RELATIONSHIPS AMONG ANXIETY, DEPRESSION, INDUCED STRESS, SLEEP DISTURBANCE, HEALTH RELATED QUALITY OF LIFE, AND IMPULSIVITY IN EMERGING ADULTS

A Dissertation

by

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ABSTRACT

Anxiety disorders are the most commonly diagnosed psychological disorders in the United States. They are often comorbid with other psychological disorders, most commonly depressive disorders. Anxiety and depression are associated with difficulties in academic achievement, social and peer relations, and lost productivity and absenteeism at work. Sleep disorders are frequently associated with anxiety and depressive disorders. In turn, sleep deprivation may increase an individual's tendency to make impulsive decisions. Further, anxiety symptoms, depressive symptoms, sleep disturbances, and impulsive behaviors have been associated with lower levels of health-related quality of life (HRQOL). The combination of an anxiety disorder and poor sleep or a disorder of impulsivity and poor sleep have been correlated with poorer HRQOL and daily functioning. Sleep disturbance can impair cognition and decision making, including impulsivity, in otherwise healthy individuals.

The present study recruited emerging adults from the Texas A&M University Department of Psychological and Brain Sciences research participant pool. Participants completed measures related to their anxiety symptoms and stress, depressive symptoms, sleep patterns, impulsivity, perceived health influence, and health-related quality of life. The Trier Social Stress Test (TSST) was used as an induced stressor during completion of some of the measures. Participants completed a sleep diary using Qualtrics during the week following the initial in-person session.

Results indicated the State Trait Anxiety Inventory State Anxiety Scale (STAI-S) showed increased participant reported state anxiety from pretest to posttest after the TSST administration, the induced stressor. Additionally, anxious arousal and anhedonic depression symptoms explained a significant portion of the variance on sleep disturbance, HRQOL, and

perceived health influence. Sleep disturbance was also found to be a partial or full mediator on the HRQOL outcomes. Sleep disturbance was associated with more self-reported impulsivity.

Implications include early assessment of anxiety and depressive symptoms and sleep patterns may provide quality improvement of health-related outcomes. The high prevalence of sleep disturbances and their association with increased levels of anxiety, depression, and impulsivity symptoms in emerging adults should inform interventions to address this health issue. The induced stress method used in this study is a common scenario for university students that may have long-term health implications. In addition, this study accentuates the importance of assessing individuals' perceived influence of life events on their psychological and health functioning.

DEDICATION

To my mother and father. For their unconditional love, constant support, and unwavering encouragement to pursue all of my goals and dreams, no matter where the quest took us.

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TABLE OF CONTENTS

4. DISCUSSION AND CONCLUSION

LIST OF TABLES

1. INTRODUCTION AND LITERATURE REVIEW

1.1 Emerging Adults

Jeffrey Arnett was the first to propose using the term *emerging adulthood* to refer to the period between ages 18 to 25 years of individuals in industrialized societies (Arnett, 2000). In his theory, Arnett distinguished this age range from adolescence or adulthood based on several key themes, including demographically and subjectively distinct experiences. Demographically, emerging adulthood is characterized by exploration, creating diversity and instability. In other words, predicting an individual's demographic status (i.e., marital status, having a child, living alone) is difficult based on their age range (Arnett, 2000). When surveyed, individuals in this age range do not see themselves as adolescents, but they do not view themselves as adults either (Arnett, 2000). Therefore, subjectively this age range is unique. Regarding identity formation, Erikson (1950) labeled adolescence as a time for identity formation versus role confusion. Later, Erikson noted that industrialized societies allow for a prolonged adolescence and period for identity exploration (Erikson, 1968). Hence, most emerging adults are concerned with their identity.

Understanding emerging adulthood is essential to a developmental approach in research. As detailed in the previous paragraph, placing emerging adults into the category of adolescent or adult is not appropriate or ideal for research. Further, characteristics of emerging adults differ in both a biological and social manner from individuals in immediately younger or older age groups. Emerging adults are no longer in puberty, are beyond secondary school, and are legally defined as adults (Arnett, 2007) and are in transition, with unique concerns, from childhood to adulthood.

Results of many studies, including the present study, may be exclusively relevant to emerging adults. For example, sleep disturbances common among college students, may not be defined in similar terms to chronic sleep disturbances in immediately younger or older age groups. Similarly issues of anxiety or depression may be uniquely experienced by college-aged students living away from their families and high school friends. In consideration of these variables, the present study focused on emerging adults and unique patterns experienced during this life period.

1.2 Anxiety

Anxiety disorders are the most commonly diagnosed psychological disorders in the United States. Approximately 30% of Americans are affected by some type of anxiety disorder over their lifetime (Kessler, Berglund, Demler, Jin, Merikangas, & Walters, 2005). Anxiety disorders are also among the most common forms of psychological disorders in children and adolescents, with a prevalence of between 10-30% in the general population and primary care settings (Chavira, Stein, Bailey, & Stein, 2004; Merikangas, He, Burstein, Swanson, Avenevoli, Cui, ... & Swendsen, 2010). This prevalence of anxiety disorders in childhood to adolescence supports the findings that these disorders tend to have an early onset. Median age of onset for anxiety has been found to be as young as age 11 years (Kessler et al., 2005).

Some levels of anxiety are considered a common experience for people. Anxiety-related experiences are important during development as protective and adaptive functions mature. This typically-occurring anxiety can become a disorder when characterized by marked irrational fear or worry causing significant distress or impairment in functioning, or both (Labellarte, Ginsburg, Walkup, & Riddle, 1999; American Psychiatric Association, 2013). Anxiety disorders in youth are associated with difficulties in academic achievement, social and peer relations, and future

emotional health, including placing children at risk for comorbid disorders and psychopathology in adulthood (Kendall, Furr, & Podell, 2010). In addition, anxiety disorders in adulthood result in medical expenditures, lost productivity at work, and functional impairments that are estimated at $42-$46 billion annually (Dupont, Rice, Miller, Shiraki, Rowland, & Harwood, 1996; Stein, Roy-Byrne, Craske, Bystritsky, Sullivan, Pyne, ... & Sherbourne, 2005; Greenberg, Sisitsky, Kessler, Finkelstein, Berndt, Davidson, … & Fyer, 1999; Rice & Miller, 1998).

The State-Trait Anxiety Inventory (STAI) was developed by Spielberger and his colleagues (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1970) to provide reliable, brief, self-report measures of both state and trait anxiety. The STAI is a self-report measure of the presence and severity of current symptoms of anxiety and a generalized propensity to be anxious, with two subscales. First, the State Anxiety Scale (STAI-S) evaluates the current state of anxiety, asking how respondents feel "right now," using items that measure subjective feelings of apprehension, tension, nervousness, worry, and activation/arousal of the autonomic nervous system. Second, the Trait Anxiety Scale (STAI-T) evaluates relatively stable aspects of "anxiety proneness," including general states of calmness, confidence, and security (Spielberger, Gonzalez-Reigosa, Martinez-Urrutia, Natalicio, & Natalicio, 1971). Responses for the STAI-S assess intensity of current feelings "at this moment" and responses for the STAI-T assess frequency of feelings "in general," each on a 4-point Likert scale, with higher scores indicating greater anxiety. A review by Barnes, Harp, and Jung (2002) compared the reliability of the STAI in 816 research studies. Results showed an internal consistency of a mean of .91 for the STAI-S and .89 for the STAI-T. The test-retest mean was .70 for the STAI-S and .88 for the STAI-T (Barnes et al., 2002).

Research has shown evidence that scores on the STAI-S increase in response to situations of physical or psychological stress and decrease in response to targeted interventions. For example, Alghamdi, Regenbrecht, Hoermann, and Swain (2017) explored the experience of Virtual Reality (VR) leading to unwanted or wanted psychological stress reactions. Specifically, the authors studied whether virtual, everyday stressors in a domestic family environment would elicit actual stress responses. The results indicated significant changes in STAI-S scores reported, including the STAI-S level being significantly higher in the exposure condition compared to the non-exposure and baseline conditions (Alghamdi et al., 2017).

Lilley and Cobham (2005) examined the interaction of anxiety sensitivity and induced physiological state on participants' interpretation of ambiguous scenarios and participation in a real-life behavioral task. Participants completed the STAI-S before and after the induced stressor. Results included a significant difference between the scores on the STAI-S between the high anxiety sensitive group and the low anxiety sensitivity group, with the high group reporting higher levels of state anxiety. In addition, participants in the experimental group, regardless of anxiety sensitivity level, reported significantly higher levels of state anxiety after the physiological stressor (Lilley & Cobham, 2005).

Zunhammer, Eberle, Eichhammer, and Busch (2013) conducted a longitudinal study with university students to assess the effects of university exams on somatization, measuring symptom intensity before, during, and after an exam. Self-report questionnaires on alexithymia, neuroticism, anxiety and depression were collected to investigate their ability to explain somatization. The STAI-S was used to assess state anxiety levels at all time-points. In summary, state anxiety was found to significantly increase during the exam period compared to both pre- and post-exam baseline assessments (Zunhammer et al., 2013).

A number of studies have used the pretest-posttest design to demonstrate the reduction of anxiety symptoms as measured by the STAI-S in response to interventions. For example, Mynatt, Wicks, and Bolden (2008) used the STAI-S to determine if treatment with INSIGHT therapy, designed specifically for women, could reduce depressive and anxiety symptoms, hopelessness, and loneliness in African American women. Although results did not include statistically significant reductions in anxiety, the authors did find clinically important reductions for several women (Mynatt et al., 2008). Courneya, Friedenreich, Sela, Quinney, Rhodes, and Handman, (2003) used the STAI-S to determine if exercise in combination with group psychotherapy improved symptoms in cancer survivors. Results showed that group psychotherapy alone was sufficient to improve anxiety symptoms (Courney et al., 2003).

Koutra, Katsiadrami, and Diakogiannis (2010) used the STAI in a group of emerging adults to study the effect of a group psychological counselling program on university students' anxiety, depression, and self-esteem. Results revealed statistically significant differences in state anxiety (STAI-S) before and after the intervention. Interestingly, results also revealed a statistically significant difference in terms of trait anxiety (STAI-T) before and after treatment (Koutra et al., 2010). Shimotsu, Horikawa, Emura, Ishikawa, Nagao, Ogata, ... and Hosomi (2014) used the STAI to evaluate the efficacy of group cognitive-behavioral therapy (CBT) in reducing the self-stigma associated with mental illness. Consistent with previous studies, the authors found a significant reduction in state anxiety (STAI-S) levels after treatment. In addition, they found a strong relationship between improvements in state anxiety (STAI-S) and the reduction of self-stigma (Shimotsu et al., 2014).

The Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993) is a standardized protocol widely used to induce social stress in a controlled setting. During the

TSST, the participant is asked to deliver a short speech to a group of associates and complete a complex arithmetic task in front of the group. The TSST protocol outlines a procedure for saliva collection to analyze differences in cortisol levels and the HPA axis (Kirschbaum et al., 1993). Research has shown the role of the hypothalamic-pituitary-adrenal (HPA) axis on anxiety, stress, and depression. Endocrine responses to psychosocial stimuli are associated with increases in several hormones including adrenocorticotropin (ACTH), cortisol, epinephrine, and growth hormone (GH). The TSST protocol is often combined with the STAI to provide evidence of a change in state anxiety (STAI-S) in response to the induced stressor.

Polheber and Matchock (2014) addressed how social support in the form of interaction with a dog affected both sympathetic and HPA reactivity in response to the TSST. A control group had no canine social support. All participants also completed the STAI. Results showed participants did not differ in their initial STAI-S or STAI-T scores between groups. Results indicated a significant difference between the pretest and posttest state anxiety, where pretest scores were significantly lower than the scores after the TSST protocol. No differences were found between the groups in the STAI-S scores, although differences were found in the cortisol levels of participants in the control group versus the canine social support group (Polheber & Matchock, 2014).

Villada, Hidalgo, Almela, and Salvador (2016) explored individual differences in response to a psychosocial stressor, the TSST. Beyond cortisol samples, state anxiety was assessed using the STAI-S. For state anxiety, results revealed significant effects of condition (control vs. stress groups) and time (before and after TSST), as well as an interaction of condition and time. No differences were found between the stress and control conditions before the TSST, but higher state anxiety was found in the stress condition, compared to the control

condition, after the TSST (Villada et al., 2016). Similar to other research, these results confirm that the TSST produced significant changes in perceived state anxiety and in cortisol levels.

