (2013). However, the cortisol response was low and blunted for the young female tennis players at the end of the training period, suggesting an asymmetry in the stress systems, but supporting a need to study a psychophysiological approach to prevent fatigue and keep the athlete healthy. Silva and colleagues (2014) found professional soccer players yielded lower cortisol concentrations immediately after the season than during the season, preseason, and after a post season rest period. Sterczala and colleagues (2014) found that NCAA football players over two seasons showed no significant variation in hormonal concentrations, although an increasing trend was seen in the data. The consistent levels may also be associated with a consistent stress state rather than any variation during collection times. These results are consistent with other findings in college students (Rafidah et al., 2009). A psychophysiological approach to the study of stress is supported and individual variation could account for some of the variance present.

Stress Impairing Quality of Life

Quality of life maintenance is essential to life satisfaction. The impact stress has on quality of life is present in the literature, but students as a population to be studied has limited research. Marshall and colleagues showed a significant negative correlation between perceived stress and mental quality of life, with a non-significant correlation with physical quality of life (2008). The mental and physical subscales of quality of life are affected by stress and will vary based on the individual's reactions as previously stated. Student-athletes are being pulled in many directions, specifically athletically, academically, and socially (Carodine et al., 2001; Miller & Kerr, 2000). Student-athletes may therefore struggle with the multitude of demands they are faced with and their quality of life may suffer. Student-athletes have been shown to be moderately satisfied with life and perceive a higher than average level of stress (Surujlal et al., 2013). This study showed a significant negative relationship between perceived stress level and life satisfaction. Life satisfaction is a concept related to quality of life. Increased perceived stress predicted decreased life satisfaction among college students, which suggests quality of life is adversely affected as well (Matheny et al., 2002). These results show some evidence there is a connection between being a student and a lower quality of life. It seems to be related to stress, both perceived and actual.

Model

There are several models of physiological and psychological stress. This research requires parts of each for a whole model for understanding. General adaptation syndrome's three stage model is an ideal structure for understanding the students' stress and their reaction to this stress. In those students who have adapted to and are effectively managing the stress, an adaptation stage has occurred, stage two, and the cortisol and perceived stress levels should be lower than the students who have not adapted and are in an exhaustion stage, stage three. These two stages should also provide the division for quality of life, those in an adaptation stage having higher quality of life than those in an exhaustion stage. The original model needs to be amended to include psychological and physiological stress as elicitors of the stress response from Lazarus's work, as well as, the adverse effects which can result from maintaining an exhaustive state, allostatic load and disease, in McEwen (1998) and Borysenko's (1987) work. The interaction of multiple systems and cognitions will affect the stress response and the quality of life experienced by the student. There is not a clear indication of which model or combination of models would be most appropriate to interpret the results of this study.

Research Questions

Question 1: What is the relationship between perceived and actual stress levels?

Question 2: How do perceived and actual stress and quality of life vary by activity level?

Question 3: How do perceived and actual stress levels (and quality of life) differ by year in school?

Question 4: How do perceived and actual stress levels (and quality of life) differ over the six week time period?

Question 5: What associations do physiological and/or psychological stress levels have with quality of life in university students?

Hypotheses

Q1. H1: It is predicted a significant positive correlation of .80 or higher will be found between perceived and actual stress levels.

Q2. H2: Sedentary males will show significantly higher actual and perceived stress levels than active males at the end of the six-week period.

Q2. H3: Sedentary males will show significantly higher stress levels and lower quality of life than active males.

Q3. H4: Younger, sedentary males will show significantly higher actual stress levels than perceived stress levels.

Q4. H5: The actual and perceived stress levels at the beginning of the six-week period will be significantly lower than the actual and perceived stress levels at the end.

Summary

Stress, psychological and physiological, elicits a physiological response. This response can be measured in cortisol, specifically urinary cortisol, as a biomarker of the chronic stress cycle. Using Selye's general adaptation syndrome as a basis with consideration for advances in the stress pathway and impact research provides the foundation for the impact stress has on someone. This stress influence is present in students and athletes from both psychological and physiological sources. This stress has been shown to affect quality of life presently and over the course of a lifetime. The current study seeks to explore these factors and the relationships between them.

CHAPTER 3. METHOD

This study explored the relationship between perceived stress and a known stress biomarker, cortisol, in male university students. It provided insight into the potential connection between these measures of stress and the students' quality of life. These three variables were measured over the course of a six-week period during a semester. A statistical analysis was performed to determine the relationships between the measured variables and other demographic information.

Participants

The participants for this study were male students at a private university in north Texas. These participants were to be full time students of the university and generally healthy. Exclusion criteria involved the following: 1) Any student who was not able to begin the study due to injury, illness, or not being enrolled full-time; 2) students who could not complete all three collection periods; and 3) any student who exhibited contraindications to exercise. The population was 34 active (generally healthy, exercising four or more days per week, 30 or more minutes per day and greater than 240 minutes (4 hours) per week, and this exercise being at a moderate to vigorous intensity as described by ACSM) and 17 sedentary (exercising two or fewer days per week, no more than 60 minutes (1 hour), and this exercise being at a low to moderate intensity as described by ACSM).

Measures

Demographics, perceived stress, quality of life, and physiological biomarkers of stress were collected from each participant. The following measures were used for data collection: a demographic questionnaire, the Perceived Stress Scale 10 item (PSS-10), the World Health Organization Quality of Life Brief version (WHOQOL-BREF), International Physical Activity

Questionnaire – Short Form (IPAQ), and urinary cortisol collection and assay supplied by MP Bio. The time segment to complete the surveys was approximately 10 minutes. The survey was completely anonymous whether completed online or on paper.

Demographics. The demographic questionnaire gathered information about the participants beyond the inclusion criteria. This included the student's age, year in school, activity level, and race/ethnicity. These demographics allowed for trends in perceived stress, stress biomarker levels, and quality of life to be seen for specific criteria.

Perceived Stress (Cohen & Williamson, 1988). Perceived stress was measured using the Perceived Stress Scale. This 10-item scale was developed as a global measure of stress and has been used frequently in the sport psychology and health fields. Psychometrics have confirmed its validity and reliability (Taylor, 2015). Internal reliability showed an alpha coefficient of 0.78. Factor analysis showed 48.9% of variance was explained by the factors, a slight improvement from the PSS-14. Construct validity was established with correlations to other measures of stress within a week ($r=0.36$, $p<.0001$) and stress now compared to a year ago ($r=0.26$, $p<.0001$). A t-test of PSS scores showed those who reported having experienced stress previously had significantly lower scores ($p<.0001$) than those who reported life was currently stressful. High PSS scores were positively correlated with increased life dissatisfaction on the Life Satisfaction Scale ($r=0.47$, $p<.0001$); (Cohen & Williamson, 1988). The PSS-10 is recommended over the PSS-14 and PSS-4 by the authors. The PSS is scored on a five-point Likert scale, reverse scoring positively stated items (4, 5, 7, and 8) and then summing all item scores. Scores range from 0-40, with an average stress score being 13.02 (Cohen & Williamson, 1988). High stress levels were determined by the results of the population, as no specific norms exist. (See Appendix A for the full scale and scoring information).

Quality of Life (WHOQOL Group, 1998). Quality of life was assessed using the WHOQOL-BREF. This scale is a shortened version of the WHOQOL-100 focusing on the domains of physical health, psychological, social relationships, and environment, with one component on overall quality of life and general health. This 26-item scale has shown a high correlation to the WHOQOL-100 (>0.89) in all domains (WHOQOL Group, 1998) and each domain has shown good construct validity and a high correlation to the general items of quality of life and health (Skevington, Lotfy, & O'Connell, 2004). Cronbach alpha values ranged from 0.68 to 0.82 showing good internal consistency. The WHOQOL-BREF has significant discriminant validity on each of the domains ($p<.01$) (Skevington et al., 2004). The test-retest reliability was tested over a 2-8 week interval with item scores ranging from 0.56 to 0.84; domain scores ranged from 0.66 to 0.87 (WHOQOL Group, 1998). Confirmatory factor analysis showed each of the four domains loaded similarly to the WHOQOL-100 (Comparative Fit Index > 0.90) and loaded to a second order factor of global quality of life (WHOQOL Group, 1998). Domain scores are calculated by multiplying the mean of all items within the domain by four: each domain score then ranges from 4-20. (See Appendix A for the full scale and scoring of all items and domains).

