Effects of Stress, Sleep Hygiene, and Exercise on Academic Engagement in Undergraduate Students

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Abstract

**CHAPTER 1**

**Introduction**

**Academic Engagement**

Academic engagement is a broad concept including aspects of behavior and both intrinsic and extrinsic characteristics that lend themselves to learning and academic success. Research on student engagement has focused and defined academic engagement in a variety of ways, identifying relevant factors such as motivation, participation, instructor relationships, achievement, challenging curriculum, and study skills (Chapman, 2003; Handelsman, Briggs, Sullivan, & Towler, 2005; NSSE, 2000; Skinner & Belmont, 1993; Zepke & Leach, 2010). Marks (2000) conceptualizes engagement as a psychological process: “specifically, the attention, interest, investment, and effort students expend in the work of learning” (p. 154-155). Furthermore, defined in this way, “engagement implies both affective and behavioral participation in the learning experience” (pss, Sleep Hygiene, and . 154-155). Further, Skinner and Belmont (1993) describe how student engagement appears in classroom settings as follows:

Children who are engaged show sustained behavioral involvement in learning activities accompanied by a positive emotional tone. They select tasks at the border of their competencies, initiate action when given the opportunity, and exert intense effort and concentration in the implementation of learning tasks; they show generally positive emotions during ongoing action, including enthusiasm, optimism, curiosity, and interest. The opposite of engagement is disaffection. Disaffected children are passive, do not try hard, and give up easily in the face of challenges [they can] be bored, depressed, anxious, or even angry about their presence in the classroom; they can be withdrawn from learning opportunities or even rebellious towards teachers and classmates (p. 572).

A systematic literature review by Zepke and Leach (2010) evaluated 93 studies from 10 different countries. Study results identified four perspectives on school engagement that include: “Motivation and agency (engaged students are intrinsically motivated and want to exercise their agency),” “Transactional engagement (students and teachers engage with each other),” “Institutional support (Institutions provide an environment conducive to learning),” and “Active citizenship (students and institutions work together to enable challenges to social beliefs and practices).” Results from this investigation highlight the potential utility of addressing academic engagement from both the macro (institutionally based) and micro (student focused) level. In other words, school engagement is a complex concept that incorporates both internal factors such as attention, effort, affect, and motivation, and extrinsic factors such as teacher/student relations, conducive learning environments, and effective institutional support and interactions with students.

To date, various studies have approached school engagement from the macro level, looking at how institutional practices can impact the likelihood of a student to engage and succeed in the academic environment (e.g., Froh & Hawkes, 1996; Skinner & Belmont, 1993). Skinner and Belmont (1993) examined a transactional form of engagement with their evaluation of the impact of teacher/student relations on academic engagement. In this study, such relationships were found to predict student engagement. Moreover, the researchers discussed how teacher relations and behaviors influence student motivation in a positive fashion. This suggests that interventions on the macro level—although potentially constrained by the differing institutional practices at different institutions and in different programs—can be beneficial to a student’s positive outcomes.

Studies have also evaluated academic engagement from an intrinsic perspective, often focusing on singular aspects of an individual such as their motivation, attention, participation, and study skills. Unlike previous studies focusing on motivation as a defining characteristic of academic engagement at the university level, Handelsman et al. (2005) approached engagement as a multi-faceted concept while developing a measure on student course engagement. Handelsman et al. (2005) chose to look at the “micro” level of a student’s engagement rather than evaluate engagement from the “macro” level, which has been addressed by previous research looking at engagement from the perspective of the institution to determine effective programs to enhance engagement in their students (Froh & Hawkes, 1996; NSSE, 2000). Study results identified four distinct factors of university student engagement: Factor 1 – “skills engagement”, Factor 2 – “emotional engagement”, Factor 3 – “participation/interaction engagement”, and Factor 4 – “performance engagement.” In light of these findings, the Student Course Engagement Questionnaire (SCEQ; Handelsman et al., 2005) is based on a four-factor model: Factor 1 includes study skills, effort, work completion, attendance, and taking and reviewing notes; Factor 2 includes emotional aspects such as desiring to learn and finding ways to make a course interesting or relevant to their lives; Factor 3 includes participatory aspects such as participating in discussions, asking questions, and seeking help when necessary; and finally, Factor 4 includes performance on tests, grades, and confidence about abilities in the specific course.