Cruess, Finitsis, Smith, Goshe, Burnham, Burbridge, and O'Leary (2015) examined whether brief (1-session) stress management strategies could reduce subjective distress and physiological stress responses to the TSST. Participants were emerging adults randomized into one of three groups: a brief enhanced-mindfulness intervention group, a brief somatic-relaxation intervention group, or an attention-only control group. The control group was designed to engage the attention of participants in an interactive book reading, without teaching any stress-reduction skills (Cruess et al., 2015). The authors used the STAI-T measure only at baseline, and the STAI-S measure was assessed at three time points as the acute subjective distress outcome measure. Results showed a significant effect of time on the STAI-S and a significant difference between the intervention groups and the control group, with higher levels of state anxiety being found immediately after the TSST and before the intervention, as well as higher scores in the control group (Cruess et al., 2015).

Guez, Saar-Ashkenazy, Keha, and Tiferet-Dweck (2016) explored the effect of the TSST on memory function, specifically item versus associative memory for neutral, verbal, and pictorial stimuli, in healthy participants. Stress reactivity was measured by the STAI. Results indicated a significant effect for group (TSST vs. control), time (pre-/post-TSST), and the interaction of group and time on levels of state anxiety. Posttest scores indicated significantly higher state anxiety scores. In addition, no difference in anxiety levels were found between groups on the pretest, but significant differences were found between groups in the posttest, with the control group having significantly lower scores (Guez et al., 2016).

Britton, Shahar, Szepsenwol, and Jacobs (2012) assessed whether Mindfulness-Based Cognitive Therapy (MBCT) was effective in reducing emotional reactivity to the TSST. Participants were subject to the TSST before and after the intervention and the STAI was administered at several time points before, during, and after the stressor. In both groups (control-no intervention vs. intervention) state anxiety levels increased from before to during the TSST, and decreased again after the stressor. However, the decrease in state anxiety scores after the stressor was only statistically significant in the intervention group (Britton et al., 2012).

In summary, anxiety symptoms and stress play a large part in the lives of university students and emerging adults. El Ansari, Oskrochi, Labeeb, and Stock (2014) examined the relationships between perceived stress and a range of self-reported symptoms and health complaints in a sample of university students. Results revealed a significant trend between increasing levels of stress and a higher frequency of symptoms (i.e., fatigue, headache, difficulties concentrating, mood swings, nervousness/anxiety, and sleep difficulties). A better understanding of anxiety symptoms, stress, and state anxiety among university students can inform preventative interventions to improve the health of this community.

1.3 Anxiety and Depression

Anxiety disorders are often comorbid with other psychological disorders, most commonly depressive disorders (Essau, Condradt, & Petermann, 2000). The lifetime prevalence of depressive disorders has been estimated at 20% (Kessler et al., 2005) and may have an onset in adolescence. Depression in adolescence is associated with risk of developing other psychiatric disorders in adulthood (Wittchen & Essau, 1993; Essau et al., 2000). Depression is a major cause of disability, absenteeism, and productivity loss among working adults (Centers for Disease Control [CDC], 2015). Depression is estimated to cause 200 million lost workdays each

year at a cost to employers of $17 to $44 billion (Stewart, Ricci Chee, Hahn, & Morganstein, 2003).

Clark and Watson's (1991) tripartite model of anxiety and depression (including negative emotions, positive emotions, and anxious arousal) suggests that depression and anxiety share a group of general distress symptoms, including irritability and poor concentration. Depression is described as including high levels of negative emotions and low levels of positive emotions; anxiety is described as including low levels of positive emotions and high levels of anxious arousal symptoms (Clark & Watson, 1991). In addition, depression is characterized by feelings of disinterest and apathy, whereas anxiety includes symptoms of physiological hyperarousal such as shortness of breath and feeling dizzy (Clark & Watson, 1991).

The Mood and Anxiety Symptom Questionnaire (MASQ) was developed by Watson and Clark (1991) to test the three symptom clusters proposed in the tripartite model (Kendall, Zinbarg, Bobova, Mineka, Revelle, Prenoveau, & Craske, 2016). The Anhedonic Depression Scale (MASQ-AD) was designed to measure symptoms of low positive emotions and anhedonia specific to depression and the Anxious Arousal Scale (MASQ-AA) was designed to measure somatic hyperarousal (Watson, Weber, Assenheimer, Clark, Strauss, & McCormick, 1995). A leading study on the MASQ demonstrated that, consistent with the tripartite model, the MASQ-AA and MASQ-AD scales both differentiated anxiety and depression well and also showed excellent convergent validity (Watson, Clark, Weber, Assenheimer, Strauss, & McCormick, 1995). However, one study examining the factor structure of the MASQ-AD within emerging adulthood (Kendall et al., 2016) determined it was inconsistent with a 1-factor conceptualization, and that future studies using the MASQ-AD should include 2-group factors labeled high positive emotions and low positive emotions.

The MASQ has been used in a variety of studies to measure an assortment of symptoms related to mood and anxiety symptoms. Lemola, Ledermann, and Friedman (2013) used subscales from the MASQ (i.e., high positive affect, general distress depressive symptoms, general distress anxious symptoms, loss of interest, and anxious arousal) in a study examining the relationship between subjective well-being and sleep quality assessed with wrist actigraphy. In this sample, higher variability of total sleep time, as measured through actigraphy, was predictive of lower satisfaction with life and higher depressive symptom scores, anxious symptom scores, loss of interest scores, and anxious arousal scores.

Kalmbach, Arnedt, Swanson, Rapier, and Ciesla (2017) utilized the MASQ Short Form to assess symptoms of depression and anxiety daily (i.e., general distress, anhedonic depression, and anxious arousal) and three items from the PSQI to assess nightly amounts of total sleep time (TST), sleep-onset latency (SOL), and sleep quality (SQ). Results showed that greater general distress and anhedonic depression each predicted longer SOL, shorter TST, and poorer SQ. Anxious arousal was not associated with SOL, TST, or SQ. The authors also examined the influence of sleep on mood symptoms. Previous night sleep was not significantly associated with general distress; longer TST and poorer SQ predicted greater anhedonic depression the following day; and poorer SQ predicted greater anxious arousal the next day (Kalmbach et al., 2017).

In the current study, the STAI-S was used to measure the reaction of participants to an experimentally-induced stressor (TSST). The MASQ-AA (anxious arousal) and the MASQ-AD (anhedonic depression) were selected via statistical procedures to measure relationships among other participant reported measures. Symptoms of anxious arousal and anhedonic depression are consistently associated with sleep disturbance and sleep disturbance negatively affects health.

Understanding the association between these constructs in a sample of emerging adults is vital to improving this growing health concern.

1.4 Sleep Disturbance

Sleep disturbance encompasses a wide range of difficulties or changes in sleep. For example, insomnia is a widespread problem, reported by up to one third of people sampled (Ancoli-Isreal & Roth, 1999), and is often comorbid with psychological conditions, such as with anxiety and depressive disorders (Ohayon & Roth, 2003). As many as 64% of individuals with an anxiety disorder were classified as poor sleepers using the Pittsburgh Sleep Quality Index (PSQI) global score (Ramsawh, Stein, Belik, Jacobi, & Sareen, 2009). Insomnia has been linked to use of health services (Novak, Mucsi, Shapiro, Rethelyi, & Kopp, 2004) and impaired daytime functioning (Ohayon & Roth, 2003). The combination of an anxiety disorder and poor sleep was correlated with worse mental health-related quality of life and increased disability in daily functioning (Ramsawh et al., 2009).

Fatigue is defined as extreme tiredness, typically resulting from mental or physical exertion or illness. Fatigue is often measured in samples of patients with chronic health conditions and has been considered a "generic symptom in pediatric chronic health conditions" (Varni & Limbers, 2008, p.106). Fatigue is prevalent among adolescents, being more prevalent in those with sleep deprivation, and is associated with feeling depressed, performing poorly in school, having bullied someone, and fighting (Holmberg & Hellberg, 2008).

The construct of fatigue is also fitting to investigate in a sample of emerging adults. As previously discussed, emerging adulthood is a unique time characterized by numerous personal challenges. One of these challenges is developing healthy sleep patterns. Studies have demonstrated that sleep disturbance is one of the most common complaints of young adults

(Yang, Wu, Hsieh, Liu, & Lu, 2003; Zullig, 2005; Varni & Limbers, 2008). Yang et al., (2003) explored coping methods used by young adults to deal with their sleep problems and the association between those methods and subjective sleep quality based on the PSQI. Overall results included that "taking naps" and "adjusting sleep schedules" were the methods associated with better subjective sleep quality. Among the participants who reported sleep difficulties, daytime sleepiness was equally impairing (Yang et al., 2003)

Varni and Limbers (2008) explored the prevalence of fatigue symptoms among emerging adults in college. This study examined the feasibility, reliability, and validity of young adults' self-reported fatigue across ages 18 to 25 years with the PedsQL Multidimensional Fatigue Scale (PedsQL-MFS). The authors determined the PedsQL-MFS differentiated fatigue between healthy participants and participants with chronic health conditions. Specifically, compared to healthy emerging adults, emerging adults with chronic health conditions reported higher general fatigue, sleep/rest fatigue, and cognitive fatigue. Results also determined the PedsQL-MFS Total Scale Score was suitable as a summary score for the primary analysis of fatigue in emerging adults and the General Fatigue, Sleep/Rest Fatigue, and Cognitive Fatigue Scales were appropriate to examine specific domains of fatigue, as well as subgroup differences (Varni & Limbers, 2008). The authors noted that their findings were consistent with previous research with healthy adults that demonstrated significant correlations between fatigue and sleep quality (Varni & Limbers, 2008).

Fatigue and sleep quality are often found to be associated in research studies and poor sleep quality has been linked to greater fatigue symptoms in healthy samples and chronically ill samples. For example, Lucchesi, Baldacci, Cafalli, Dini, Giampietri, Siciliano, and Gori (2016) investigated fatigue, daily sleepiness, subjective sleep quality, anxiety symptoms and depressive

symptoms in a sample of migraine patients. Results showed a greater occurrence of fatigue, poor sleep quality, and anxiety-depressive symptoms in chronic migraine compared to episodic migraine patients. Yennurajalingam, Tayjasanant, Balachandran, Padhye, Williams, Liu, ... and Bruera (2016) investigated associations in advanced-stage cancer patients among daytime activity and fatigue, sleep quality, objective sleep variables, anxiety and depression, and overall survival, and other variables. Among the results, daytime activity was significantly associated with anxiety and total sleep time and sleep quality, as measured by the PSQI, and was significantly associated with fatigue, anxiety, and depression in this sample of advanced-stage cancer patients.

Lee, Lee, Lee, Ryu, Chung, Chung, and Kim (2014) investigated gender differences in the effect of insomnia symptoms on depression, anxiety, fatigue, daytime sleepiness, and quality of life in patients with obstructive sleep apnea. In general, women had higher depression, fatigue, and daytime sleepiness and lower health-related quality of life than men; however, the presence of insomnia symptoms were correlated with higher fatigue and poorer quality of life only in men. No difference emerged in the prevalence of insomnia symptoms between women and men; therefore, the authors concluded that men are more susceptible to the negative impact of comorbid insomnia symptom and obstructive sleep apnea than women (Lee et al., 2014).

In a healthy sample, Matos, Gaspar, Tomé, and Paiva (2016) evaluated the influences of sleep duration, difficulties in sleep initiation, fatigue and sleep duration variability on school-related variables. Results indicated that sleep duration variability was associated with higher perception of school work pressure, more frequent skipping classes, more frequent fatigue, and more frequent difficulties in sleep initiation. In addition, poor sleep quality, sleep duration variability, and insufficient sleep duration were associated with less favorable school-related

variables (Matos et al., 2016). Baroni, Bruzzese, Di Bartolo, Ciarleglio, and Shatkin (2018) developed a semester-long sleep course for undergraduate college students that focused on sleep and dreaming and completed a study to evaluate the preliminary efficacy of the course on sleep, mood, and anxiety. Results indicated that sleep course students reported significant differences in sleep hygiene perceived sleep latency and circadian sleep phase compared to control participants who were not enrolled in the course. At the 2-month post-course evaluation, the authors reported that sleep course students maintained most of the gains and reported fewer symptoms of depression and anxiety than the control participants (Baroni et al., 2008).

In summary, sleep and fatigue difficulties are prevalent among university students and emerging adults. Especially during this time of transition, assessing daily life challenges, including impulsivity and HRQOL, is also very relevant.