***Physical Health*.** The domain of physical health consists of seven items. Significant discriminant validity between the means of all sick and well responders has been shown ($t=39.2$, $p<.01$). An average of all locations Cronbach alpha resulted in an overall value of 0.82 showing good internal consistency (Skevington et al., 2004). An example item from the physical health domain is, "Do you have enough energy for everyday life?" (WHOQOL-BREF, WHOQOL Group, 1998).

Psychological. The domain of psychological consists of six items. Significant discriminant validity has been shown when considering all locations ($t=19.9$, $p<.01$). An overall Cronbach alpha value of 0.81 shows good internal consistency (Skevington et al., 2004). An example item from the psychological domain is, “How well are you able to concentrate?” (WHOQOL-BREF, WHOQOL Group, 1998).

Social Relationships. The domain of social relationships consists of three items. Discriminant validity was shown to be significant across all responders ($t=13.0$, $p<.01$). A Cronbach alpha value for all locations of 0.68 shows good internal consistency, though a 3-item domain is lower than the recommended four item minimum for Cronbach alphas (Skevington et al., 2004). An example item from the social relationships domain is, “How satisfied are you with the support you get from your friends?” (WHOQOL-BREF, WHOQOL Group, 1998).

Environment. The domain of environment consists of eight items. Discriminant validity was shown to be significant when considering all responders ($t=7.6$, $p<.01$). An overall Cronbach alpha value of 0.80 was found, showing good internal consistency (Skevington et al., 2004). An example item from the environment scale is, “How safe do you feel in your daily life?” (WHOQOL-BREF, WHOQOL Group, 1998).

Activity Level (Booth, 2000). Activity level was measured using the International Physical Activity Questionnaire Short Form (IPAQ). This 7-item measure was developed as a reliable and valid self-administrated measure of physical activity participation for research purposes. The appropriateness of this measure for college students has been confirmed (Dinger, Behrens, & Han, 2006). Reliability showed an average Spearman coefficient of 0.76 and a test-retest reliability coefficient of 0.75. Concurrent validity was established with the IPAQ long form and other short forms instruments at coefficients of 0.67 and 0.58, respectively. Criterion validity was established against accelerometers and the IPAQ short form had less variable correlation values (Craig et al., 2003). Validity among college students was established with correlations to objective measures of vigorous activity (ρ=0.30-0.47, $p<.01$) and moderate activity (ρ=0.19-0.23, $p<.01$). An intraclass correlation coefficient ranged from 0.71-0.89 ($p<.01$) indicating high reliability of the items (Dinger et al., 2006). Active students were considered those engaging in moderate to vigorous exercise, as defined by ACSM, four or more days per week, 30 or more minutes per day and greater than 240 minutes (4 hours) per week. Sedentary students were considered those exercising one or fewer days per week, no more than 60 minutes (1 hour), and this exercise being at a low to moderate intensity as defined by ACSM. (See Appendix A for the full scale and scoring information).

Urinary Cortisol. First morning urinary (FMU) cortisol levels served as the physiological biomarker for stress. Cortisol is a known biomarker of stress and can be obtained through urinary collection. There is a significant relationship between FMU levels and salivary cortisol levels ($p<.05$). However, urinary cortisol produces higher levels for variation to be detected more easily (Sarkar, Zeng, Chen, Salvante, & Nepomnaschy, 2013). Urinary collection has some benefits over salivary collection: urinary collection is less time consuming, it lends itself to self-collection reducing the anticipatory response, FMU reduces the impact of diurnal confounding factors and food or liquid consumption as urination is a primary morning function, and FMU has been shown to indicate variation in cortisol levels related to self-reported stress (Nepomnaschy, Lee, Zeng, & Dean, 2012; Sarkar et al., 2013). Urinary cortisol is a better indicator of chronic stress levels than salivary cortisol, which has a more acute response (Sarkar et al., 2013).

Urine samples were collected and an assay was used to determine exact free cortisol levels. The assay kit was a radioimmunoassay (RIA) urinary cortisol kit purchased from MP Bio. The assay is based on a competitive binding technique in which the sample competes with a cortisol standard for a limited number of binding sites on the coated tubes. A tracer is added to the coated tubes and after incubation the liquid is aspirated. The radioactivity of the tubes is counted for 1 minute with a gamma counter. The radioactivity is then converted to cortisol concentrations. The kit has an intra-assay variability of ≤ 78% and an inter-assay variability of ≤ 8%. The average sample recovery was 98%. The kit has as sensitivity up to 0.07 μg/dL from the calibrator 0 at the 95% confidence limit. The performance characteristics are provided by MP Bio (2015).

Procedures

Approval was obtained from the Department of Kinesiology Human Subjects Committee and the university's IRB. After gaining approval, male university students were contacted via flier (posted in campus buildings and online), email (some university classes), and in person (some university classes) and invited to participate in a study about psychological and physiological stress and quality of life. Once interest was received, a meeting with the student was set up to explain the study and have the student complete informed consent form and the demographic questionnaire. Students were told urine samples would be collected and questionnaires would be completed at three time points, early October, mid-November, and mid-December (see Table 1). Students were given specific instructions regarding urine collection and questionnaire completion prior to the dates of collection.

Urine samples were collected in sample collection cups as soon as the students woke in the morning. These samples were collected independently, with collection cups and consistent instructions for all groups provided the previous night. Students then brought the samples to the Rickel Building prior to their morning workouts or class. The investigator was present for all sample receiving. The samples were stored or aliquoted and then stored at 2-8 °C or at -20 °C if being stored for longer than one week.

The questionnaires (PSS, WHOQOL-BREF, and IPAQ) were completed at the time of urine collection via a Qualtrics online survey link. An email was sent to the students the morning of collections which included the link and their specific reference number for identification. Reminder emails about collections were sent the night before collection days. If the survey was not completed via the online survey, then a paper copy was available to the student when they delivered their urine sample to the researcher prior to leaving for a workout or class. The samples were delivered by the students between 6am and 9am, within three hours of collection. The researcher collected the samples for processing or freezing to be processed at a later date. Any paper questionnaires submitted in lieu of the Qualtrics survey were collected by the researcher for recording and analysis.

Urine samples and questionnaire responses were collected within a window based on schedules of the students (see Table 1). Collections aimed to be on mornings between 6:00am and 9:00am during appropriate collection windows, but also to make sure the process was completed before academic classes began each morning. The participants were informed to maintain a positive hydration status throughout the study. The participants were informed hydration status could be monitored by urine color, the clearer (less yellow) the urine, the more positive the hydration status.

Table 1.

Timeline for Data Collection by Activity Level

Activity Level	Collection 1 (6:00-9:00am)	Collection 2 (6:00-9:00am)	Collection 3 (6:00-9:00am)
Active	October 1-14	November 11-13	December 9-11
Sedentary	October 1-14	November 11-13	December 9-11

Urine samples were frozen and processed at a later date using a RIA urinary cortisol kit (MP Bio, 2015) to determine the cortisol levels for each participant at each time point. The assay data was calculated using the procedure provided by the company (see Appendix B for full product insert and procedures). This derived data and the data from the questionnaires were statistically analyzed at the completion of the study using SPSS (version 11).

The pre-meeting and the three collection windows served as the data collection for this study. The students were informed their participation was voluntary and signed an informed consent form. The researcher conveyed their samples and responses would be confidential and anonymous and they could decline participation in the study. Once consent was obtained, the researcher explained the purpose of the study and the measures included in brief to provide sufficient understanding for the student to comprehend each, the demographic questionnaire, the PSS-10, the WHOQOL-BREF, the IPAQ, and the urine collection at the time of completion by the student.

Statistical Design

In order to test the hypotheses and exploratory question, analytical statistics were conducted for descriptive statistics, each hypothesis, and the exploratory question using SPSS (version 11). The statistical analysis were as follows: Q1:H1) Pearson correlations were run to determine if a significant positive relationship existed between the perceptions of stress and biomarker levels of stress; Q2: H2) An independent T-test was conducted to determine if a significant difference in stress levels existed between active males and sedentary males at the end of the six week period; Q2: H3) A MANOVA was conducted with Scheffé post-hoc tests to determine if a significant difference in perceived and actual stress levels and quality of life existed between the active and sedentary males; Q3: H4) A MANOVA was conducted with Scheffé post-hoc tests to determine if a significant difference between stress levels and quality of life existed between active males and sedentary males of differing ages; Q4: H5) A repeated measures ANOVA was conducted with Scheffé post-hoc tests to determine if a significant difference between actual and perceived stress levels existed between the collection points during the collection period; Q5) Multiple analyses, including Pearson correlations, difference of means, and regressions were conducted to determine if any meaningful relationship existed between the perceived stress, biomarker stress levels, and quality of life exists.