**Why does Engagement Matter?**

Academic engagement matters in that research has shown that it is related to successful academic outcomes (Finn & Rock, 1997). Marks (2000) highlights this notion with the following statement: “engagement is an important facet of students' school experience because of its logical relationship to achievement and to optimal human development” (p. 155). In fact, the previously provided definition of academic engagement is conceptually similar to such outcome measures. As an example, the “Performance Factor” as proposed by Handelsman et al. (2005), which includes grades and performance on tests, is included as a measure of engagement. As such, academic engagement is often evaluated in the literature as a component of its parts, with academic achievement a common area of focus. Finn and Rock (1997) identified this link in a study evaluating graduation rates and levels of academic achievement in a sample of 1,803 minority high school? students. Study results indicate that students with the most successful scholastic outcomes were the most likely to show the highest level of school engagement behaviors.

Disengagement at the university level can lead to failing grades, higher dropout rates, and feeling disenfranchised. Therefore, to optimize performance among university students, it is important to evaluate the variables that impact academic engagement and the mechanisms involved. As suggested by results from the Handelsman et al. (2005) study, the current study aims to evaluate students on the “micro” level and by assessing variables such as stress, which have commonly been linked to poor academic outcomes and affect. It is believed that investigating internal factors affords more opportunities for interventions since they can be implemented on an individual or in a small group setting, and not be constrained by the challenges of making large institutional changes.

**Stress**

University students are inundated with potential stressors that range from managing the responsibilities of new-found independence to navigating the intricacies of finding success in a rigorous academic setting. To achieve academic success, it is important for students to be actively engaged in school. Stress, however, has been implicated in reducing school engagement (Lloyd, Alexander, Rice, & Greenfield, 1980). For example, Pechtel and Pizzagalli (2011) found that even early life stress has shown long-term impacts on various areas related to academic engagement, including memory, executive functioning, and cognitive performance. Further, Vaez and Laflamme (2008) identified an association between types of stress and lower graduation rates.

Stress, as measured through the number of stressful life events recently experienced, has been found to directly impact academic performance as well as influence other aspects of academic engagement. For example, mood, life satisfaction, attention, and executive functioning have all been found to be negatively affected by high levels of stress. In a study by Kim, Conger, Elder, and Lorenz (2003), higher levels of life stressors were associated with higher levels of depression and anxiety. Similarly, research by Leggett, Burgard, and Zivin (2016) identified similar effects of stress on symptoms of depression. Misra and McKean (2000) noted not only relationships between stress and anxiety, but also stress and time management, albeit directionality between these variables was not established.

Although stress has been associated with these aspects of academic engagement, studies have shown the potential influence of interacting variables on stress. In a study by Minkel et al. (2012), individuals experiencing a night of total sleep deprivation showed less ability to manage stress and showed pronounced levels of anger and anxiety in response to low levels of stress, indicating that sleep is important for mood regulation, even in situations of low stress. In another study evaluating the impact of stress, undergraduate students who participated in vigorous exercise displayed lower levels of perceived stress (VanKim & Nelson, 2013). Such findings suggest that important mediators/moderators may exist that influence academic engagement in university students.

**Sleep**

Sleep is essential for the consolidation of memory, learning, decision making, alertness, mood, and cognitive performance (Banks & Dinges, 2007; Pilcher & Walters, 1997). Deficits in sleep have been shown to negatively impact academic performance (Gomes, Tavares, & de Azevedo, 2011; Gilbert & Weaver, 2010). Specifically, sleep quality and duration are correlated with lower academic achievement and course grades in college students (Pilcher, Ginter, & Sadowsky, 1997). It is also important to note that college students do not have good insight into the impact of sleep loss on their cognitive functioning, believing their abilities and functioning to be much higher than those students with adequate sleep levels (Pilcher & Walters, 1997).