1.5 Impulsivity

The concept of impulsivity has developed throughout the years, as research groups integrated different conceptualizations of the construct. Initially, Eysenck and colleagues (Eysenck & Eysenck, 1985; Eysenck, Pearson, Easting, & Allsopp, 1985) proposed that impulsivity consists of two factors: (a) venturesomeness (e.g., risk-taking, openness to new and exciting experiences) and (b) impulsiveness (e.g., acting without thinking). Later, Baratt and colleagues (Barratt, 1993; Patton, Standford, & Barratt, 1995) developed the Barratt Impulsiveness Scale to assess three central impulsivity factors: (a) motor impulsivity (acting without thinking), (b) nonplanning impulsivity (failure to plan ahead), and (c) attentional impulsivity (rapid decision making). Whiteside and Lynam (2001) conducted factor analysis on measures assessing impulsivity and identified four factors of impulsivity, with overlapping constructs to the Patton, Standford, and Barratt (1995) factors, including: (a) negative urgency,

(b) lack of premeditation, (c) lack of perseverance, and (d) sensation seeking (as cited in Hamza, Willoughby, & Heffer, 2015, a meta-analytic study).

Relationships among aspects of sleep disturbance and impulsivity have been documented in a number of groups. Individuals with impulse control disorders often report sleep problems, and sleep deprivation can impair cognition and decision making in otherwise healthy individuals (Acheson, Richards, & de Wit, 2007). Van Veen, Karsten, and Lancel (2017), investigated the relationship between poor sleep and impulsivity in patients with antisocial or borderline personality disorders. Results indicated sleep quality was significantly associated with self-rated impulsivity, such that higher scores (i.e., lower sleep quality) on PSQI were associated with higher impulsivity scores on the 11th revision of the Barratt Impulsiveness Scale (BIS-11).

Turel and Bechara (2017) investigated the relationships among poor sleep quality, elevated motor activity, and problematic behaviors on social networking sites. The research team recruited emerging adults from a university who were actively using social media. Results demonstrated that although impulsivity alone was associated with problematic behaviors on social media, associations were stronger when individuals also reported poor sleep quality (Turel & Bechara, 2017).

Defining the multiple facets of impulsivity is important to determine what dimension is being investigated. For example, Tashjian, Goldenberg, and Galván (2017) investigated whether the impact of sleep on impulsivity depends on the type of impulsivity examined in adolescents using naturally-occurring sleep differences. The authors concluded that poor sleep quality was related to greater affect-related impulsivity, but not response inhibition or cognitive impulsivity. Demos, Hart, Sweet, Mailloux, Trautvetter, Williams, ... and McCaffery (2016) investigated the effects of partial sleep deprivation (PSD) on impulsive action versus impulsive decision-making.

Results indicated that at least four days of PSD (i.e., 6 hours vs. 9 hours of sleep) increased impulsive actions, but not impulsive decision-making. The unique impact of investigating "short-sleep" time in this study may be especially relevant to adolescents and emerging adults, who often exhibit disturbed sleep patterns and shorter duration of sleep (Wolfson & Carskadon, 2003; Taylor, Gardner, Bramoweth, Williams, Roane, Grieser, & Tatum, 2011).

For the current study, impulsivity as defined by Baratt and colleagues measured by the BIS-11, was used to investigate the relationship between impulsivity and sleep patterns. Specifically, hypothesized analyses used the BIS-11 Total Score, which is a composite of motor impulsivity, non-planning impulsivity, and attentional impulsivity subscales.

1.6 Health-Related Quality of Life

Health-related quality of life (HRQOL) is a multi-dimensional concept (including physical, mental, emotional, and social functioning domains) regarding the impact of health status on one's quality of life (HealthyPeople.gov, 2015). In 1995, the World Health Organization (WHOQOL) initiated a project to develop an international quality of life assessment (WHOQOL group, 1995). The WHOQOL group stated the importance of including a person's quality of life in treatment decisions, new pharmaceuticals, and policy research as the impetus for this directive (WHOQOL group, 2005). Since then, numerous researchers have investigated HRQOL, how chronic illnesses affect it, and how best to measure it. HRQOL should represent "…the ultimate goal of all health interventions…" (Mosaku, Kolawole, Mume, & Ikem, 2008, p. 73).

In research studies, maladaptive functioning including anxiety, depression, and sleep disturbances have demonstrated negative effects on HRQOL (Lim, Jin, & Ng, 2012; Creed, Morgan, Fiddler, Marshall, Guthrie, & House, 2002; Strine & Chapman, 2005; Chen, Gelaye, &

Williams, 2014). Further, greater mean health care costs have been found in samples of individuals with clinical and subthreshold anxiety and depression (Creed et al., 2002).

The presence of multiple health impairments has been found to predict worse quality of life compared to a single impairment (Lim et al., 2012). For example, Lim et al. (2012), hypothesized that the presence of both an anxiety disorder and depression would correlate with poorer HRQOL. Using two subscales from the Short Form Health Survey, the authors found that participants with both disorders had significantly lower scores on the mental and physical component subscales of the survey compared to those with no psychological diagnosis.

Creed et al. (2002) extended these findings to include HRQOL and the associated health care costs related to the presence of clinical and subthreshold levels of anxiety and depression. The subthreshold cases of anxiety and depression showed significantly lower scores than non-anxious or depressed control participants on a measure of HRQOL. In reference to the associated health care costs, results showed that total costs were significantly lower for the control group than for the clinical and subthreshold groups (Creed et al., 2002).

Because sleep disturbances are common, how sleep affects HRQOL has, therefore, been emphasized in research (Strine & Chapman, 2005; Chen et al., 2014). Strine and Chapman (2005) examined the correlation of insufficient sleep and HRQOL. Their sample was part of an ongoing telephone survey of individuals aged 18 years and older in the United States, Guam, Puerto Rico, and the Virgin Islands and consisted of almost 80,000 non-clinical participants. Within this sample, 26% reported frequent sleep deficiency (Strine & Chapman, 2005). Individuals with frequent sleep deficiency were significantly more likely to report fair/poor general health, frequent mental distress, frequent depressive symptoms and frequent anxiety.

These individuals were also more likely to engage in adverse behavior-related risk factors compared to those who did not report frequent sleep deficiency (Strine & Chapman, 2005).

In a similar study, Chen et al. (2014) narrowed their focus to young adults (*n* = 2,391, aged 20-39 years) from the National Health and Nutrition Examination Survey. Sleep disturbances were common among this sample with over 35% sleeping less than seven hours, over 40% reporting insomnia, and over 8% reporting a diagnosed sleep disorder (i.e., sleep apnea). Those who reported sleep disturbances were more likely to report poor general health, low physical HRQOL, low mental HRQOL, and low overall HRQOL, compared to those not reporting sleep disturbances (Chen et al., 2014).

HRQOL is also associated with Attention-Deficit/Hyperactivity Disorder (ADHD), a disorder that includes impulsive behaviors, hyperactivity, and inattention. Research suggests that ADHD is generally associated with low HRQOL. Adler, Sutton, Moore, Dietrich, Reimherr, Sangal, ... and Allen (2006) found that adults with untreated ADHD had significantly lower scores than the U.S. norms on the Short Form Health Survey (SF-36) mental component scales. Gjervan, Torgersen, Rasmussen, and Nordahl (2014) further investigated those findings in relation to the four domains of HRQOL as measured by the SF-36 mental component scales (i.e., vitality, social function, role-emotional, and mental health). Results indicated that symptoms of hyperactivity/impulsivity were a strong predictor of the social function and mental health domains of HRQOL.

Limbers, Ripperger-Suhler, Heffer, and Varni, (2011) evaluated measurement properties of the PedsQL Generic Core Scales in a sample of pediatric patients with ADHD and a comorbid psychiatric disorder, including a mood or anxiety disorder. Results indicated that patients with

ADHD and comorbid psychiatric disorders exhibited significantly lower HRQOL than a sample of healthy youth ages 5 to 18 years.

Clearly, any single aspect of anxiety symptoms, depression symptoms, sleep disturbances, and difficulties with impulsivity has a negative impact on HRQOL. A combination of any of these conditions certainly further exacerbates their impact on HRQOL. For the current study, we measured HRQOL with the PedsQL Generic Core Scales Young Adult Version because of its strong psychometric properties in samples of emerging adults and connections to the PedsQL-Multidimensional Fatigue Scale.

1.7 Summary

Anxiety disorders are the most commonly diagnosed psychological disorders in the United States. Studies show that approximately 30% of Americans are affected by some type of anxiety disorder over their lifetime (Kessler et al., 2005). Anxiety disorders are often comorbid with other psychological disorders, most commonly depressive disorders (Essau et al., 2000). Anxiety and depression are associated with difficulties in academic achievement, social and peer relations, as well as with lost productivity and absenteeism at work. Sleep disorders are frequently associated with anxiety and depressive disorders (Ohayon & Roth, 2003). Sleep deprivation may increase an individual's tendency to make impulsive decisions (Libedinsky, Massar, Ling, Chee, Huettel, & Chee, 2013).

In research studies, disorders including anxiety, depression, and sleep disturbances have been associated with poorer HRQOL (Lim et al., 2012; Cree et al., 2002; Strine & Chapman, 2005; Chen et al., 2014). As a result, greater mean health care costs have been found in samples of individuals with clinical and subthreshold anxiety and depression (Creed et al., 2002). The combination of an anxiety disorder and poor sleep was correlated to poorer mental HRQOL and

increased disability in daily functioning (Ramsawh et al., 2009). Individuals with impulse control disorders often report sleep problems and sleep deprivation can impair cognition and decision making in otherwise healthy individuals (Acheson, Richards, & de Wit, 2007). Studies have indicated that sleep quality was significantly associated with self-rated impulsivity and was significantly associated with poorer HRQOL.

In a sample of emerging adults, this study investigated state-anxiety changes in response to a psychosocial stressor (TSST); and associations among anxiety symptoms, depression symptoms, sleep disturbance and fatigue, HRQOL, and impulsivity. This study recruited emerging adults from the Texas A&M University Department of Psychological and Brain Sciences' research participant pool. Participants completed measures related to their anxiety symptoms and stress, depressive symptoms, sleep patterns, impulsivity, perceived health influence, and HRQOL. The TSST was used as an induced stressor during completion of the state anxiety measure. Participants completed a sleep diary using Qualtrics during the week following the initial in-person session.

1.8 Hypotheses

1. We hypothesized that state anxiety at posttest of the TSST would be significantly higher than state anxiety at pretest of the TSST.
2. We hypothesized that higher levels of anxious arousal symptoms would be associated with: (a) more sleep disturbance, (b) lower levels of HRQOL, and (c) more impairment in health functioning, such as a higher number of physician visits, more missed or delayed activities due to health/fatigue, or greater perceived negative influence of health/fatigue on daily life.
3. We hypothesized higher levels of anhedonic depressive symptoms would be associated with: (a) more sleep disturbance, (b) lower levels of HRQOL, and (c) more impairment in health

functioning, such as a higher number of physician visits, more missed or delayed activities due to health/fatigue, or greater perceived negative influence of health/fatigue on daily life.

4. Given the likelihood of the covariance of anxiety and depressive symptoms affecting all outcome variables, we hypothesized that the interaction of anxious arousal symptoms and anhedonic depressive symptoms would be associated with greater impairments in all outcome variables considered, above and beyond that of anxious arousal symptoms or anhedonic depressive symptoms independently.
5. We hypothesized that participants who reported more sleep disturbance would report higher levels of self-reported impulsivity.
6. In addition, sleep disturbance was hypothesized to emerge as a partial mediator between anxious arousal symptoms and/or anhedonic depressive symptoms and the outcome variables of: (a) HRQOL and (b) health functioning, such as a higher number of physician visits, more missed or delayed activities due to health/fatigue, or greater perceived negative influence of health/fatigue on daily life.

2. METHOD

2.1 Participants

Emerging adults (n = 110) were recruited from the Texas A&M University Department of Psychological and Brain Sciences research participant pool, who completed the study for partial fulfillment of a course requirement. Please refer to Table 1 for descriptive characteristics of participants, who ranged in ages from 18 to 22 years (M = 18.68 years, SD = 0.826 years). More than half of the participants were female (61.8%) and none were married or had children. Data analyzed varied slightly within the analyses that follow because of missing data for a given measure. Across all data sets at least 101 participants or more were available for analyses.