Summary

Stress, perceived and actual, levels were measured in male students over the course of a six-week period. Data was collected three times over the course of the collection period: the beginning, middle, and end. The data were collected using the PSS-10, WHOQOL-BREF, IPAQ, and assays of first morning urinary cortisol. The results were determined using statistical analysis and sought to confirm the hypotheses and provide information toward the exploratory question. Recommendations were made based on the gathered results.

CHAPTER 4. RESULTS

The following results represent data collected from university males at a small private university in North Texas. Data on first morning urinary cortisol, perceived quality of life, and perceived stress are presented. The following research questions were asked: (1) What is the relationship between perceived and actual stress levels? (2) How do perceived and actual stress and quality of life vary by activity level? (3) How do perceived and actual stress levels (and quality of life) differ by year in school? (4) How do perceived and actual stress levels (and quality of life) differ over the collection period? (5) What associations do the physiological and/or psychological stress levels have with quality of life in university students? These findings are presented in the following sections: (a) Descriptive Statistics, (b) Relationship Between Perceived Stress, Actual Stress, and Quality of Life, (c) Perceived and Actual Stress and Quality of Life by Activity Level and Time, (d) Associations Between Perceived Stress, Actual Stress, and Quality of Life. Results for question three are not presented because sufficient data was not collected.

Descriptive Statistics

An initial sample of 71 male students participated in the activity level screening and began the study. Fifty-one male students completed all three trials, resulting in a 72% retention rate. These students were divided into active (N=34, 67%) and sedentary (N=17, 33%) groups. The means and standard deviations for age are shown by activity level in Table 2.

Table 2.

Means and Standard Deviations of Age by Activity Level

Group	N	Age (yrs)	SD
Active	34	20.47	2.22
Sedentary	17	19.71	1.65
Total	51	20.22	2.06

The age of all participants in the study ranged from 18-30 years of age. The mean age of all students was 20.22 years, the mean age for the active group was 20.47 years, and the mean age for the sedentary group was 19.71 years. The number of participants by year in school was: 15 Freshman, 18 Sophomores, 4 Juniors, 14 Seniors. Race/Ethnicity was self-identified in the sample as follows: 38 White/Caucasian, 1 Indian, 2 Asian/Pacific Islander, 2 Black/African American, 8 Hispanic. Due to the sample size being limited, year in school and race/ethnicity were not used as independent variables in any further analyses.

The total sample of descriptive statistics for urinary cortisol, perceived quality of life, and perceived stress have been calculated for their means and standard deviations. The mean urinary cortisol levels for all participants at each trial were as follows (μg/dL): T1) 18.22, T2) 19.17, T3) 21.61. The mean perceived quality of life for all participants at each trial was as follows (range: 0 to 8): T1) 6.08, T2) 6.25, T3) 6.25. The mean perceived stress levels for all participants at each trial were as follows (range: 0 to 40): T1) 16.55, T2) 15.71, T3) 14.29. These overall means and standard deviations are reported in Table 3. The quality of life subscales were calculated for means and standard deviations in addition to the general quality of life scores. These are shown in Table 4. The mean physical scores for active and sedentary participants for each trial was: T1) 21.09, T2) 21.29, T3) 21.32 and T1) 21.59, T2) 21.29, T3) 21.12, respectively. The mean psychological scores for active and sedentary participants for each trial was: T1) 17.44, T2)

17.12, T3) 17.38 and T1) 17.59, T2) 16.76, T3) 17.12, respectively. The mean social scores for active and sedentary participants for each trial was: T1) 8.15, T2) 8.50, T3) 8.32 and T1) 8.12, T2) 8.06, T3) 7.65, respectively. The mean environment scores for active and sedentary participants for each trial was: T1) 23.44, T2) 23.97, T3) 24.09 and T1) 24.47, T2) 24.35, T3) 23.47, respectively.

Table 3.

Means and Standard Deviations for Cortisol, Perceived Stress, and General Quality of Life for All Participants

Variables	T1	SD	T2	SD	T3	SD
Cortisol	18.22	7.71	19.17	10.66	21.61	11.93
PSS	16.55	5.8	15.71	6.42	14.29	6.61
QOL-G	6.08	1.23	6.25	1.23	6.25	1.34

Table 4.

Means and Standard Deviations for Cortisol, Perceived Stress, and Quality of Life by Group and Collection Period

Variables	Active						Sedentary					
	T1	SD	T2	SD	T3	SD	T1	SD	T2	SD	T3	SD
Cortisol	18.25	6.16	19.89	11.52	20.32	11.24	18.14	10.38	17.73	8.84	24.20	12.99
PSS	15.68	5.38	15.41	6.49	14.18	6.52	18.29	6.38	16.29	6.44	14.53	7.00
QOL-G	6.29	1.19	6.47	1.19	6.47	1.31	5.65	1.22	5.82	1.24	5.82	1.33
QOL-Phys	21.09	3.11	21.29	3.22	21.32	3.46	21.59	3.36	21.29	3.46	21.12	4.31
QOL-Psy	17.44	2.94	17.12	4.10	17.38	3.51	17.59	2.96	16.76	3.96	17.12	3.30
QOL-Soc	8.15	2.10	8.50	2.06	8.32	2.01	8.12	1.22	8.06	1.64	7.65	1.97
QOL-Env	23.44	4.10	23.97	4.30	24.09	3.98	24.47	3.48	24.35	3.89	23.47	4.30

Relationship Between Perceived Stress, Actual Stress, and Quality of Life

Pearson Product Correlations showed a non-significant relationship between perceived and actual stress (cortisol) at all three time points. No significant relationships between actual stress and quality of life existed. Significant negative correlations existed between perceived stress and quality of life. Significant positive correlations existed between quality of life and each of the other subscales. Significant correlations ranged from -0.71 to 0.75 with p<0.05 or p<0.01. The correlations are reported by time point in Table 5.

Table 5.

Correlations Between Cortisol, Perceived Stress, and Quality of Life at Each Collection Period

Correlations T1	PSS	QOL-G	QOL-Phys	QOL-Psy	QOL-Soc	QOL-Env
Cortisol	-0.11	-0.13	0.05	0.07	-0.03	0.05
PSS		-0.33*	-0.55^	-0.61^	-0.43^	-0.51^
QOL-G			0.64^	0.56^	0.28*	0.52^
QOL-Phys				0.68^	0.30*	0.68^
QOL-Psy					0.40^	0.57^
QOL-Soc						0.29*

*=p<0.05, ^=p<0.01

Correlations T2	PSS	QOL-G	QOL-Phys	QOL-Psy	QOL-Soc	QOL-Env
Cortisol	-0.02	-0.04	0.09	0.07	0.05	0.00
PSS		-0.48^	-0.57^	-0.71^	-0.55^	-0.57^
QOL-G			0.64^	0.64^	0.48^	0.61^
QOL-Phys				0.75^	0.58^	0.69^
QOL-Psy					0.68^	0.60^
QOL-Soc						0.57^

^=p<0.01

Correlations T3	PSS	QOL-G	QOL-Phys	QOL-Psy	QOL-Soc	QOL-Env
Cortisol	-0.14	0.02	0.06	0.06	-0.04	-0.14
PSS		-0.49^	-0.45^	-0.63^	-0.48^	-0.54^
QOL-G			0.68^	0.70^	0.67^	0.61^
QOL-Phys				0.67^	0.51^	0.66^
QOL-Psy					0.63^	0.62^
QOL-Soc						0.59^