**Self-Care Practices**

Good sleep hygiene has been shown to impact sleep quality **(**Brown, Buboltz, & Soper, 2002; Cho, Kim, & Lee, 2013**)**. Positive sleep hygiene practices such as keeping a regular sleep/wake schedule, maximizing conditions that are conducive to sleeping, and avoiding the consumption of alcohol and caffeine before bed are associated with improved sleep and consequently with improved performance in activities impacted by sleep (e.g. executive functioning including working memory tasks, reading and math performance, physical conditioning, and emotional regulation).

**Exercise**

Similar to sleep, exercise has been shown to positively impact a myriad of life’s functions including mood, mental health, telomere length, cognitive functioning, attention, cardiovascular health, stress levels, academic achievement, and self-esteem (Dunn, Trivedi, & O’Neal, 2001; Fedeway & Ahn, 2011; Galper, Trivedi, Barlow, Dun, & Kampert, 2006; Manger & Motta, 2005; Puterman et al. 2010; Shephard, 1996; Spence, McGannon, &Poon, 2005; VanKim & Nelson, 2013). One study on the benefits of exercise by Manger and Motta (2005) found that exercise can help attenuate symptoms of Post-Traumatic Stress Disorder (PTSD) as well as anxiety and depression.

Sleep and exercise have been shown to mitigate some of the influences of stress on one’s wellbeing. Specifically, sleep is a restorative process that also reduces stress levels and increases attention, focus, memory, and mood (Minkel et al., 2012; Oginska & Pokorski, 2006; Sadeh, Gruber, & Raviv, 2003). In light of these impacts, sleep is likely to influence academic engagement, both in terms of achievement, and other components of engagement (Gomes et al. 2011; Gilbert & Weaver, 2010; Sadeh et. al., 2003). Consistent with the definition of academic engagement delineated above, aspects of self-care may be essential to healthy academic engagement. More specifically, areas of academic engagement directly influenced by self-care practices are proposed to have a greater mediating/moderating effect of sleep hygiene and exercise on the relationship between stress and academic engagement. For instance, the skills engagement factor of academic engagement is comprised of many aspects reliant on executive functioning such as completing work, paying attention in class, studying, taking notes, and being organized, which have been shown to be directly impacted by sleep quality and exercise (Fedewa & Ahn, 2011; Sadeh et al., 2003; Turner, Drummond, Salamat, & Brown, 2007). Consequently, sleep hygiene practices focused on optimizing sleep quantity and quality should, in turn, influence the improvement of executive functioning in the classroom. The same will likely be true for the impact of sleep on performance engagement since substantial research shows a link between sleep and achievement (Dewald, Meijer, Oort, Kerkhof, & Bogels, 2010; Sadeh et al., 2003; Wolfson & Carskadon, 1998). Although self-care practices including good sleep hygiene and physical activity have also been shown to promote mood (Manger & Motta, 2005; Pilcher et al.; 1997), the emotional factor of academic engagement as defined by Handelsman et al. (2005) revolves around the concept of applying course content to your life and finding ways to make it personally interesting. As such, the impact on mood may influence engagement indirectly because improvements in mood may increase the desire to learn and apply concepts outside of the classroom. Additionally, such improvements in mood might also indirectly improve other areas of engagement, including increasing participation in the classroom, improving confidence in one’s performance, and showing effective study skills.

Finally, exercise has been postulated to increase arousal in students. Therefore, because of heightened alertness associated with physical activity, the participatory factor of engagement (e.g. participating in discussions, asking questions) also may benefit.