Table 1 Participant Descriptive Characteristics (N = 110)

Variable	***N***	**Percentage of Total**
Sex		
Female	68	61.8%
Male	42	38.2%
Age (in years)		
18	53	48.2%
19	44	40.0%
20	7	6.4%
21	4	3.6%
22	1	0.9%
Class		
Freshman	78	70.9%
Sophomore	23	20.9%
Junior	7	6.4%
Senior	2	1.8%
Married		
No	110	100%
Yes	0	0%
Children		
No	110	100%
Yes	0	0%

Note. Sums for each descriptive data section of this table that differ from the sample total of 110 reflect missing data for a given variable.

2.2 Procedures

All research assistants were trained to complete the check-in process, the Trier Social Stress Test (TSST) protocol, and how to appropriately collect all data. All participants were seen individually for check-in procedures in a private office. Research assistants then transferred the participant to a different room to complete the questionnaires and preparation stage of the TSST protocol. The participant was then transferred to a room with video equipment and "the audience," composed of one or more additional research assistants, to complete the TSST testing period. At completion of the TSST protocol, the participant returned to the check-in room for debriefing, relaxation period, and explanation of sleep diary procedures.

Participants were asked to complete measures related to their sleep behaviors (Pittsburgh Sleep Quality Index, PedsQL-Multidimensional Fatigue Scale), depressive symptoms, (Mood and Anxiety Questionnaire), anxiety symptoms and stress (Mood and Anxiety Questionnaire, State Trait Anxiety Scale, and Perceived Stress Scale), impulsivity (Barratt Impulsiveness Scale - 11), and HRQOL (PedsQL Generic Core Scales Young Adult Version). Additionally, demographic, and health information were collected at baseline, including a modified version of the PedsQL Family Information Form. Participants completed a Sleep Diary using Qualtrics during the week following the initial experimental session and were required to attend a second session, one week post-baseline for the experiment. During this session, the Sleep Diary was reviewed and completion confirmed so that credit was awarded for completion of the experiment. Please see Table 2 for a summary of study measures and tasks.

Table 2. Study Measures and Tasks

Measures	Tasks
	5-minute rest period to adjust to research setting.
	Baseline saliva sample (sample a)
Modified PedsQL Family Information Form	
Mood and Anxiety Questionnaire	
State Trait Anxiety Scale	
Perceived Stress Scale	
Pittsburgh Sleep Quality Index	
PedsQL Multidimensional Fatigue Scale	
Barratt Impulsiveness Scale	
PedsQL Generic Core Scales Young Adult Version	
	TSST with saliva samples b-d
STAI-State Scale	
Debriefing	
	Saliva sample e collected
Sleep Diary for 1 week after baseline session	
	Return to verify Sleep Diary

2.3 Measures

Trier Social Stress Test (TSST) Protocol

The procedure, with minor adjustments as outlined by Krischbaum et al. (1993), was implemented in defining the time points for measuring state anxiety and salivary sample collection during the TSST. Specific hypotheses and analyses of cortisol changes in response to the TSST and associations with other study variables are part of another study separate from the current study. The TSST protocol began with a 5-minute rest period to allow participants to adjust to the research setting. Participants then provided a baseline saliva sample (sample a). Participants were given questionnaires (described below) to complete. After completing questionnaires, including the State Trait Anxiety Scale (Spielberger, 1983), participants were led into the experimental room and introduced to three research assistants who participants were told were student members of a grading committee that would report to the Introduction to

Psychology class professor the points earned toward the communication skills portion of participants' final course grade. Participants were told to prepare a 5-minute speech to present to the grading committee, who would grade the speech. The interviewers were introduced as being trained to monitor both verbal and nonverbal behavior. Participants were also told that their speech would be video-recorded, analyzed, and scored. This point was marked as the onset of the stressor. Participants were then led back into the experimental room and given 10 minutes to prepare the speech, after which a second saliva sample was collected (sample b).

After 10 minutes, participants were led back into the experimental room where they delivered their speech. If the participant finished the speech before 5 minutes, the interviewers responded in a standard way by saying "You still have some time, please continue." The interviewers then asked a list of prepared questions. A third saliva sample was collected at the conclusion of the speech (sample c). After the sample was collected and approximately 10 minutes after the start of the speech, the interviewers asked the participants to perform an arithmetic test, which consisted of serially subtracting by 13, starting from 1022, as quickly as possible without making any mistakes. Participants who gave an incorrect answer were asked to start again. This phase of the TSST took approximately 5 minutes, after which the fourth sample was collected (sample d), which was the time point of peak cortisol reactivity, approximately 30 minutes after the onset of the stressor. Following the TSST, participants were led to the other room where they again completed the State-Trait Anxiety Inventory-State Anxiety Scale (STAI-S). Participants were then fully debriefed regarding the purpose of the TSST and the nature of the deception. A fifth and final cortisol sample was collected one hour after the end of the TSST procedure (sample e).

For the current study, the saliva cortisol samples were not analyzed, but will be used in a separate study, and are described here to provide an accurate account of the TSST procedures. Studies show mixed results of the effect of induced stress on cortisol levels, including increased cortisol in anticipation of a socially stressful task (Martel, Hayward, Lyons, Sanborn, Varady, & Schatzberg,1999; Kirschbaum, et al., 1993); no differences in baseline cortisol levels (Condren, O'Neill, Ryan, Barrett, & Thakore, 2002); and no elevation in cortisol reactivity (Furlan, DeMartinis, Schweizer, Rickels, & Lucki, 2001; Beaton, Schmidt, Ashbaugh, Santesso, Antony, McCabe, ... & Schulkin, 2006)

The STAI has been used in over 3000 studies (Rossi & Pourtois 2012) and frequently is used to study pretest and posttest differences in anxiety levels (Lilley & Cobham, 2005; Zunhammer et al., 2013; Leal, Goes, da Silva, & Teixeira-Silva, 2017). The STAI-S was used in the current study to analyze hypotheses of participants' responses to the TSST protocol (i.e., administered before the TSST protocol began and again approximately 30 minutes after the onset of the induced stressor). Therefore, it was postulated that a change in the score from the pretest STAI-S to the posttest STAI-S would be directly related to the induced stress in this experiment. In studies cited earlier, STAI-S scores were used to evaluate stressor-related changes in response to the TSST and yielded comparable findings to changes observed in salivary cortisol.

State-Trait Anxiety Inventory (STAI, Spielberger et al., 1970).

The STAI is a self-report measure of the presence and severity of current symptoms of anxiety and a generalized propensity to be anxious. One subscale, the State Anxiety Scale (STAI-S), evaluates the current state of anxiety, asking how respondents feel "right now," using items that measure subjective feelings of apprehension, tension, nervousness, worry, and activation/ arousal of the autonomic nervous system. The other subscale, the Trait Anxiety Scale

(STAI-T), evaluates relatively stable aspects of "anxiety proneness," including general states of calmness, confidence, and security. The STAI has 40 items, 20 items allocated to each of the two subscales. Responses for the State Scale assess intensity of current feelings "at this moment" and responses for the Trait Scale assess frequency of feelings "in general," each on a 4-point Likert scale, with higher scores indicating greater anxiety.

A review by Barnes, Harp, and Jung (2002) compared the reliability of the STAI in 816 research studies. Results showed an internal consistency of mean of .91 for the State Scale and .89 for the Trait Scale. The test-retest mean was .70 for the State Scale and .88 for the Trait Scale (Barnes et al., 2002).

*Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 198*9*).*

The PSQI is a 19-item self-report questionnaire used to evaluate subjective sleep quality during the previous month that contains seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Each item is rated on a 4-point Likert scale, where 0 = not during the past month and 3 = three or more times per week. The global/total PSQI score ranges between 0 and 21, with higher scores indicating a poorer quality of sleep and a score higher than 5 indicating a poor sleeper. The PSQI has a diagnostic sensitivity of 90% and a specificity of 87% in distinguishing between good and poor sleepers and internal consistency is estimated by Cronbach's alpha at .73 (Buysse et al., 1989).

Sleep Diary

To determine whether questionnaire measures of sleep disturbance are associated with observational sleep measures, each participant was asked to complete an electronic sleep diary posted on Qualtrics. Participants recorded their sleep patterns twice per day (in the morning and

before bed) for the week following the session to complete the TSST and questionnaire measures. Email messages were sent to participants twice per day for the week as a reminder to complete the survey, with feedback on days they already provided on-line sleep information in Qualtrics. Participants were required to attend a second session to review and confirm the completion of the sleep diary before full credit was awarded for participation in the study.

Mood and Anxiety Symptom Questionnaire (MASQ; Watson & Clark, 1991)

The MASQ is a 90-item scale based on Watson and Clark's tripartite model of anxiety and depression (Clark & Watson, 1991) that identifies the presence of common anxiety and depression symptoms. Participants indicate to what extent they had experienced each symptom (1 = not at all, 5 = extremely) "during the past week, including today" (Watson et al., 1995).

The MASQ divides distress symptoms into the three scales. The General Distress scale (GD) contains 38 items that appear in the symptom criteria of both the anxiety and mood disorders (e.g., feelings of irritability and confusion; insomnia; difficulty concentrating). The Anxious Arousal Scale (AA) consists of 17 items dealing with somatic tension and hyperarousal. The Anhedonic Depression Scale (AD) consists of 22 items dealing with loss of interest and positive affect. The remaining 13 items are included in the MASQ, but do not load on one of the three factors reliably. Reliability analysis conducted revealed Cronbach's alphas ranging from .88 to .95 for the three scales (Keogh & Reidy, 2000).

Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983).

The PSS is a 14-item questionnaire designed to measure the degree to which situations in one's life, as well as one's individual coping style, are considered stressful. Items are measured on a 5-point Likert scale and include questions such as "how often have you been upset because of something that happened unexpectedly," "how often have you been able to control irritations

in your life," and "how often have you felt difficulties were piling up so high that you could not overcome them." Higher total scores indicate higher levels of perceived stress. Past research has found that the PSS has good internal consistency (Cronbach's alpha estimates ranging between 0.84 and 0.86) and test-retest reliability (r = .85; Cohen et al., 1983).

Barratt Impulsiveness Scale, (BIS-11; Spinella, 2007).

The BIS-11, the 11th version of the scale originally reported in Barratt, Patton, and Stanford (1975), is a 30-item self-report questionnaire designed to measure trait impulsiveness. Items are on a 4-point Likert scale (1 = rarely/never, 4 = almost always). Patton et al. (1995) reported items from three scales: (a) non-planning ("I plan tasks carefully," inverted item), (b) motor impulsivity ("I act on impulse"), and (c) attentional impulsivity ("I concentrate easily," inverted item). Internal consistency for undergraduate students was found to be within acceptable limits, Cronbach's alpha of .82 (Patton, Standford, & Barratt, 1995).

Pediatric Quality of Life Inventory 4.0 Generic Core Scales Young Adult Version (Varni & Limbers, 2009)

The 23-item PedsQL 4.0 Generic Core Scales Young Adult Version was designed as a self-report measure for ages 18 to 25 years and includes: (a) Physical Functioning (eight items), (b) Emotional Functioning (five items), (c) Social Functioning (five items), and (d) Work/School Functioning (five items). Items are essentially identical to those on the PedsQL 4.0 Generic Core Scales Adolescent Version (ages 13–18 years). The only notable difference on the PedsQL 4.0 Generic Core Scales Young Adult Version is the inclusion of the word ''work'' on some of the School Functioning items, given the importance of measuring both work and school functioning in young adults. A 5-point Likert response scale is utilized (0 = never a problem; 1 = almost never a problem; 2 = sometimes a problem; 3 = often a problem; 4 = almost always a

problem). Items are reverse scored and linearly transformed to a 0–100 scale (0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0), so that higher scores indicate better HRQOL (Varni & Limbers, 2009).

All of the PedsQL scores exceed the minimum reliability standard of .70 and most effect sizes are in the medium to large effect size range. Internal consistency reliabilities include the Total Scale Score of α = .90, Physical Health Summary of α = .76, Psychosocial Health Summary Score of α = .83, Emotional Functioning Score of α = .71, Social Functioning Score of α = .78, and Work/School Functioning Score of α = .75 (Varni & Limbers, 2009).

PedsQL™ Multidimensional Fatigue Scale (PedsQL-MFS; Varni & Limbers, 2008).