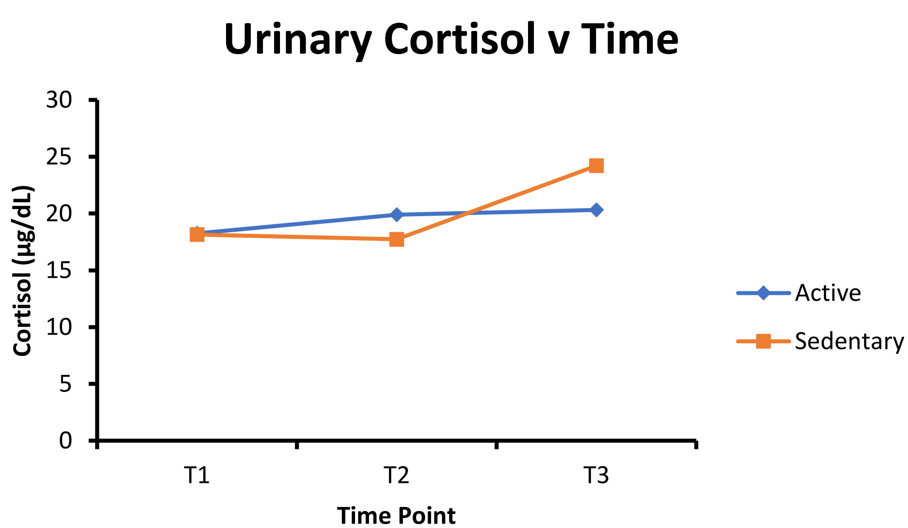
^=p<0.01

Perceived and Actual Stress and Quality of Life by Activity Level and Time

Multiple repeated measures ANOVAs were performed to determine if differences existed by collection period and group. The two groups were composed of active and sedentary students. The exercise levels were based on ACSM standards for active and sedentary individuals. The active group participated in moderate to vigorous physical activity four or more days and at least 240 minutes each week, with each session of activity at least 30 minutes in length. The sedentary group participated in low to moderate physical activity fewer than two days and less than 60 minutes total each week. No significant differences in actual stress (urinary cortisol), perceived stress, or quality of life were found by time by group. The means and standard deviations are shown in Table 4. The trends over time are shown in Graph 1, Graph 2, and Graph 3.

Graph 1.

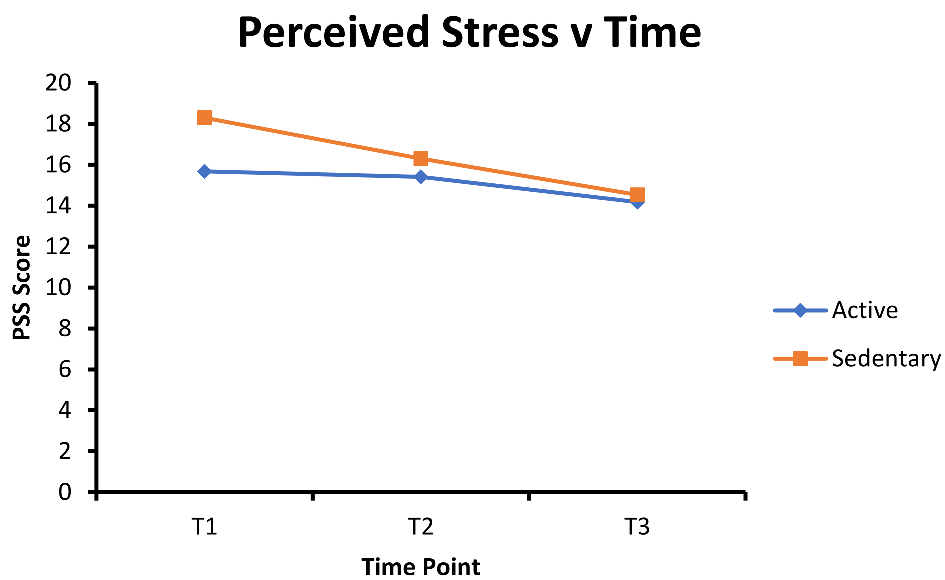
Urinary Cortisol over Time by Group



Note: Urinary Cortisol average values range from 3 to 40 µg/dL in samples (RIA Principle MP Bio)

Graph 2.

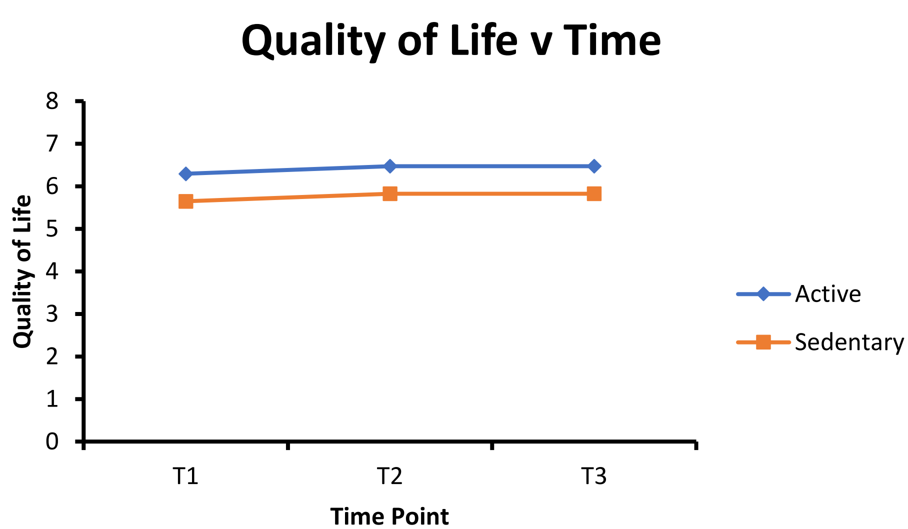
Perceived Stress over Time by Group



Note: Perceived Stress values range from 0 to 40, the top y-axis value is 20 for clarity purposes.

Graph 3.

Quality of Life – General over Time by Group



Associations Between Perceived Stress, Actual Stress, and Quality of Life

As previously noted, there were no relationships found between actual stress and perceived stress or quality of life, nor were there any significant differences in any variable by time between groups. However, follow-up Independent T-tests revealed two significant trends within the sedentary group. Urinary cortisol was significantly different between T1 (18.1 μg/dL) and T3 (24.2 μg/dL) at $p<.05$, showing an increased level of cortisol at T3. Perceived stress was significantly different between T1 (18.3) and T3 (14.5) at $p<.01$, showing a decreased level of perceived stress at T3. The trends can be seen in Graph 1 and 2 and the means and standard deviations are reported in Table 4.

CHAPTER 5. DISCUSSION

Stress and quality of life are becoming more significant issues for universities to address in their students. Attenuating stress and supporting quality of life are the goals for universities. Educational opportunities and programming are being implemented to attain these goals. Identifying beneficial opportunities and programming or impactful levels of current practices are necessary to support university students' success. Physical activity has been shown to reduce perceptions of stress and improve quality of life (Barney, Benham, & Haslem, 2014; Marshall et al., 2008; Sigmund et al., 2014). Physical activity has also been shown to be beneficial to physiological stress levels and reduce the risk for disease (Alghadir, Gabr, & Aly, 2015; Baum & Posluszny, 1999; Bland, Melton, Bigham, & Welle, 2014; McEwen, 1998; Moreira et al., 2010).

Descriptive statistics are covered, including the age of students and the actual stress, perceived stress, and general quality of life of all participants. Next, the relationships between actual stress and perceived stress are examined and quality of life is discussed. A discussion of the change in variables over time and by group will follow. Limitations of the study are presented, as well as, a summary of the findings and recommendations for future research regarding physical activity, stress, and quality of life in university student populations.

Descriptive Statistics

The students recruited were divided into two groups: active and sedentary. There was a discrepancy in group size. The active group (N=34) included double the participants of the sedentary group (N=17). This discrepancy could be due to a number of factors including the locations of recruitment, the motivation of students to participate, or the trend of the university population to be more active than sedentary as a whole.

The age for the population was to be typical college age, which is generally thought of as 18-22 years of age. The average for this sample was 20.22 with a range of 18 to 30. The range reflects some students returning to university after employment or military service, which is not uncommon. The active group had a mean age of 20.47 years, while the sedentary group had a mean age of 19.71 years. These means suggest a sample of mainly sophomore students, which is reflected in the frequency distribution of year in school.

The distribution of race/ethnicity for this study was mainly White/Caucasian, which does reflect the distribution of the university from which the participants were recruited. While there were Indian, Black/African American, Asian, and Hispanic students among the participants, no group exceeded 16% of the population. White/Caucasian students accounted for approximately 75% of the population. This disparity was unlikely to be overcome at the university the study was conducted but may have been overcome by recruiting participants from multiple universities.