It Here provide an integrative statement about the scope of your study----

The purpose of the current study is to evaluate the relationships between stress, the self-care practices of sleep hygiene and exercise, and academic engagement, including its four factors, in undergraduate students. Sleep hygiene and exercise will be looked at as a mediator and moderator, respectively, in the relationship between the independent variable of stress and the dependent variable of academic engagement/factors. More specifically, sleep hygiene will be evaluated to elucidate the intermediary process that leads from stress to academic engagement; exercise or physical activity will be evaluated to identify its influence as a moderator in the relationship between stress and academic engagement/factors; and all independent variables will be evaluated to determine those that best predict academic engagement/factors in order to provide a better picture of the influencing aspects of engagement.

In light of the former, the current study proposes the following research questions and hypotheses:

**Research Question 1: What is the relationship between stressful life events and academic engagement in undergraduate college students?**

*Hypothesis 1: It is hypothesized that increased levels of life stressors will be associated with lower levels of academic engagement. Specifically, it is hypothesized that academic engagement will be lower in undergraduate students who experience a greater number of stressful life events.*

**Research Question 2: What is the relationship between sleep hygiene (SH) and academic engagement in undergraduate students?**

*Hypothesis 2: It is hypothesized that lower levels of sleep hygiene will be associated with impairments in academic engagement. Specifically, academic engagement will be lower in undergraduate students who experience reduced levels of healthy sleep hygiene practices.*

*Additionally, it is hypothesized that sleep hygiene practices will have the largest effect on both the skills engagement and the performance engagement factors since these factors are based in executive functioning and achievement, areas that have shown consistent links in the literature to impaired sleep.*

**Research Question 3: Does sleep hygiene mediate the relationship between stressful life events and academic engagement?**

*Hypothesis 3: I believe the negative relationship between stressful life events and academic engagement will be mediated mitigated by good sleep hygiene practices in undergraduate students.*

*Additionally, I hypothesize that sleep hygiene practices will show the greatest mediating effect on the academic engagement factors of skills engagement and performance engagement due to the research indicating strong associations between sleep quality and both executive functioning and academic achievement.*

**Research Question 4: What is the relationship between physical activity and academic engagement in undergraduate students?**

*Hypothesis 4: I hypothesize that increased levels of exercise (based on number of days per week) for strenuous exercise will be associated with higher levels of Academic Engagement.*

**Research Question 5: Does exercise moderate the relationship between stressful life events and academic engagement?**

*Hypothesis 5: I hypothesize that students with higher levels of stressful life events will experience lower academic engagement, if they show low levels of physical activity. Due to the fact that the positive impacts of exercise seem to be based on a dosage-threshold, I postulate that high levels of strenuous activity will mitigate the relationship between stressful life events and academic engagement.*

**Research Question 6: What is the hierarchical influence of stressful life events, sleep hygiene, and exercise on academic engagement?**

*Hypothesis 6: Since self-care practices have been shown to improve various elements of engagement, how these self-care practices differentially impact academic engagement will be explored to identify the aspects that most influence academic engagement, and/or the four factors of academic engagement, in undergraduate students.*

**CHAPTER 2**

**REVIEW OF RELEVANT LITERATURE**

**Stress/Stressful Life Events (SLEs)**

Although research specific to undergraduate students is limited, research on children/adolescents/adults in addition to that found for undergraduate students shows that stress significantly impacts the likelihood of experiencing externalizing behaviors (Kim et al. 2003, subjects = adolescents), internalizing behaviors (Kim et al. 2003; McKnight, Huebner, Suldo, 2002; Suldo & Huebner, 2004, subjects = adolescents), psychopathology and poor mental health (Furniss, Beyer, Muller, 2009, subjects = preschool students), binge eating (Sulkowski, Dempsey, & Dempsey, 2011, subjects = university students), lowered life satisfaction or feelings of well-being (Ash & Huebner, 2001, subjects = adolescents; McCullough, Huebner, & Laughlin, 2000, subjects = adolescents; McKnight, Huebner, Suldo, 2002; Suldo & Huebner, 2004), delinquent behaviors (Kim et al. 2003), negative affect or depression (McCullough, Huebner, & Laughlin, 2000; Sherina, Rampal, & Kaneson, 2004, subjects = undergraduate medical students – talk about the symptom of stress reported as causing sleep problems in sleep section p. 208 and make sure to CITE this paper), heightened distress (Cameron, Palm, & Follette, 2010, subjects = college students), and poor academic performance (Lloyd et al., 1980; subjects = university students). (Cameron, Palm, & Follette, 2010 (subjects = college students – predictors of PTSD – use somewhere else too like in the discussion about stressors not being dependent on the severity but quantity – can use Furniss for this too.; Furniss, Beyer, Muller, 2009). In a 6-year long longitudinal study of adolescents, Kim et al. (2003) found that Stressful Life Events (SLEs) predicted internalizing behaviors such as anxiety and depression as well as externalizing and delinquent behaviors.