The 18-item PedsQL-MFS includes three subscales: (a) General Fatigue (six items, e.g., ‘‘I feel tired.’’; ‘‘I feel too tired to do things that I like to do.’’), (b) Sleep/Rest Fatigue (six items, e.g., ‘‘I feel tired when I wake up in the morning.’’; ‘‘I rest a lot.’’), and (c) Cognitive Fatigue (six items, e.g., ‘‘It is hard for me to keep my attention on things.’’; ‘‘It is hard for me to remember what people tell me.’’). The response format is a 5-point Likert scale, with higher scores indicating better HRQOL (i.e., lower fatigue symptoms). PedsQL-MFS scores exceed the minimum reliability standard of .70; the Total Fatigue Scale Score and the Cognitive Fatigue Scale Score achieve the reliability criterion of .90 (Varni & Limbers, 2008).

*PedsQL Family Information Form (*Varni & Limbers, 2009*).*

Participants completed the PedsQL Family Information Form, modified as the Health Functioning Questionnaire (HFQ) for the current study, which contained demographic information including participants’ date of birth and gender, as well as the health functioning questions. One survey question asks participants to report on the presence of a chronic health condition (‘‘In the past 6 months, have you had a chronic health condition?’’) defined as a physical or mental health condition that has lasted or is expected to last at least six months and

interferes with daily activities. If participants checked ‘‘Yes’’ to this question, they were asked to write in the name of the chronic health condition. Additional survey questions asked participants to report over the last six months on the number of times they visited a physician, the number of activities missed or shortened due to health/fatigue, and perceived negative influence of health/fatigue on daily life (0 = no negative influence; 1 = almost never negative influence; 2 = sometimes negative influence; 3 = often negative influence; 4 = almost always negative influence).

3. RESULTS

3.1 Results

A summary of score means, standard deviations, and ranges of all study measures are provided in Table 3.

Table 3. Descriptive Statistics of Study Measures

Measures	*N*	*M*	*SD*	Range
PSQI (sleep)				
Total Score	103	6.51	3.46	1.00-16.00
Actual Sleep Time	108	6.63	1.36	2.0-9.00
Sleep Quality Score	108	1.05	0.65	0-3.00
Sleep Diary Actual Sleep Time	110	7.10	0.95	4.43-8.90
Sleep Diary Sleep Quality	110	2.00	0.47	1.00-3.00
PedsQL-MFS (fatigue)				
Total Score	110	60.73	13.99	26.39-97.22
General Fatigue	110	63.18	20.50	8.33-100.00
Sleep/Rest Fatigue	110	56.44	16.95	0-91.68
Cognitive Fatigue	110	62.58	18.09	8.33-100.00
PedsQL (HRQOL)				
Total Score	110	80.76	11.41	54.35-100.00
Physical Functioning	109	86.27	12.22	53.13-100.00
Emotional Functioning	110	69.86	21.14	15.00-100.00
Social Functioning	110	89.81	11.61	40.00-100.00
School Functioning	110	74.50	14.06	35.00-100.00
Health Summary Score	110	234.18	36.94	135.00-300.00
PedsQL-Health Functioning Questionnaire (health)				
Physician Visits	110	0.45	0.50	0-1.00
Missed Activities	110	0.27	0.45	0-1.00
Missed School	110	0.17	0.38	0-1.00
Perceived Influence	110	1.67	1.11	0-4.00
MASQ-AA (anxious arousal anxiety)	109	24.93	7.31	17.00-59.00
MASQ-AD (anhedonic depression)	109	70.17	15.32	34.00-108.00
PSS-14 (stress)	110	25.52	7.70	34.00-108.00

Table 3. Descriptive Statistics of Study Measures (Continued)

Measures	*N*	*M*	*SD*	Range
Total Score	110	61.05	10.08	42.00-84.00
Attentional	110	16.85	3.65	9.00-25.00
Motor	110	21.05	4.15	13.00-34.00
Non-Planning	110	23.15	4.98	13.00-36.00
STAI-State Pretest (anxiety)	110	38.66	11.21	20.00-69.00
STAI-State Posttest (anxiety)	110	46.86	11.97	23.00-79.00
STAI-Trait (anxiety)	103	41.53	10.41	23.00-67.00

3.2 Hypothesis 1

We hypothesized that state anxiety at posttest of the TSST would be significantly higher than state anxiety at pretest of the TSST. The STAI-S was administered as a pretest before the TSST induced stressor and approximately 30 minutes after the onset of the induced stressor, before the debriefing. The analysis completed was a paired sample *t*-test. The paired sample *t*-test is used to determine whether the mean difference between two sets of observations is zero. In a paired sample *t*-test, each unit is measured twice, resulting in pairs of observations.

The analysis was significant, $t(109) = -7.248$, $p < .001$, such that the difference between the means significantly differed from zero. The mean of the pretest STAI-S ($M = 38.66$; $SD = 11.21$) was significantly lower than the posttest STAI-S ($M = 46.85$; $SD = 11.97$).

To further examine the change in state anxiety from pretest to posttest, participants were divided into a lower anxiety group and a higher anxiety group based on a mean split analysis of the STAI-S pretest score before the TSST. The analysis was significant, $t(108) = 3.681$, $p < .001$, such that the posttest score from the lower anxiety group significantly differed from the posttest score in the higher anxiety group. The mean of the lower anxiety group posttest STAI-S ($M = 41.82$; $SD = 11.62$) was significantly lower than the higher anxiety group posttest STAI-S ($M = 54.13$; $SD = 8.18$).

Additionally, male vs. female was entered as a variable to explore gender differences in state anxiety reactions to a social induced stressor, the TSST. The ANOVA analysis was not significant for gender, $F(1,109) = 2.346$, $MSE = 250.823$, $p = 0.129$ or the interaction of gender and group $F(1,109) = 0.454$, $MSE = 48.572$, $p = 0.502$. Therefore, state anxiety reaction to the induced stressor did not differ by gender in this sample of emerging adults.

3.3 Hypothesis 2

We hypothesized that higher levels of anxiety symptoms would be associated with: (a) more sleep disturbance, (b) lower levels of HRQOL, and (c) more impairment in health functioning, such as a higher number of physician visits, more missed or delayed activities due to health/fatigue, or greater perceived negative influence of health/fatigue on daily life. Due to the potential issue of multicollinearity, analyses were completed on the several anxiety scales to choose which scale would be a better predictor variable. Multicollinearity occurs when high correlations emerge between two or more predictor variables. This creates redundant information that can skew the results in a regression model. After reviewing the variance and histograms of the various anxiety measures, the MASQ Anxious Arousal scale (MASQ-AA) was chosen as the predictor variable due to higher variance. In addition, the MASQ Anhedonic Depression scale (MASQ-AD) was selected to determine anhedonic depressive symptoms and the interaction of depressive and anxiety symptoms. Therefore, the interaction of depressive and anxiety symptoms was measured using an instrument specifically created to distinguish between symptom clusters. Moreover, the MASQ-AA and the STAI-T were significantly correlated ($r = .30$, $p = .002$).

Multiple regression analyses were completed to determine whether higher levels of MASQ-AA anxiety symptoms endorsed predicted the outcome variables that were continuous

scores (e.g., sleep disturbance, HRQOL, and perceived health functioning). Logistic regression analyses were completed on the variables that were categorical (e.g., health functioning) scores.

A number of regression analyses were not significant. Specifically, in the analyses based on participant report of anxious arousal symptoms (MASQ-AA) and sleep disturbance, anxious arousal symptoms did *not* significantly predict the:

- PSQI Total Score, $R^2 = .003$, F (1, 100) = .286, $p = .594$, the PSQI Actual Sleep Time, $R^2 = .003$, $F(1, 105) = .274$, $p = .601$, or the PSQI Overall Sleep Quality, $R^2 = .003$, F (1, 105) = .338, $p = .552$.
- Sleep Diary Actual Sleep Time, $R^2 = .001$, $F(1, 107) = .110$, $p = .741$ or the Sleep Diary Overall Sleep Quality, $R^2 < .001$, $F(1, 107) = .020$, $p = .889$.
- PedsQL-MFS Sleep/Rest Fatigue subscale, $R^2 < .001$, $F(1, 107) = .034$, $p = .854$.

Therefore, these results do not support the hypothesis that higher levels of anxious arousal symptoms would be associated with more sleep disturbance.

Alternatively, several analyses based on the PedsQL-MFS *were* significant, including the Fatigue Total Score, the General Fatigue subscale and the Cognitive Fatigue Scale. Specifically, anxious arousal symptoms (MASQ-AA) significantly predicted PedsQL-MFS Fatigue Total Score, $\beta = -.603$, $t(107) = -3.422$, $p < .001$. Anxious arousal symptoms also explained a significant proportion of variance in Fatigue Total Score on the PedsQL-MFS, $R^2 = .099$, $F(1, 107) = 11.713$, $p < .001$.

Analyzing the subscales of the PedsQL-MFS, anxious arousal symptoms (MASQ-AA) significantly predicted the General Fatigue Score, $\beta = -.1.213$, $t(107) = -4.944$, $p < .001$, and explained a significant proportion of variance in the General Fatigue Score, $R^2 = .186$, $F(1, 107) = 24.443$, $p < .001$. In addition, anxious arousal symptoms (MASQ-AA) significantly predicted

the Cognitive Fatigue Score, β = -.554, $t(107) = -2.363$, $p = .020$, and explained a significant proportion of variance in the Cognitive Fatigue Score, $R^2 = .050$, $F(1, 107) = 5.583$, $p = .020$.

Greater elaboration can be found in the discussion section of this manuscript, but the construct of "fatigue" being measured by these scales differs from the "sleep" construct in the PSIQ and Sleep Diary. In a broader understanding of "sleep disturbance" that includes aspects of fatigue, these exploratory results support the hypothesis that higher levels of anxiety symptoms would be associated with more fatigue-related "sleep disturbance."

Participant report of anxious arousal symptoms (MASQ-AA) significantly predicted the HRQOL as measured by the PedsQL Total Score, β = -.920, $t(107) = -7.543$, $p < .001$, and explained a significant proportion of variance in the PedsQL-Total Score, $R^2 = .347$, $F(1, 107) = 56.904$, $p < .001$. This result supports the hypothesis that higher levels of anxious arousal symptoms would be associated with poorer HRQOL.

Based on exploratory analyses of the subscales of the PedsQL, participant report of anxious arousal symptoms (MASQ-AA) significantly predicted the:

- PedsQL-Physical Functioning Score, β = -.911, $t(106) = -6.628$, $p < .001$, and explained a significant proportion of variance in the PedsQL-Physical Functioning Score, $R^2 = .293$, $F(1, 106) = 43.935$, $p < .001$.
- PedsQL-Psychosocial Health Summary Score, β = -2.648, $t(107) = -.6348$, $p < .001$, and explained a significant proportion of variance in the PedsQL-Psychosocial Health Summary Score, $R^2 = .274$, $F(1, 107) = 40.295$, $p < .001$, which is a summary scale of the items on the Emotional, Social, and School Functioning subscales.

These exploratory analyses support the hypothesis that higher levels of anxious arousal symptoms would be associated with poorer HRQOL.

Participant report of anxious arousal symptoms (MASQ-AA) significantly predicted the perceived influence of health on daily life, from the Health Functioning Questionnaire (HFQ), $\beta = .033$, $t(107) = 2.275$, $p = .025$, and explained a significant proportion of variance in the perceived influence of health on daily life, $R^2 = .046$, $F(1, 107) = 5.176$, $p = 0.25$. This result supports the hypothesis that participants who endorsed higher levels of anxious arousal symptoms, would endorse a greater negative influence of health/fatigue on daily life.

Participant report of anxious arousal symptoms (MASQ-AA) significantly differed in the HFQ number of missed daily activities (other than school), $\chi^2(1, N = 109) = 6.64$, $p = .010$. This result supports the hypothesis that higher levels of anxious arousal symptoms would be associated with an increased number of missed daily activities. However, participant report of anxious arousal symptoms did *not* significantly differ in the HFQ number of physician visits $\chi^2(1, N = 109) = 3.24$, $p = .072$ or days missed of school $\chi^2(1, N = 109) = .64$, $p = .42$.

3.4 Hypothesis 3

We hypothesized higher levels of anhedonic depressive symptoms would be associated with: (a) more sleep disturbance, (b) lower levels of HRQOL, and (c) more impairment in health functioning, such as a higher number of physician visits, more missed or delayed activities due to health/fatigue, or higher perceived negative influence of health/fatigue on daily life. Regression analyses were completed to determine whether higher levels of anhedonic depressive symptoms endorsed predicted the outcome variables (e.g., sleep disturbance, HRQOL, and health functioning).