There were several potential variables not considered in this study. The type of stressors experienced by the students were among those not considered, instead it was assumed students were experiencing the general stressors of college (Barney et al., 2014; Hubbs, Doyle, Bowden, & Boyle, 2012; Kausar, 2010; Miller & Kerr, 2002). Stilger and colleagues (2001) explored multiple types of perceived stress (behavioral, cognitive, and somatic) in their study of college students and Rafidah and colleagues (2009) considered stress factors (health, social, academic) in their study. These various stressors may have a lesser or greater effect on students collectively or individually and were not measured or considered in this study. Another potential variable not considered was alternative stress relief methods. These could be alternative stress reducers, such as drugs or alcohol, and the students were informed there would not be any drug testing performed on their urine samples. Student motivation for participation in the study was not considered and may have affected results as well. Students were offered interpretations of their personal results after the conclusion of the study but were not compensated for participation. It is possible the motivations of this group were very similar and may have limited variability of the results in the groups. Additionally, what each individual student perceives to be stress, specifically distress, may be different and may have impacted results. These are only some of the potential variables not considered in this study that may have affected the outcomes of the study. The measured variables will be discussed in the following sections.

Relationship Between Perceived Stress, Actual Stress, and Quality of Life

In this study, students supplied urine samples and reported perceived stress and quality of life at each collection period. The results of this study showed perceived stress and quality of life are inversely related which is supported by other studies (Hubbs et al., 2012; Marshall et al., 2008; Matheny et al., 2002; Surujlal et al., 2013). In fact, the inverse relationship is present at each collection period. Given the strength of the correlations, there is evidence to suggest university students are psychologically aware of their state of being and interpret their lives similarly to adults. There were not enough participants in the study to determine if underclassmen interpret these variables congruently with their upperclassmen peers. This study does not indicate at what age or stage of life the ability to accurately assess the self psychologically, but based on the findings, university students have this capability.

However, a similar relationship between actual stress and quality of life was not present in the data. This suggests physiological stress is not connected to quality of life, but it may be students do not associate stress with other physiological symptoms caused by chronic stress states. The physical subscale of quality of life not being related to actual stress provides some evidence to support this idea. This relationship has not been studied extensively in many populations, mostly diseased populations, and it is possible the bodily awareness required to interpret this relationship is a skill that can be developed. Education for students around the symptoms and impact of stress on quality of life could potentially be a pathway to learning this skill. Based on the results of this study, university students do not possess this ability.

Additionally, contrary to what was predicted, there was no relationship between the actual and perceived stress of the students. Previous research in similarly aged active individuals suggests these variables should be aligned (Fernandez-Fernandez et al., 2015; Filaire et al., 2003; Haneishi et al., 2007). Students may struggle to accurately perceive the stress their bodies are experiencing or may become more accustomed to the stress level and perceive it as less stressful than they did previously. This potentially suggests an exhaustion stage may be reached by the student before returning to a resistance stage as the body manages the level of stress more effectively. While it is necessary to develop successful stress management due to the pressures of being a student, bodily awareness may be an overlooked component of the current stress management practices. Students with a better understanding of the stress sources and consequences, both psychologically and physiologically, may be better at perceiving their actual stress levels similar to the active individuals in previous research. It should be noted, not all students will understand or manage all stressors in the same way or as adequately as others. There are themes about which students may be educated, but individual differences may limit the overall effectiveness of standardized training for all students about stress management and bodily awareness of stress.

Anecdotally, it seems there would be a clear relationship between perceived stress, actual stress, and quality of life. The results of this study only support an inverse relationship in perceived stress and quality of life. There is not support for a relationship between psychological variables and physiological variables, which underscores the need to continue psychophysiological studies in multiple populations and circumstances.

Perceived and Actual Stress and Quality of Life by Activity Level and Time

The ANOVA results indicated there were no significant differences in urinary cortisol, perceived stress, or quality of life by group over time. As Graphs 1, 2, and 3 show both groups maintained relatively consistent levels of each variable. This suggests over the course of the collection periods there were not significant changes in the stress or quality of life experienced by the students. This was a moderate level of stress based on the actual stress levels in comparison to the RIA Principle (MP Bio, 2014). This was a moderate level of stress as indicated by the perceived stress scores and moderate to high quality of life. These levels are consistent with previous research (Rafidah et al., 2009; Stilger et al., 2001). This may be due to the collection periods being between the midterm cycle and finals week, a generally higher stress time during the semester. The baseline period for the study was not optimal, but it is not possible to say when an appropriate baseline would be measured. The beginning of the semester may be a less stressful time for some but may not be for others. There was not an opportunity in this study to ensure an accurate, low stress time period was used as the baseline and likely the stress levels measured were already elevated at the baseline measurement. It is also not possible to control for class schedules, which may not have the same testing cycles or workload requirements throughout the semester. This variability could have contributed to the lack of variability in the results found in this study.

The difference between the active and sedentary groups was not significant in urinary cortisol, perceived stress, or quality of life. This suggests the amount of physical activity performed by university students is possibly not the driving factor for stress attenuation or quality of life support. This is incongruent with previous research, which supports stress reduction and enhanced quality of life through more physical activity (Barney et al., 2014; Cruz et al., 2013; Joseph et al., 2014; Maher et al., 2014; Molina-Garcia et al., 2011; Sigmund et al., 2014; Surujlal et al., 2013). The reasoning for physical activity and other consequences of participation may be influential to the amount of exercise not being significant in this study. A higher expectation of fitness and physique may be present on this particular university campus, which may create an additional stressor interfering with the potential benefits of physical activity. There may also be differences in how students perceive exercise in relation to stress. For example, a student attempting to lose weight may find exercise to be a burden or a necessary task versus a student exercising for the pleasure of it versus a student exercising because they view exercise as a stress reliever. The perception exercise relieves stress was not measured in this study but has been shown to exist previously (Barney et al., 2014). How a student perceives the physical activity they are engaging in may influence their perceived stress levels and quality of life scores and may alter their body's physiological management of various stressors.

The lack of differences between perceived stress, actual stress, and quality of life by activity level or time period are in contrast with the predictions of this study. As discussed, there are many potential factors or interpretations possible for these outcomes. Limitations and potential directions for future research will be presented further in the following sections.

Associations Between Perceived Stress, Actual Stress, and Quality of Life

Additional independent t-tests showed two significant trends in the sedentary group. Urinary cortisol increased over the course of the study and perceived stress decreased over the course of the semester. While the group size was small (17), the t-tests were significant. These two trends are in opposition to each other. As discussed, this study did not show any relationship between actual stress and perceived stress, but it is surprising these trends would contradict each other. This further supports the conclusion students do not have an accurate understanding of their physiological stress levels for any number of reasons. However, this conclusion appears counterintuitive given the physiological pathways and their activations. Both the sympathetic adrenal medullary and hypothalamic-pituitary-adrenocortical axes originate in the adrenal cortex and can be stimulated by physiological or psychological stimuli (Lazarus, 1966). This lack of discrimination in stimuli type suggests perceived stress and actual stress should be congruent, but it does not consider the individual differences in perception of stressors. There may be limitations in the measure of actual stress used leading to this result, but the contradicting trends are unexpected and not readily explained.

Limitations

This study encountered several limitations throughout the course of recruitment, data collection, and evaluation. Initially 150 participants, with equal numbers in the active and sedentary groups, were expected. This level of participation was not met, and the groups were not equivalent in size. The power of this study is limited by both the sample size and the unequal groups. This limitation is likely due to the recruitment process. Students were not individually incentivized in a monetary fashion, though some professors offered extra credit in classes for participation. The extra credit was mainly in exercise related classes or in the kinesiology department at the university, which generally has more active individuals. There was also not a significant dispersal of the recruitment locations. For example, active students were recruited from outside the gym, but there is not a typical location to find inactive students. The retention of the individuals who did initially participate also contributed to this limitation. While 71% retention is relatively good, this reflects the loss of 20 participants from the data pool. A larger sample size may also provide a more diverse sample in both age/year in school and race/ethnicity, which were not evenly distributed in this study. The sample only being male and undergraduate students also limits the ability to apply the results of this study to a greater population, including that of college campuses. Another limitation may have been the collection process of urinating into a cup. This may not be an appealing process for many university students, especially when the collection needs to take place first thing in the morning. The measure used for quality of life may not be the most appropriate for this population. While the WHOQOL Group (1995,1998) suggests it be used for participants 18 years and older, not all items of the survey may be applicable to a generally healthy population.

Future Directions and Considerations

As research moves forward in these stress related areas with QOL, this study leads to several potential avenues. Due to the lack of differences between active and sedentary students across all measures, further research should confirm or refute these findings. These differences should be studied in a psychophysiological manner if possible to continue to explore the relationships between these variables. Including participants interpretations of exercise and how it relates to stress may be an additional component this study did not consider. It is also important to expand the sample of this research beyond university males to university females, graduate students, and potentially high school students to explore the differences in gender and age. There can be benefits to considering factors such as race/ethnicity, school disposition towards exercise, school location, access to exercise facilities, area of study for the student, and school size. It is recommended there be more emphasis and opportunity for education in stress management and body awareness to develop students' personal capabilities in these areas.