Stressful life events have also been found to have either a direct or indirect impact on academic engagement (AE), including life satisfaction (McKnight et al. 2002; Suldo & Huebner, 2004, subjects = adolescents), locus-of-control (Ash & Huebner, 2001), and anxiety and time management (Misra & McKean, 2000, subjects = university undergraduates). Additionally, stress has been found to be a growing concern at the college level as schools see an influx of students seeking mental health resources through university clinics because of issues with stress, anxiety, and depression (Novotney, 2014), and the majority of undergraduate students are reporting heightened levels of stress (Campbell, Svenson, & Jarvis, 1992 CITE in references; Hudd et al., 2000 CITE in references) and symptoms related to stress (Sherina, Rampal, & Kaneson, 2004, CITE in references). These mental health concerns are negatively impacting academic engagement, retention rates, and student success. Stress not only increases the likelihood of mental illness, it also impacts the likelihood of developing behavior problems. *Need a study or two on this relationship*

Suldo and Huebner (2004) found that life satisfaction mediated the relationship between stressful life events and psychopathology. They posited that life satisfaction can influence the relationship between stress and the development of behavior problems by acting as a protective factor, which reduces the likelihood of these behaviors developing. In a study evaluating the effects of stressful life events on mental health, Furniss et al. (2009) administered stress and psychiatric symptoms questionnaires to the parents of 1,887 German preschool students with results reflecting a highly significant relationship between the number of stress events and the number of mental health problems in those children.

**Stress and Academic Engagement**

Academic engagement is a multifaceted concept and the impact of stress on AE has been evaluated in different ways across studies. Some studies have investigated academic performance as a whole, while others have focused more specifically at impacts of stress on mood*,* executive functioning*,* memory, and mental health. Lloyd et al. (1980) investigated life events (e.g. “change in line of work”) and found them to be negatively related to academic performance. Essentially, academic performance worsened as stress events increased. Interestingly, they identified a threshold (12 items) at which life events began to show detrimental impacts. In a more recent example of the impact of stress on academic performance measures, Vaez and Laflamme (2008) found that some aspects of stress were associated with lower graduation rates. Even early life stress has shown long-term effects on memory, emotional regulation, executive functioning, and cognitive performance (Pechtel & Pizzagalli, 2011). Although the body of research specifically pertaining to the effects of stress on achievement/academic engagement is sparse, especially in more recent years, the research is more prolific when looking into mood, behaviors, and other related aspects of academic engagement.

Research has also shown that stress has a detrimental impact on symptoms of depression. In this regard, Legget et al. (2016) found a significant association between stressful life events and depression. To elucidate the mechanism of that relationship further, sleep was evaluated as a moderator. Results indicated an interaction effect, whereby sleep influenced the likelihood of depressive symptoms by moderating the impact of stress events. In the same study, having quality sleep led to less risk for depressive symptoms when stressful life events were elevated. As the authors explained, “Sleeping restfully may allow individuals the rejuvenation needed to manage stress adaptively and reduce depressive symptom burden. Further, this association shows that stressors and risk factors may not always act independently of one another, and intervening on one risk factor, such as sleep disturbance, may have a positive impact on the entire pathway of biopsychosocial risk to depressive symptoms” (pp. 125). Also related to the effects of stress on mental health, stressful life events have been found to predict factors of psychological well-being such as global self-concept (McCullough et al., 2000).