Multiple regression analyses were completed to determine whether higher levels of anhedonic depressive symptoms endorsed predicted the outcome variables that were continuous

scores (e.g., sleep disturbance, HRQOL, and perceived health functioning). Logistic regressions were completed on the variables that were categorical (e.g., health functioning) scores.

A number of regression analyses were not significant. Specifically, in the analyses based on depression and sleep disturbance, participant report of anhedonic depressive symptoms (MASQ-AD) did *not* significantly predict the:

- PSQI Total Score, $R^2 < .001$, $F(1, 100) = .023$, $p = .880$ or the PSQI Actual Sleep Time, $R^2 < .001$, $F(1, 105) = .047$, $p = .829$.
- Sleep Diary Actual Sleep Time, $R^2 < .001$, $F(1, 107) = .016$, $p = .898$ or the Sleep Diary Overall Sleep Quality, $R^2 = .006$, $F(1, 107) = ..637$, $p = .427$.
- PedsQL-MFS Sleep/Rest Fatigue subscale, $R^2 = .010$, $F(1, 107) = 1.104$, $p = .296$.

Therefore, these results do *not* support the hypothesis that higher levels of anhedonic depressive would be associated with more sleep disturbance.

Alternatively, several analyses based on the PSQI and PedsQL- MFS *were* significant, including PSQI Sleep Quality and the PedsQL-MFS Total Score, the General Fatigue subscale and the Cognitive Fatigue Scale. Specifically, participant report of anhedonic depressive symptoms (MASQ-AD) significantly predicted PSQI Sleep Quality, $\beta = -.010$, $t(105) = -2.530$, $p = .013$ and explained a significant proportion of variance in the PSQI Sleep Quality, $R^2 = .057$, $F(1, 105) = 6.402$, $p = .013$. Although this finding is significant, it does *not* support the hypothesis that higher anhedonic depressive would be associated with more sleep disturbance. Specifically, the direction of the relationship was reversed, such that higher levels of anhedonic depressive symptoms were associated with higher sleep "quality."

As previously stated with anxious arousal symptoms analyses, the construct of "fatigue" being measured by these scales differs from the "sleep" construct in the PSIQ and Sleep Diary.

In a broader understanding of "sleep disturbance," these exploratory results do *not* support the hypothesis that higher levels of anhedonic depressive symptoms would be associated with more sleep disturbance. In fact, the opposite result was found, such that higher levels of anhedonic depressive symptoms were associated with less "sleep disturbance."

Participant report of anhedonic depressive symptoms (MASQ-AD) significantly predicted the PedsQL-MFS Fatigue Total Score on the, $\beta = .320$, $t(107) = 3.983$, $p < .001$, and explained a significant proportion of variance in PedsQL-MFS Fatigue Total Score, $R^2 = .129$, $F(1, 107) = 15.864$, $p < .001$. Analyzing the subscales of the PedsQL-MFS, anhedonic depressive symptoms (MASQ-AD) significantly predicted the General Fatigue Score, $\beta = .533$, $t(107) = -4.477$ $p < .001$, and explained a significant proportion of variance in the General Fatigue Score, $R^2 = .158$, $F(1, 107) = 20.040$, $p < .001$. Anhedonic depressive symptoms also significantly predicted the PedsQL-MFS Cognitive Fatigue Score, $\beta = .322$, $t(107) = 2.963$, $p = .004$, and explained a significant proportion of variance in the PedsQL-MFS Cognitive Fatigue Score, $R^2 = .076$, $F(1, 107) = 8.778$, $p = .004$.

Participant report of anhedonic depressive symptoms (MASQ-AD) significantly predicted HRQOL as measured by the PedsQL-Total Score, $\beta = .435$, $t(107) = 7.393$, $p < .001$, and explained a significant proportion of variance in PedsQL-Total Score, $R^2 = .338$, $F(1, 107) = 54.657$, $p < .001$. This result supports the hypothesis that higher levels of anhedonic depressive symptoms would be associated with lower levels of HRQOL.

Based on exploratory analyses of the PedsQL subscales, participant report of anhedonic depressive symptoms (MASQ-AD) significantly predicted the,

- PedsQL Physical Functioning Score, $\beta = .377$, $t(106) = 5.516$, $p < .001$, and explained a significant proportion of variance in the PedsQL Physical Functioning Score, $R^2 = .223$, $F(1, 106) = 30.427$, $p < .001$.
- PedsQL Psychosocial Health Summary Score, $\beta = 1.372$, $t(107) = 7.108$, $p < .001$, and explained a significant proportion of variance in the PedsQL Psychosocial Health Summary Score, $R^2 = .321$, $F(1, 107) = 50.528$, $p < .001$, which is a composite of the Emotional, Social, and School Functioning subscales.

These exploratory analyses support the hypothesis that higher levels of anhedonic depressive symptoms would be associated with lower levels of HRQOL.

Participant report of anhedonic depressive symptoms (MASQ-AD) significantly predicted the HFQ perceived influence of health on daily life, $\beta = -0.14$, $t(107) = -2.028$, $p = 0.45$, and explained a significant proportion of variance in the perceived influence of health on daily life, $R^2 = 0.37$, $F(1, 107) = 4.112$, $p = 0.45$. This result supports the hypothesis that participants who endorsed higher levels of anhedonic depression, would endorse a greater negative influence of health/fatigue on daily life.

Participant report of anhedonic depressive symptoms (MASQ-AD) did *not* significantly differ in the HFQ number of missed activities, χ^2 (1, $N = 109$) = 1.83, $p = .176$. In addition, anhedonic depressive symptoms did *not* significantly differ in the HFQ number of physician visits χ^2 (1, $N = 109$) = .94, $p = .333$ or days missed of school χ^2 (1, $N = 109$) = .18, $p = .674$. These results do *not* support the hypothesis that higher levels of anhedonic depressive symptoms are associated with problematic levels of these aspects of health functioning.

3.5 Hypothesis 4

Given the likelihood of the covariance of anxiety and depressive symptoms influencing all outcome variables, we hypothesized that the interaction of anxious arousal symptoms and anhedonic depressive symptoms would be associated with greater impairments in all outcome variables considered, above and beyond that of anxious arousal symptom or anhedonic depressive symptoms independently. Interaction effects of sleep disturbance were analyzed on all outcome variables using either multiple regression or logistic regression as previously described.

No interaction effects were found to be significant. Therefore, the results did *not* support the hypothesis that the interaction of anxious arousal symptoms and anhedonic depressive symptoms would predict greater impairment on the outcome variables. However, the combination of anxious arousal symptoms and anhedonic depressive symptoms in the interaction analyses *did* indicate significance on certain outcomes.

Anxious arousal symptoms and anhedonic depressive symptoms (MASQ-AD and MASQ-AA scores) combined explained a significant amount of variance in the PSQI Overall Sleep Quality, $\Delta R^2 = .058$, $F(2, 103) = 3.167$, $p = .046$. After controlling for anxious arousal symptoms, the unique effects of anhedonic depressive symptoms were significant, $\beta = -.010$, $t(105) = -2.429$, $p = .017$. After controlling for anhedonic depressive symptoms, the unique effects of anxious arousal symptoms were *not* significant, $\beta = .001$, $t(105) = .101$, $p = .920$.

Anxious arousal symptoms and anhedonic depressive symptoms (MASQ-AD and MASQ-AA scores) combined explained a significant amount of variance in the PedsQL-MFS Total Score, $\Delta R^2 = .192$, $F(1, 105) = 12.477$, $p < .001$. After controlling for anhedonic depressive symptoms, the unique effects of anxious arousal symptoms were significant, $\beta =$ -

.489, $t(105) = -2.900$, $p = .005$. After controlling for anxious arousal symptoms, the unique effects of anhedonic depressive symptoms were significant, $\beta = .261$, $t(105) = 3.246$, $p = .002$.

In addition, in exploratory analyses, anxious arousal symptoms and anhedonic depressive symptoms (MASQ-AD and MASQ-AA scores) combined explained a significant amount of variance in the:

- PedsQL-MFS General Fatigue Score, $\Delta R^2 = .278$, $F(2, 105) = 20.2050$, $p < .001$. After controlling for anhedonic depressive symptoms, the unique effects of anxious arousal symptoms were significant, $\beta = -1.013$, $t(105) = -4.219$, $p < .001$. After controlling for anxious arousal symptoms, the unique effects of anhedonic depressive symptoms were significant, $\beta = .413$, $t(105) = 3.604$, $p < .001$.
- PedsQL-MFS Cognitive Fatigue Score, $\Delta R^2 = .105$, $F(2, 105) = 6.160$, $p = .003$. After controlling for anhedonic depressive symptoms, the unique effects of anxious arousal symptoms were *not* significant, $\beta = -.435$, $t(105) = -1.866$, $p = .065$. After controlling for anxious arousal symptoms, the unique effects of anhedonic depressive symptoms were significant, $\beta = .271$, $t(105) = 2.434$, $p = .01$.
- PedsQL Total Score, $\Delta R^2 = .550$, $F(2, 105) = 64.133$, $p < .001$. After controlling for anhedonic depressive symptoms, the unique effects of anxious arousal symptoms were significant, $\beta = -.745$, $t(105) = -7.065$, $p < .001$. After controlling for anxious arousal symptoms, the unique effects of anhedonic depressive symptoms were significant $\beta = .346$, $t(105) = 6.883$, $p < .001$.
- PedsQL Physical Score, $\Delta R^2 = .416$, $F(2, 104) = 37.034$, $p < .001$. After controlling for anhedonic depressive symptoms, the unique effects of anxious arousal symptoms were significant, $\beta = -.765$, $t(104) = -5.901$, $p < .001$. After controlling for anxious arousal

symptoms, the unique effects of anhedonic depressive symptoms were significant, β = .288, $t(104) = 4.697$, $p < .001$.

- PedsQL Health Summary Score, $\Delta R^2 = .478$, $F(2, 105) = 48.023$, $p < .001$. After controlling for anhedonic depressive symptoms, the unique effects of anxious arousal anxiety symptoms were significant, β = -2.082, $t(105) = -5.655$, $p < .001$. After controlling for anxious arousal anxiety symptoms, the unique effects of anhedonic depressive symptoms were significant, β = 1.126, $t(105) = 6.401$, $p < .001$.
- HFQ perceived influence of health on daily life $\Delta R^2 = .066$, $F(1, 104) = 3.718$, $p = 0.28$. After controlling for anhedonic depressive symptoms, the unique effects of anxious arousal symptoms were *not* significant, β = 0.27, $t(104) = 1.824$, $p = 0.71$. After controlling for anxious arousal anxiety symptoms, the unique effects of anhedonic depressive symptoms were *not* significant β = -.011, $t(104) = -1.526$, $p = 0.130$.

In summary, the combined effects of anhedonic depressive symptoms and anxious arousal symptoms were a significant predictor of the variance in the PSQI Overall Sleep Quality Score; the PedsQL-MFS Total, General Fatigue, and Cognitive Fatigue scores; the PedsQL-Total, Physical Functioning, and Health Summary scores; and the HFQ rating of perceived influence of health on daily life.

Consistent with the analyses in Hypothesis 1, anxious arousal symptoms (MASQ-AA) were a significant predictor of the variance in the PedsQL-MFS Total and General Fatigue scores; and the PedsQL Total, Physical Functioning, and PedsQL-Health Summary scores. Consistent with the analyses in Hypothesis 2, anhedonic depressive symptoms (MASQ-AD) were a significant predictor of the variance in the PSQI Overall Sleep Quality score; the PedsQL-

MFS Total, General Fatigue, and Cognitive Fatigue scores; and the PedsQL Total, Physical Functioning, and Health Summary scores.

3.6 Hypothesis 5

We hypothesized participants who reported more sleep disturbance would report higher rates of impulsivity. As previously discussed, due to the potential issue of multicollinearity, analyses were conducted on the several sleep scales to choose which scale would be a better predictor variable. After reviewing the variance and histograms of the various sleep measures, the PedsQL-MFS was chosen as the predictor variable due to higher variance. The question of "sleep" as a construct is evident in these results again. The construct of "fatigue" being measured by the PedsQL-MFS differs from the "sleep" construct in the PSQI and Sleep Diary. In a broader understanding of "sleep disturbance," that includes aspects of fatigue, these results analyzed the hypothesis that higher levels of fatigue-related "sleep disturbance" would be associated with greater impulsivity.

Multiple regression analyses were completed to determine whether higher levels of fatigue-related sleep disturbance endorsed (PedsQL-MFS Total Score) predicted the outcome variable of impulsivity (BIS-11 Total Score).