Summary

The findings of this study are preliminary and should be studied further for consistency. There is a growing body of research in the psychophysiological stress area to which this study can contribute. The use of urinary cortisol as a stress biomarker and the longitudinal design in a university population among the strengths of the study. Perceived stress and quality of life being inversely related is supported by this study, however any relationship between actual stress and those variables is not. Differences in perceived stress, actual stress, and quality of life due to activity level or time period were not supported, in contrast to previous research. The perceptions an individual has for how activity influences their stress levels may be an important consideration in future studies.

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APPENDIX A. Questionnaires

Quality of Life

Please read each question, assess your feelings, and circle the number on the scale that gives the best answer for you for each question.

(Please circle the number)

For office use		Very poor	Poor	Neither poor nor good	Good	Very Good
G1 / G1.1	1. How would you rate your quality of life?	1	2	3	4	5

(Please circle the number)

For office use		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
G4 / G2.3	2. How satisfied are you with your health?	1	2	3	4	5

The following questions ask about **how much** you have experienced certain things in the last two weeks.

(Please circle the number)

For office use		Not at all	A little	A moderate amount	Very much	An extreme amount
F1.4 / F1.2.5	3. To what extent do you feel that physical pain prevents you from doing what you need to do?	1	2	3	4	5
F11.3 / F13.1.4	4. How much do you need any medical treatment to function in your daily life?	1	2	3	4	5

F4.1 / F6.1.2	5. How much do you enjoy life?	1	2	3	4	5

(Please circle the number)

For office use		Not at all	A little	A moderate amount	Very much	An extreme amount
F24.2 / F29.1.3	6. To what extent do you feel your life to be meaningful?	1	2	3	4	5

(Please circle the number)

ffice use		Not at all	Slightly	A Moderate amount	Very much	Extremely
F5.2 / F7.1.6	7. How well are you able to concentrate?	1	2	3	4	5
F16.1 / F20.1.2	8. How safe do you feel in your daily life?	1	2	3	4	5
F22.1 / F27.1.2	9. How healthy is your physical environment?	1	2	3	4	5

The following questions ask about **how completely** you experience or were able to do certain things in the last two weeks.

(Please circle the number)

For office use		Not at all	A little	Moderately	Mostly	Completely
F2.1 / F2.1.1	10. Do you have enough energy for everyday life?	1	2	3	4	5
F7.1 / F9.1.2	11. Are you able to accept your bodily appearance?	1	2	3	4	5

F18.1 / F23.1.1	12. Have you enough money to meet your needs?	1	2	3	4	5
F20.1 / F25.1.1	13. How available to you is the information that you need in your day-to-day life?	1	2	3	4	5

(Please circle the number)

For office use		Very poor	Poor	Neither poor nor well	Well	Very well
F21.1 / F26.1.2	14. To what extent do have the opportunity for leisure activities?	1	2	3	4	5
F9.1 / F11.1.1	15. How well are you able to get around?	1	2	3	4	5

The following questions ask you to say how **good** or **satisfied** you have felt about various aspects of your life over the last two weeks.

(Please circle the number)

For office use		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
F3.3 / F4.2.2	16. How satisfied are you with your sleep?	1	2	3	4	5
F10.3 / F12.2.3	17. How satisfied are you with your ability to perform your daily living activities?	1	2	3	4	5

For office use		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
F12.4 / F16.2.1	18. How satisfied are you with your capacity for work?	1	2	3	4	5
F6.4 / F8.2.2	19. How satisfied are you with yourself?	1	2	3	4	5
F13.3 / F17.2.3	20. How satisfied are you with your personal relationships?	1	2	3	4	5
F15.3 / F3.2.1	21. How satisfied are you with your sex life?	1	2	3	4	5
F14.4 / F18.2.5	22. How satisfied are you with the support you get from your friends?	1	2	3	4	5
F17.3 / F21.2.2	23. How satisfied are you with the conditions of your living place?	1	2	3	4	5
F19.3 / F24.2.1	24. How satisfied are you with your access to health services?	1	2	3	4	5
F.23.3 / F28.2.2	25. How satisfied are you with your mode of transportation?	1	2	3	4	5

(Please circle the number)

The follow question refers to **how often** you have felt or experienced certain things in the last two weeks.

For office use		*(Please circle the number)*				
		Never	**Seldom**	**Quite often**	**Very often**	**Always**
F8.1 / F10.1.2	26. How often do you have negative feelings, such as blue mood, despair, anxiety, depression?	**1**	**2**	**3**	**4**	**5**

THANK YOU FOR YOUR HELP

Perceived Stress

Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts **during the last month**. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

Name ____Date________

Age___________Gender (*Circle*): **M F** Other______________________________

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly?	**0**	**1**	**2**	**3**	**4**
2. In the last month, how often have you felt that you were unable to control the important things in your life?	**0**	**1**	**2**	**3**	**4**
3. In the last month, how often have you felt nervous and "stressed"?	**0**	**1**	**2**	**3**	**4**
4. In the last month, how often have you felt confident about your ability to handle your personal problems?	**0**	**1**	**2**	**3**	**4**
5. In the last month, how often have you felt that things were going your way?...	**0**	**1**	**2**	**3**	**4**
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	**0**	**1**	**2**	**3**	**4**
7. In the last month, how often have you been able to control irritations in your life?	**0**	**1**	**2**	**3**	**4**
8. In the last month, how often have you felt that you were on top of things?..	**0**	**1**	**2**	**3**	**4**
9. In the last month, how often have you been angered because of things that were outside of your control?..................................	**0**	**1**	**2**	**3**	**4**
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	**0**	**1**	**2**	**3**	**4**

Please feel free to use the *Perceived Stress Scale* for your research.

References

The PSS Scale is reprinted with permission of the American Sociological Association, from Cohen, S., Kamarck, T., and Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24,* 386-396.

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Activity Level

International Physical Activity Questionnaire

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ days per week

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ hours per day

   _____ minutes per day

   ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

______ **hours per day**

______ **minutes per day**

☐ Don’t know/Not sure

This is the end of the questionnaire, thank you for participating.

APPENDIX B. Assay Statistics

Cortisol Solid Phase Component System

Catalog No. 06B256635, Cortisol Antibody Coated Tubes Catalog No. 06B256617, Cortisol Tracer Solution Catalog No. 06B256722, Cortisol Serum Standards Set

For the Quantitative Determination of Cortisol in Serum, Plasma or Urine.

Summary and Explanation of the Test

Cortisol, the major glucocorticoid produced and secreted by the adrenal gland, is involved in the regulation of protein, fat and carbohydrate metabolism, electrolyte balance, body water distribution, blood pressure regulation and immunosuppressant anti-inflammatory action[1].

In response to a variety of stimuli (stress, diurnal rhythm, low blood sugar) the cerebral cortex stimulates the hypothalamus to release corticotropin releasing factor (CRF). CRF causes the release of adrenocorticotropic hormone (ACTH) from the anterior lobe of the pituitary gland, and glucocorticoids are synthesized in response to ACTH. In the normal individual, cortisol participates in a negative feedback loop by inhibiting the release of ACTH by the anterior pituitary[2].

Since cortisol levels depend upon interaction of the hypothalamus, pituitary and adrenal glands, measurement of serum or urine cortisol levels can aid in the differential diagnosis of disease states of these glands. Cortisol testing in such situations usually consists of a schedule of clinical maneuvers designed to stimulate or suppress production of cortisol and related analytes.

A condition which results in under-production of cortisol is classified as an adrenal insufficiency (Addison's Disease being an example of chronic under-production), while the most commonly observed disease state characterized by overproduction of cortisol is Cushing's syndrome[3,4].

Principle of the Test

In radioimmunoassay, the antibody used should have an equal affinity for the standard and the analyte which is present in the sample. The unlabeled analyte competes with labeled analyte for the limited number of available antibody binding sites thereby reducing the amount of labeled analyte bound to antibody. The level of radioactivity bound is, therefore, inversely related to the concentration of analyte in the patient sample or standard. After an adequate incubation period, the bound and free fractions are separated and the radioactivity quantitated. In the MP Biomedicals Cortisol Solid Phase Component System tubes coated with a cortisol antibody are used for the separation of the bound cortisol from the free cortisol.