Participant report of fatigue-related sleep disturbance (PedsQL-MFS Total Score) was significantly associated with impulsivity(BIS-11 Total Score), $\beta = -.226$, $t(108) = -3.424$, $p = .001$, and explained a significant proportion of variance in the BIS-11 Total Score, $R^2 = .098$, $F(1, 108) = 11.724$, $p = .001$. This result supports the hypothesis that more fatigue-related sleep disturbance would be associated with higher levels of self-reported impulsivity.

Exploratory analyses of the BIS-11subscales revealed that fatigue-related sleep disturbance (PedsQL-MFS Total Score) did *not* significantly predict the BIS-11 Motor Scale

Score, R^2 = .006, F(1, 108) = .639, p = .426. However, participant report of fatigue-related sleep disturbance (PedsQL-MFS Total Score) was significantly associated with the:

- BIS-11 Attentional Scale Score, β = -.117, t(108) = -.5233, p < .001, and explained a significant proportion of variance in the Attentional Scale score, R^2 = .202, F(1, 108) = 27.386, p < .001.
- BIS-11 Non-planning Scale Score, β = -.085, t(108) = -2.556, p = .012, and explained a significant proportion of variance in the BIS-11 Non-planning Scale Score, R^2 = .057, F(1, 108) = 6.584, p = .012.

These results support the hypothesis that more fatigue-related sleep disturbance would be associated with higher levels of self-reported impulsivity.

3.7 Hypothesis 6

Sleep disturbance was expected to emerge as a partial mediator between anxious arousal symptoms and/or anhedonic depressive symptoms and the outcome variables of HRQOL and health functioning, such as a higher number of physician visits, more missed or delayed activities due to health/fatigue, or higher perceived negative influence of health/fatigue on daily life.

A mediator is defined as a variable that intervenes in the relation between a predictor and an outcome (Baron & Kenny, 1986; Holmbeck, 1997). According to Baron and Kelly (1986), a mediator specifies "how" a given effect occurs. Specifically it is the "mechanism through which the focal independent variable is able to influence the dependent variable of interest" (p.1173).

Sobel (1982) uses the multivariate delta method based on a first order Taylor series approximation for testing the product of coefficients for the intervening variable (as cited in MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). This approach, used to analyze the mediation effects of sleep disturbance in the present study, tests the significance by dividing the

estimate of the intervening variable effect by its standard error and comparing that value to a standard normal distribution. If sleep disturbance served as a partial mediator as predicted, the relationship between anxiety and/or anhedonic depressive and the outcome variables would be significantly smaller when sleep disturbance is included, but would still be greater than zero.

Following the method outlined by Baron and Kelly (1986), mediation analysis was conducted by first testing the direct relationship between the anxious arousal symptoms (MASQ-AA) and anhedonic depressive symptoms (MASQ-AD) predictor variables and the HRQOL (PedsQL Total Score, Physical Functioning Score, and Health Summary Score) and the health-related outcome variables (HFQ number of physician visits, missed activities, missed school days, and perceived health influence). The relationship between the predictor variables and the mediating sleep disturbance/fatigue variables (e.g., PSQI Total Score, Actual Sleep Time, Sleep Quality Score; Sleep Diary Actual Sleep Length, Sleep Quality; and PedsQL-MFS Total Score, General Fatigue, Sleep/Rest, and Cognitive Fatigue) were then analyzed. Finally, the relationship between the predictor variables and the mediating variables on the outcome variables were analyzed. Only relationships that were significant when testing the direct relationships were tested for mediation. The results of the first two analyses were discussed in the Hypotheses 1 and Hypotheses 2 sections, respectively. The mediation analyses are presented in this Results section.

As previously discussed, after reviewing the variance and histograms of the various sleep measures, the PedsQL-MFS was chosen as the predictor variable due to a higher variance. The question of "sleep" as a construct is evident in this data again. The construct of "fatigue" being measured by these scales differs from the "sleep" construct in the PSQI and Sleep Diary. In a broader understanding of "sleep disturbance," that includes aspects of fatigue, these results

analyzed the hypothesis that fatigue-related "sleep disturbance" would emerge as a mediator between anxiety and/or anhedonic depressive and the outcome variables of HRQOL and health functioning.

The relationship between anxious arousal symptoms (MASQ-AA) and HRQOL (PedsQL Total Score) was partially mediated by fatigue-related sleep disturbance, $\beta_{anxiety}$ = -.719, $t(106)$ = -6.356, $p < .001$; β_{sleep} = .334, $t(106) = 5.660$, $p < .001$. Further, the relationship between anxious arousal symptoms (MASQ-AA) and the HFQ perceived influence of health on daily life was fully mediated by fatigue-related sleep disturbance, $\beta_{anxiety} = 0.21$, $t(106) = 1.440$, $p = .153$; β_{sleep} = -.019, $t(106)$ = -2.452, $p = .016$.

Regarding exploratory analyses of the PedsQL subscales, the relationship between anxious arousal symptoms (MASQ-AA) and HRQOL (PedsQL Social Functioning) was *not* mediated by fatigue-related sleep disturbance, $\beta_{anxiety}$ = -.556, $t(106)$ = -3.752, $p < .001$; β_{sleep}= .053, $t(106) = .680$, $p = .498$. However, the relationship between anxious arousal symptoms (MASQ-AA) and HRQOL, as measured by the:

- PedsQL Physical Functioning Score was partially mediated by fatigue-related sleep disturbance, $\beta_{anxiety}$ = -.687, $t(105)$ = -5.324, $p < .001$; β_{sleep} = .358, $t(105) = 5.396$, $p < .001$.
- The PedsQL Emotional Functioning Score was partially mediated by fatigue-related sleep disturbance, $\beta_{anxiety}$ = -.1.115, $t(106)$ = -4.557, $p < .001$; β_{sleep} = .464, $t(106) = 3.635$, $p < .001$.
- PedsQL School Functioning Score was partially mediated by fatigue-related sleep disturbance, $\beta_{anxiety}$ = -.366, $t(106)$ = -3.326, $p = .026$; β_{sleep} = .481, $t(106) = 5.699$, $p < .001$.
- PedsQL Health Summary Score was partially mediated by fatigue-related sleep disturbance, $\beta_{anxiety}$ = -2.047, $t(106)$ = -5.112, $p < .001$; β_{sleep} = .998, $t(106) = 4.780$, $p < .001$.

The relationship between anhedonic depressive symptoms (MASQ-AD) and HRQOL (PedsQL Total Score) was partially mediated by fatigue-related sleep disturbance, $\beta_{depression}$ = .321, $t(106) = 5.799$, $p < .001$; β_{sleep} = .357, $t(106) = 5.757$, $p < .001$. Further, the HFQ perceived influence of health on daily life was fully mediated by fatigue related sleep disturbance $\beta_{depression}$ = -.007, $t(106) = -.958$, $p = .340$; β_{sleep} = -.002, $t(106) = -2.760$, $p = .007$.

Regarding exploratory analyses of the PedsQL subscales, the relationship between anhedonic depressive symptoms (MASQ-AD) and HRQOL (PedsQL Social Functioning Score) was *not* mediated by fatigue-related sleep disturbance, $\beta_{depression}$ = .329, $t(106) = 4.670$, $p < .001$; β_{sleep} = .037, $t(106) = .462$, $p = .645$. However, the relationship between anhedonic depressive symptoms (MASQ-AD) and HRQOL, as measured by the:

- PedsQL Physical Functioning Score was partially mediated by fatigue-related sleep disturbance, $\beta_{depression}$ = .241, $t(105) = 3.780$, $p < .001$; β_{sleep} = .420, $t(106) = 5.868$, $p < .001$.
- PedsQL Emotional Functioning Score was partially mediated by fatigue-related sleep disturbance, $\beta_{depression}$ = .579 $t(106) = 4.955$, $p < .001$; β_{sleep} = .449, $t(106) = 3.426$, $p = .001$.
- PedsQL School Functioning Score was fully mediated by fatigue-related sleep disturbance, $\beta_{depression}$ = .145, $t(106) = 1.841$, $p = .068$; β_{sleep} = .511, $t(106) = 5.774$, $p < .001$.
- PedsQL Health Summary Score was partially mediated by fatigue-related sleep disturbance, $\beta_{depression}$ = 1.053, $t(106) = 5.569$, $p < .001$; β_{sleep} = .996, $t(106) = 4.696$, $p < .001$).

4. DISCUSSION AND CONCLUSION

4.1 Conclusions

This study examined relationships among a range of self-reported anxiety, depression, impulsivity, and sleep disturbance levels, as well as stress responses to an induced stressor, in a sample of emerging adults. The induced stressor used in this study was the TSST. Further, how HRQOL co-varied among levels of anxious arousal symptoms, anhedonic depressive symptoms, and sleep disturbance/fatigue was investigated. Similar to the literature, the findings from this study provided mixed results. Analyses supported several expected relationships among anxiety and depression symptoms and the variance in numerous aspects of sleep disturbance, HRQOL, and health functioning. In contrast, other results did not show a relationship among these variables. Although some results did follow the proposed direction of the hypotheses, other results were *opposite* to the proposed direction of the relationship.

The results of the analysis of the STAI-S demonstrated a significant difference between mean level of state anxiety before and after the TSST protocol was administered. The STAI is one of the most established and commonly used measures of anxiety in research, appearing in over 3000 studies (Bieling, Antony, & Swinson, 1998; Rossi & Pourtois 2012). The STAI has also been used to study pretest and posttest differences in anxiety levels (Lilley & Cobham, 2005; Zunhammer et al., 2013). For example, Leal, Goes, da Silva, and Teixeira-Silva (2017) used the STAI to investigate changes in state anxiety in participants exposed to threatening situations. Results, similar to the findings of the current study, showed an increase in state anxiety from before, during, and after phases of the stress inducing experiment.

Although over 50% of this emerging adult sample was classified as poor sleepers by the PSQI (i.e., Total Score higher than 5), curiously nonsignificant findings emerged based on

participant report of anxious arousal (MASC-AA), anhedonic depression (MASQ-AD), and sleep disturbance as measured by the PSQI Total Score, Actual Sleep Time reported, and Overall Sleep Quality rating (MASQ-AA only); the Sleep Diary Actual Sleep Time and Overall Sleep Quality rating; and the PedsQL-MFS Sleep/Rest Fatigue Score. Therefore, these results do *not* support the hypothesis that higher levels of anxious arousal or anhedonic depression would be associated with more sleep disturbance. This is in contrast to previous studies (Lemola et al., 2013) that found variability in sleep was predictive of higher depressive symptom scores, anxious symptom scores, and anxious arousal scores and that anhedonic depressive symptoms predicted sleep disturbances (Kalmbach et al., 2017).

Alternatively, several analyses that are related to sleep disturbance or low vitality/energy level (i.e., fatigue) based on the PedsQL-MFS *were* significant, including the Total, General Fatigue subscale, and Cognitive Fatigue subscale scores. These results *do* support the hypothesis that higher levels of anxious arousal or anhedonic depression would be associated with more sleep disturbance, as defined more broadly as fatigue-related. These results are consistent with previous research that the PedsQL-MFS Total Scale Score was suitable as a summary score for the primary analysis of fatigue in young adults and the General Fatigue, Sleep/Rest Fatigue, and Cognitive Fatigue Scales were appropriate to examine specific domains of fatigue, as well as subgroup differences (Varni & Limbers, 2008).

The construct of "fatigue" being measured by various subscales of the PedsQL-MFS differs from the "sleep" construct in the other study scales (i.e., PSQI, Sleep Diary, and the PedsQL-MFS Sleep/Rest subscale). The PedsQL-MFS includes three subscales: (a) General Fatigue (e.g., ''I feel tired.''; ''I feel too tired to do things that I like to do.''), (b) Sleep/Rest Fatigue (e.g., ''I feel tired when I wake up in the morning.''; ''I rest a lot.''), and (c) Cognitive

Fatigue (e.g., ‘‘It is hard for me to keep my attention on things.’’; ‘‘It is hard for me to remember what people tell me.’’). The Sleep/Rest subscale measures a similar “sleep disturbance” construct as the PSQI and Sleep Diary, including the quality of sleep. The PedsQL-MFS subscales, General Fatigue and Cognitive Fatigue, measure the broader concept of “fatigue” as a potential outcome of experiencing “sleep disturbance.”

In a broader understanding of “sleep disturbance,” these results support the hypothesis that higher levels of anxious arousal or anhedonic depression would be associated with common outcomes of fatigue-related sleep disturbance, such as low vitality/energy levels and cognitive inefficiencies, which also are associated with depressive symptoms and sometimes anxiety symptoms.

Interestingly, anhedonic depression (MASQ-AD) also explained a significant proportion of variance in PSQI Sleep Quality. This result is consistent with the results of Kalmbach et al. (2017) that anhedonic depressive symptoms predicted sleep disturbances. Although this finding is significant, it does not support the hypothesis that higher levels of anhedonic depression would be associated with more sleep disturbance. In fact, the direction of the relationship is reversed in the current study, such that higher anhedonic depression was associated with *higher* sleep quality, which is in contrast to the Kalmbach et al. (2017) findings. Sleep quality is measured on the PSQI with a question asking the participant to rate their quality of sleep from very good to very bad. A possible explanation is that as anhedonic depression symptoms increase, the person is sleeping more and thus rated the quality of their sleep as “better,” although the actual quality my not have been “better.”

Additional participant report of anxious arousal (MASQ-AA) and anhedonic depression (MASQ-AD) indicated that higher anxious arousal symptoms was significantly associated with

lower HRQOL and HFQ higher ratings on perceived negative influence of health on daily life. Anxious arousal was also significantly associated with an increased number of missed daily activities. On all of these scales, higher levels of anxious arousal symptoms were associated with poorer outcome variables. These results support the hypotheses and previous research indicating that anxiety, depression, and sleep disturbances are associated with poorer HRQOL (Lim, Jin, & Ng, 2012; Strine & Chapman, 2005; Chen, Gelaye, & Williams, 2014). In addition, Creed et al. (2002) studied subthreshold cases of anxiety and depression, similar to the present study, and found significantly lower HRQOL scores for these participants compared to non-anxious or non-depressed participants.

Unexpectedly, no interaction effects of anxious arousal (MASQ-AA) and anhedonic depression (MASQ-AD) were found to be significant. However, the combination of anxious arousal symptoms and anhedonic depressive symptoms in the interaction analyses *did* achieve significance on certain outcomes. Therefore, similar to previous research, the presence of multiple impairments (anxious arousal symptoms combined with anhedonic depression symptoms) was found to predict poorer quality of life compared to a single mood or anxiety impairment (Lim et al., 2012).

Results indicated that sleep disturbance, as measured by the PedsQL-MFS, was significantly associated with impulsive behaviors, as measured by the BIS-11 Total, Attentional Impulsivity, and Non-planning Impulsivity scores. These results support the hypothesis and previous research that higher levels of sleep disturbance would be associated the higher levels of impulsivity. Similar to the current study, Van Veen et al. (2017) found that the BIS-11 Attentional Impulsivity subscale score was significantly associated with a measure of sleep quality, but, in contrast to the current study, not the other BIS-11 subscale or Total scores.

McGowan and Coogan (2018) studied the relationship between sleep patterns (i.e., PSQI and actigraphy) and trait impulsivity (i.e., BIS-11) in a university sample of healthy emerging adults. Impulsivity was associated with shorter sleep duration, less efficient sleep, a delayed timing of sleep and greater diurnal arousal. In addition, comparing the subscales of the BIS-11 indicated that attentional and non-planning impulsiveness was associated with late bedtime and midsleep, reduced total sleep time, period variability, and increased diurnal activity, but motor impulsiveness only showed modest association with reduced sleep efficiency (McGowan & Coogan, 2018). Obviously, how aspects of impulsivity are associated with sleep patterns varies across research samples of college students.

Additional research on emerging adults in university settings is developing on relationships between sleep disturbances and symptoms of anxiety, depression, and impulsivity. In a large, multi-university sample, Becker, Jarrett, Luebbe, Garner, Burns, and Kofler (2018) described rates of sleep problems, as measured by the PSQI, and examined the associations of anxiety, depression, and ADHD in relation to the PSQI. Similar to the current study, over 60% of student participants qualified as poor sleepers based on the PSQI Total Score cutoff. Additional results indicated anxiety symptoms, depressive symptoms, and ADHD symptoms were consistently associated with poorer sleep, such that: (a) anxiety symptoms were associated with more sleep disturbances, including daytime sleepiness, and (b) sleep medication use and depressive symptoms were uniquely associated with increased daytime dysfunction (i.e., daytime sleepiness and difficulty maintaining enthusiasm). ADHD-Inattentive symptoms were associated with poorer sleep quality and increased daytime dysfunction, and ADHD-Impulsive symptoms were associated with more sleep disturbances, but less daytime negative effects on functioning (Becker et al., 2018).

The current mediation results indicated sleep disturbance partially mediated the relationship between anxious arousal symptoms (MASQ-AA) and HRQOL. The relationship between anxious arousal symptoms and the HFQ perceived influence of health on daily life was fully mediated by sleep disturbance. These findings support previous findings, for example Ramsawh et al. (2009), in which the combination of an anxiety disorder and poor sleep was correlated to poorer "mental" HRQOL and increased disability in daily functioning.

Mediation results also indicated sleep disturbance partially mediated the relationship between anhedonic depression (MASQ-AD) and HRQOL. The relationship between anhedonic depression and the HFQ perceived influence of health on daily life was fully mediated by sleep disturbance. These findings concur with the literature that sleep disturbances are often comorbid with psychological conditions, especially anxiety and depressive disorders (Ancoli-Israel & Roth, 1999; Ohayon & Roth, 2003).

4.2 Limitations

One limitation of the current study involves common challenges to sleep research. Participants were asked to complete surveys twice per day for a week, but the integrity of when they completed the surveys was not able to be monitored. Perhaps the use of actigraphy, in addition to the sleep diary, could lessen this measurement issues, although measurement integrity has also been reported for technology-assisted sleep pattern data collection (Lawrence & Muza, 2018; Lemola et al., 2013). Short, Gradisar, Lack, Wright, and Carskadon (2012) found that actigraphy estimates of wake after sleep onset were substantially greater than sleep diary estimates and actigraphy estimates of total sleep time were substantially less than sleep diary and parent report. In addition, the results found actigraphy estimates displayed no significant

relationship with daytime functioning, suggesting the sleep diary was more accurate in their sample (Short el al., 2012).

Similarly, Lockley, Skene, and Arendt (1999) investigated the ability of actigraphy and sleep logs to identify circadian sleep/wake disorders and measure changes in sleep patterns over time. Results included good correlations when comparing the measurement of sleep timing and duration, and for measuring changes in sleep patterns over time, but poor correlations in their assessment of transitions between sleep and wake states.

Another measurement issue limitation was that the constructs of "sleep disturbance" and "fatigue" were not considered prior to implementation of the current study. In future studies, the sleep construct, particularly methods for measuring sleep patterns, perceived sleep quality, and aspects of *fatigue*, should be more thoroughly defined and hypothesized about before the start of a study.

Other measurement issues include the self-report measures themselves. Although most psychological research of humans uses self-report data, these measures may be inaccurate in the frequency of symptoms since participants are asked to recall how often they had certain experiences based on memory of the previous weeks. Additionally, causal relationships cannot be made among most of the constructs in this study. The study procedures were completed in a way that associations between anxious arousal symptoms, anhedonic depression symptoms, sleep disturbances/fatigue, impulsivity symptoms, health functioning, and health related quality of life can be made, but no causal relationships between these variables can be assumed.

Another limitation of the current study may be the generalizability of the findings. As previously discussed, emerging adults differ in both a biological and social manner from individuals in immediately younger or older age groups. The results of the current study may be

exclusively relevant to emerging adults. For example, sleep disturbances common among college students, may not be defined in similar terms to chronic sleep disturbances in immediately younger or older age groups. Similarly issues of anxiety or depression may be uniquely experienced by college-aged students who typically are living away from their families and high school friends. However, a purpose of the current study was to investigate patterns specific to emerging adults.

Additionally, the current sample of emerging adults was partially a convenience sample. Students were recruited from the Texas A&M University Department of Psychological and Brain Sciences research participant pool, all of whom were students enrolled in an undergraduate introduction to psychology class. Although all students were emerging adults, a more random sample of university students would add to the generalizability of these findings.

4.3 Implications

Implications of these finding include that early assessment of anxiety and depressive symptoms, even sub-threshold patterns, may provide quality improvement of health outcomes and inform targeted interventions. Similar to other studies, the high prevalence of sleep disturbances and their association with increased levels of anxiety, depression, and impulsivity symptoms in emerging adults should inform interventions to address this health issue (Doane, Gress-Smith, & Breitenstein, 2015). The specific induced stress method used in his study, is a common scenario for university students and may have long-term health implications

Another implication to bring to the attention of clinicians is the importance of client-perceived influence of life events. Most of the HFQ items, including the number of physician appointments, missed activities (i.e., depression results), and number of missed school days did not reach a level of significance. However, it is important to note that the question that asked the

perceived influence on daily life yielded results such that more negative ratings were associated with *higher* levels of reported anxiety (MASQ-AA) and depression (MASQ-AD). Implications for clinicians include the importance of the client's perception of their health influence to consider beyond the number physician visits or missed daily activities. This type of question is easy to ask in an assessment and evidently important for interventions and case conceptualizations.

Although many researchers report only the BIS-11 Total Score, this study explored the BIS-11 subscale scores (i.e., Attentional, Motor, Non-planning) to account for their individual contribution to the relationships being tested. Sleep disturbance (i.e., aspects of "fatigue") was significantly associated with overall, attentional, and non-planning aspects of impulsivity, but was *not* associated, similar McGowan and Coogan (2018), with the movement aspects of impulsivity.

In addition, studies using HRQOL measures often analyze only the Total Score. To account for their individual contributions to the relationship being tested, the current study explored the PedsQL subscales (i.e., Physical Functioning and Health Summary) and the PedsQL-MFS subscales (i.e., General Fatigue, Sleep/Rest Fatigue, and Cognitive Fatigue). Poorer HRQOL as measured by PedsQL subscales and Total scores were similarly significantly associated with higher levels of reported anxious arousal symptoms and anhedonic depressive symptoms. Within the PedsQL, the subscales measure a similar health construct of quality of life, which is indicated by the Health Summary Score, a composite of three of the four subscales.

Within the PedsQL-MFS subscales, the Sleep/Rest subscale score was *not* significantly related to higher anxious arousal symptoms and anhedonic depressive symptoms. In contrast, the General Fatigue and Cognitive Fatigue subscale scores were significantly related to higher

anxious arousal symptoms and anhedonic depressive symptoms. The construct of "fatigue" measured by the General Fatigue and Cognitive Fatigue subscales, differs from the construct on the Sleep/Rest subscale, which measures the quality of sleep rather than the broader understanding of "sleep disturbance" that includes cognitive inefficiencies and low energy/vitality aspects of fatigue.

4.4 Future Directions for Research and Practice

The current study adds to the literature on the relationships between anxiety and stress symptoms, depression symptoms, sleep disturbances, and self-reported impulsivity, health functioning, and HRQOL. The prevalence of these constructs among emerging adults in university settings raises concerns for preventative actions.

Future research on the current data will analyze the saliva samples collected during the TSST to investigate the cortisol responses to the induced stressor in this sample of emerging adults with a range of anxiety symptoms, depressive symptoms, impulsivity, sleep disturbance, and HRQOL. As clarified here, however, the STAI-S, as a self-report of state anxiety, has been established as a solid measure of response to an induced stressor.

Although gender differences were analyzed for Hypothesis 1, another direction for future research includes exploring influences of gender among the study variables. Further, additional measures of impulsivity and delayed discounting could be included in future studies to better explain relationships between aspects of sleep disturbances and impulsive decision making. Another future direction relates to the construct of sleep. As previously stated, a more precise definition of the constructs of fatigue versus sleep disturbances should be refined. In addition, perhaps a more controlled sleep environment in a sleep lab would allow for more accurate reports of sleep disturbances and collection of cortisol samples at bedtime and wake-time.

Implications for practice applications include further developing evidence-based prevention and problem-response services for emerging adults as they work to find their identities. Furthermore, a research study with interventions to reduce the stress, anxiety, and depressive patterns associated with starting college can be implemented and evaluated for effectiveness. For example, the pilot study completed by Baroni et al. (2008) offering a sleep course at a university can be replicated. Their findings suggested that sleep education and targeted cognitive behavioral skills can improve sleep disturbances and possibly mood and anxiety symptoms in university students. In addition, Baroni et al. (2008) suggested manualized interventions to be used during the sleep course tom improve these symptoms.

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