Reagents

For *In Vitro* Diagnostic Use

1. Cortisol Antibody-Coated Tubes, Anti-Tubes Catalog No. 06 B256635 polypropylene tubes coated with Cortisol antiserum (rabbit); 100 tubes/package. Storage: Store refrigerated or at room temperature (2-25°C). Do not intermix coated tubes of different lot numbers. Reseal unused tubes in the original containers. Stability: Refer to expiration date on package. Stability after opening: Two months.
2. Cortisol Serum Standards A-G, STD 1-7 Catalog No. 06B256722, containing cortisol in human serum* with 0.1% sodium azide** and other preservative; one vial of each standard.
   1.0 mL/vial. Storage: Refrigerate at 2 to 8°C. Stability: Refer to expiration date on vial. Stability after opening: Two months.

Standard	Concentration (µg/dL)	Concentration (nmol/L) SI Units
A	0	0
B	1	27.6
C	2.5	69.0
D	6	165.6
E	15	414
F	30	828
G	60	1656

3. Cortisol Tracer Solution, [^{125}I] TRACER Catalog No. 06B256617, less than 5 µCi (185 kBq) Cortisol [^{125}I] in phosphate buffer with ANS (8-anilino-1-naphthalene sulfonate) and 0.1% sodium azide** as a preservative. A bottle contains >50 mL and is sufficient for 100 tubes. Storage: Refrigerate at 2-8°C; protect from light. Stability: Refer to expiration date on bottle.

*** CAUTION:** Handle as if capable of transmitting infection: Source material from which this product was derived was found nonreactive for HBsAg and negative for HIV antibody when tested with licensed reagents. No known test method can offer assurance that product derived from human blood will not be infectious. Refer to CDC/NIH Biosafety in Microbiological and Bioimedical Laboratories publication (HHS Publication No. [CDC] 84- 8395).

**** WARNING:** Reagents contain sodium azide. Sodium azide may react with lead and copper plumbing to form highly explosive metallic azides. On disposal, flush with a large volume of water to prevent azide build-up. Very toxic if swallowed. Contact with acids
liberates very toxic gas. After contact with skin, wash immediately with plenty of water.

WARNING: CONTAINS RADIOACTIVE MATERIAL

This MP Biomedicals Solid Phase Component System contains less than 5 microcuries (185 kilobecquerels) of [^{125}I] per vial of tracer.

This radioactive material may be received, acquired, possessed and used only by physicians, clinical laboratories or hospitals and only for in vitro clinical or laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use and transfer are subject to the regulations and a general license of the U.S. Nuclear Regulatory Commission or a State with which the Commission has entered into an agreement for the exercise of regulatory authority.

MP Biomedicals LLC

Adherence to the basic rules of radiation safety should provide adequate protection. The user is referred to National Bureau of Standards Handbook No. 92, "Safe Handling of Radioactive Materials", issued March 9, 1964, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. A summary follows:

Do not eat, drink, smoke or apply cosmetics where radioactive materials are used. Do not pipet radioactive solutions by mouth. Avoid direct contact with all radioactive materials by using protective articles such as lab coats and disposable gloves. All radiological work should be done in a designated area away from traffic. Radioactive materials should be stored in their original containers in a designated area. A record book for logging receipt and disposal of all radioactive materials should be kept. Laboratory equipment and glass-ware which are subject to contamination should be segregated to prevent cross-contamination of different radioisotopes. Any radioactive spills should be taken care of immediately in accordance with established procedures. All radioactive materials must be disposed of in accordance with the prevailing regulations and guidelines of the agencies holding jurisdiction over the laboratory.

Uncontaminated containers may be discarded in non-radioactive waste providing that labels and labeling are defaced.

Equipment and Reagents Required but not Provided:

1. Evacuated glass tubes (containing anticoagulant, if plasma is desired).
2. Water bath, 37 ± 1°C.
3. Aspirator.
4. Precision pipette (25 µL).
5. Semi-automatic pipette (0.5 mL) or an automatic pipettor-dilutor.
6. Gamma counter for measuring [125I].
7. Vortex Mixer.
8. Urine collection container containing boric acid as a preservative.
9. Suitable graph paper such as linear, semilog or logit-log paper.

Specimen Collection

Serum or Plasma Samples: Collect the blood in a 5 mL evacuated glass tube. Use EDTA or heparin if plasma is desired for analysis. If serum is being collected, allow blood to clot at room temperature. Centrifuge for 10 minutes and collect the serum or plasma.

Serum may be stored refrigerated (2-8°C) if the assay is to be run within 2 days of collection. If storage is expected to exceed 48 hours, the sample must be frozen (< -20°C).

Avoid exposing frozen samples to freeze-thaw cycles as is common with self defrosting freezers. Frozen serum should be brought to room temperature gradually, and mixed gently before pipetting.

Urine Samples: Collect 24 hour urine; measure and record the volume. Add 10 g of boric acid per liter of urine as a preservative and store frozen at -20°C. Thawed urine specimens may be centrifuged before sampling if particulate matter is observed.

Shipping of Specimens: Carefully packed serum should be shipped at 2-8°C. If shipping time is expected to exceed 48 hours, the samples should be shipped frozen. Urine specimens should be shipped at -20°C or below.

Assay Procedure

Bring reagents and samples to room temperature before use. In order to minimize deterioration, return to recommended storage immediately after use. Do not use reagents other than those provided as a matched set within each assay. If an automatic pipettor is used, the pipetting of standards/samples and tracer solution can be done simultaneously; avoid sample carryover.

Run all determinations (standard level points and patient samples) in duplicate. Control sera should be run at the same time as standards and samples. Preparation of the standard curve and the clinical determinations must be run simultaneously.

1. Number 14 Antibody-Coated Tubes for the standard curve. Beginning with 15, number two additional tubes for each clinical sample.

2. Add 25 µL of Standards, controls or patient samples (serum, plasma or urine) to Antibody-Coated Tubes according to the outline below.

3. Add 500 µL of Cortisol Tracer to each tube. Mix the tubes by vortexing for 2-3 seconds.

4. Incubate in a water bath at 37 ± 1°C for 45 minutes. Place all tubes, standards and samples, in the bath at the same time. The level of the bath water must be above the solution in the tubes without allowing the tubes to float.

   At the end of the required incubation time, thoroughly aspirate the liquid from each tube, or decant. Allow the tubes to drain for at least 3 minutes, inverted on absorbent paper. Then, remove all residual droplets by sharply rapping the rims of the tubes on the paper.

5a. Option: If desired, add 1.0 mL of distilled water and re-aspirate or decant.

5. Count the radioactivity in the tubes in sequence for one minute with a gamma counter.

A longer counting time may be required for an instrument with a low efficiency. The counting time required for an accumulated trace level count of 15,000 will indicate the time required for all the assays with the user's gamma counter.

CORTISOL SOLID PHASE RADIOIMMUNOASSAY [^{125}I]					
Tube	Cortisol Standards	Patient Sample	Cortisol Tracer Solution	Incubate	Aspirate or Decant
1, 2 3, 4 5, 6 7, 8 9,10 11,12 13,14 15,16	25 µL A 25 µL B 25 µL C 25 µL D 25 µL E 25 µL F 25 µL G ---	--- --- --- --- --- --- --- 25 µL	add 0.5 mL to all tubes. Vortex.	Incubate all tubes at 37°C for 45 min.	Aspirate or decant all tubes.*

* • If desired, add 1.0 mL of distilled water and re-aspirate or decant.
- Count the radioactivity in all tubes.
- Calculate.
- Draw Standard Curve and determine patient assay values.

Calculation of Results

<u>Note</u>: Counting data need not be expressed as counts per minute (cpm). However, the unit of time must be constant for all tubes counted.

1. Average the counts for tubes 1 and 2 to give the "Trace Level Count" for the assay.
2. Divide the counts for each tube by the Trace Level Count to give the Percent of Trace Level for each tube.
3. A Standard Curve may be plotted as follows: Using logit-log paper, plot % of Trace Level versus µg/dL Cortisol Standard on the log scale. Typical counting data are shown in Table
   1. The Standard Curve plotted for these data is shown in Figure 1.
4. The concentration of Cortisol in a patient serum is determined by interpolation from the Standard Curve of % of Trace Level versus µg/dL Cortisol (Figure 1).
5. Alternative methods of plotting a standard curve may be used such as counts per minute plotted versus µg/dL Cortisol.

Urinary Cortisol

The following equation is used to convert the urinary cortisol value from µg/dL to µg of cortisol per 24 hour period:

$$\text{24-hour Urinary Cortisol} = \frac{\text{Sample x Volume}}{100}$$

where Sample = urine sample concentration in µg/dL Volume = total urine volume per 24 hour period (mL)

Limitations of the Procedure

Administration of drugs used in suppression and stimulatory tests must be halted to obtain accurate basal levels.
Samples which are above 60 µg/dL should be diluted with standard A to provide more accurate results.

Extracted urine procedures for cortisol assays are inherently more variable than the direct urine or serum procedures[5]. It is recommended that the direct procedure be used when evaluating urinary cortisol.
Prednisone is converted to prednisolone in vivo. Prednisolone, a synthetic cortisol analog, interferes in cortisol immunoassays due to its structural similarity to cortisol. Therefore, this assay should not be run on patients undergoing prednisone or prednisolone treatment, as falsely high apparent cortisol values may result.
Total pipetting time when sample and tracer are pipetted separately must be limited to two hours when pipetting manually and 90 minutes when using liquid handling systems in a sequential delivery mode. When using a liquid handling system which pipets sample and tracer simultaneously, the total pipetting time must be limited to two hours.

Expected Values

It is recommended that each laboratory establish its own normal range on a representative sample population.
In evaluating the serum cortisol levels of 87 apparently healthy individuals, the mean serum cortisol level was found to be 10.3 µg/dL, with a range of 4.1 to 22.4 µg/dL. These samples were drawn at mid-morning from non-fasting individuals.
The mean urinary cortisol level in a study of 45 apparently healthy adults was determined to be 209 µg/24 hours with a range of 88 to 359 µg/24 hours.
Cortisol levels vary diurnally and as a function of clinical suppression maneuvers[6]. Morning sample results are generally 2 to 3 times the value of samples drawn in the afternoon. Morning samples generally read less than 5 µg/dL following metyrapone testing or dexamethasone suppression[7].
Oral contraceptives may elevate cortisol levels due to their alteration of serum proteins.

Specific Performance Characteristics Sensitivity

The sensitivity of the assay is 0.07 µg/dL, determined at -2 S.D. from B_o (n = 20).

Precision

	Intra-Assay		
	Number of determinations	Mean µg/dL	% CV
Low Pool	20	3.5	7.9
Medium Pool	20	21.5	4.7
High Pool	20	37.7	7.7

	Inter-Assay		
	Number of determinations	Mean µg/dL	% CV
Low Pool	119	3.3	7.4
Medium Pool	119	21.9	7.6
High Pool	119	39.5	6.6

Recovery

A serum sample was spiked with cortisol. Recoveries were calculated.

$$\frac{\text{Found}}{\text{Expected}} \times 100$$

Spike µg/dL	Found	Percent Recovery
0	5.6	----
1	6.5	98%
5	11.1	105%
10	16.6	106%
25	34.0	111%
50	64.1	115%

Antiserum Specificity

The cross reactivities of various compounds calculated at fifty percent trace binding are given below

Compound	Current Antibody % Cross-Reactivity	Prior Antibody % Cross-Reactivity
Cortisol	100.0%	100.0%
Prednisolone	94.1%	65.8%
Prednisone	1.2%	0.28%
Cortisone	0.8%	0.6%
17-Hydroxyprogesterone	<0.05%	0.2%
Corticosterone	1.2%	4.1%
Metyrapone	<0.01%	<0.01%
Dexamethasone	0.8%	0.04%
11-Deoxycortisol	2.2%	5.3%

APPENDIX C. Consent Form

Texas Christian University
Fort Worth, Texas

CONSENT TO PARTICIPATE IN RESEARCH

Title of Research: Quality of life and stress in active and sedentary university males

Funding Agency/Sponsor: N/A

Study Investigators:
TCU – Phillip Wadle, Debbie Rhea, EdD, Joel Mitchell, PhD, Stephanie Jevas, PhD

What is the purpose of the research?
The overall purpose of this thesis is to understand the relationship between actual and perceived stress levels of males. A secondary purpose is to examine actual and perceived stress level differences between sedentary and active males at a pre and post time periods. Next, what association actual and perceived stress levels may have on the student's quality of life by year in school.

How many people will participate in this study?
The participants for this study will be 150 full-time, undergraduate, male students at a private university in north Texas. The participants will be of usual undergraduate age (18-26) and be participating voluntarily. These students will be divided into two groups: 75 active males and 75 sedentary males. The active group will be determined by meeting the following requirements: being generally healthy (no contraindications to exercise), exercising four or more days per week, 30 or more minutes per day and greater than 240 minutes (4 hours) per week, and this exercise being at a moderate to vigorous intensity as described by ACSM. The sedentary group will be determined by meeting the following requirements: exercising one or fewer days per week, no more than 60 minutes (1 hour), and this exercise being at a low to moderate intensity as described by ACSM. Students who do not meet the requirements of one of these two groups will not be invited to participate in the study.

What is my involvement for participating in this study?
The participants will be asked to complete three collection periods. During a collection period the participant will self-collect urine in a provided collection cup, complete an online survey anonymously through the use of provided ID number, and return the collected urine to the investigator. These collection periods will take place October 1-14, November 11-13, and December 9-11, 2015.

How long am I expected to be in this study for and how much of my time is required?

The study will conclude for participants after the third collection period. Each collection period requires approximately 10 minutes, for urine collection and survey completion. The return of the urine sample is at the participant's convenience the morning of collection (6:00-9:00am), prior to class or activity.

What are the risks of participating in this study and how will they be minimized?
There is minimal risk to the male students. Questionnaire responses and cortisol assay results will be kept confidential. There is some risk involved with anonymity and that it could be violated. Every precaution will be taken to ensure anonymity including: all names being removed from data sheets in statistical files, keeping data in a locked and secure location, using Qualtrics to collect survey data in order to keep it more secure and using a number to identify each student for urine collection. There is also some risk involved with self-delivery of samples. If an outside agent were to gain possession of a urine sample, the sample could be inappropriately used. To prevent such incidents we are taking precautions to ensure they are delivered in a timely manner after collection and will be labelled with only the identification number of the student and sample time. All samples will be stored and processed in a locked laboratory in the exercise physiology lab after being collected and only the investigator will collect the samples

What are the benefits for participating in this study?
The participants of this study will benefit in that the general scientific community may benefit from the results of this study. The information gathered will contribute to the knowledge of stress, actual and perceived, and quality of life, in active and sedentary university males.

Will I be compensated for participating in this study?
There is no compensation for participation in this study.

What is an alternate procedure(s) that I can choose instead of participating in this study?
The participant may decline participation in this study. There is no alternative procedure for this study.

How will my confidentiality be protected?
Urine samples will be stored in the TCU Exercise Physiology lab until analysis. Hard copies of informed consent forms and screening forms will be stored in a locked cabinet in a separate laboratory and the cabinet will remain locked when not in use. An identification number will be provided to each participant and will be used during sample and data analysis. During analyses there will only be the number known with no reference to your name. Only the primary investigators will have access to the subject key. Only the primary investigators and necessary lab technicians will have access to subject data.

Is my participation voluntary?
Participation is completely voluntary.

Can I stop taking part in this research?
The participant may withdraw from the study at any point without consequence, penalty, or punishment.

What are the procedures for withdrawal?
The participant need only contact the primary investigator by phone, email, or in person and inform him of their desire to no longer participate.

Will I be given a copy of the consent document to keep?
Yes

Who should I contact if I have questions regarding the study?
Mr. Phillip Wadle, primary investigator, 630-303-1239, p.t.wadle@tcu.edu

Who should I contact if I have concerns regarding my rights as a study participant?
Dr. Tim Barth, Co-Chair, TCU Institutional Review Board, Phone 817-257-6427.
Dr. Dan Southard, Chair, TCU Institutional Review Board, Phone 817 257-6869.
Dr. Bonnie Melhart, TCU Research Integrity Office, Telephone 817-257-7104.

Your signature below indicates that you have read or been read the information provided above, you have received answers to all of your questions and have been told who to call if you have any more questions, you have freely decided to participate in this research, and you understand that you are not giving up any of your legal rights.

Participant Name (please print): ____

Participant Signature: ______________________________ Date:_____________

Investigator Name (please print):__________________________ Date:_____________

Investigator Signature: ______________________________ Date:_____________