McKnight et al. (2002) investigated how SLEs impact a student’s internalizing and externalizing behavior. More specifically, they examined the potential moderating and mediating effects of life satisfaction on this relationship. Study findings indicated several associations with increased SLEs, including a decrease in life satisfaction, an increase in both externalizing and internalizing negative behaviors, and a mediating effect of life satisfaction on maladaptive behaviors. Although a significant mediator, life satisfaction was not found to be a moderator in that relationship.

Such an outcome is expected based on the notion

that when an individual has an overall positive (vs. negative) outlook on her life, which is at least

moderately stable, he or she is less likely to adapt to SLEs in maladaptive ways such as through

internalizing or externalizing behaviors. In other words, we predicted that the relationship between

SLEs, and behavior problems would be smaller for students with high life satisfaction than for

those students with low life satisfaction.

**Stressful Life Events: Acute vs Chronic**

Stress is a multifaceted construct that includes aspects of both acute and chronic adversity. In a study on how life satisfaction varies based on accumulated SLEs, Ash and Huebner (2001) isolated negative life events from chronic stressors in order to determine their differential impact. They found that the inclusion of both stressor types significantly improved predictability of life satisfaction. In a similar vein, McCullough et al. (2000) found that negative daily events showed a greater influence on participant affect than the contribution of major life events. Similar findings have been found in studies that include a clinical population of cancer patients. For example, Willard, Long, and Phipps (2016) found that regardless of cancer status, cumulative events, including those that do not meet diagnostic criteria as traumatic events but are more common problems associated with school and family issues, were significantly correlated with psychological functioning. When teased apart, these common stressful events showed a greater association with psychological distress than those classified as “Potentially Traumatic Events.”

While developing The Undergraduate Stress Questionnaire (USQ) looking at stressors specific to the life of undergraduate students, Crandall, Preisler, and Aussprung (1992) found that daily hassles resulted in a similar level of perceived stress as major life events. Consequently, they argued that weighted scales were not necessary in the measure of overall stress, since their research indicated that both types of stressors contributed in a similar manner to the overall stress score. They posited that it is more essential to utilize questionnaires that include items that are salient to the subjects whose stress levels are being evaluated. For instance, a measure used with undergraduate students should contain items pertaining to college life and the school environment to accurately depict the potential overall stress of these individuals. The importance of this finding is underscored by the fact that the study participants were more likely to endorse items related to their university experience than they were to the other stressors on the measure.

When considering variables that potentially impact academic performance in first-year undergraduates, Trockel, Barnes, and Egget (2000) found that sleep habits showed the greatest association with student’s grade point averages above other variables that were measures such as perceived stress, mood, exercise, and eating habits. Additionally, they found an association between higher GPAs and strength training in these students. These findings, and those of the Legget et al. (2016) study, highlight the need to look closely at the impacting mechanisms or potentially mediating variables, in the relationship between stress and academic engagement.

**Sleep**

Sleep is essential to a variety of life’s activities. Sleep deprivation has been found to impair motor performance, cognitive performance, and even mood (Pilcher & Huffcutt, 1996; Pilcher & Walters, 1997). Some of the areas of cognitive functioning that have been shown to be impacted by sleep disturbances include: working memory, attention, perseveration, cognitive flexibility/inflexibility, creative thinking, decision making, and long-term memory (Alhola & Polo-Kantola, 2007; Harrison & Horne, 1998; Horne, 1988; Redline et al., 2007). In Pilcher and Huffcut’s (1996) meta-analysis of 56 studies examining the impact of sleep loss on performance in adults, study results indicate that cognitive abilities were more impaired than motor abilities. Interestingly, they found that a partial sleep deprivation versus long- or short-term deprivation had the most profound detrimental influence on cognitive performance tasks. This is significant in that the majority of students do not experience full sleep deprivation as measured by above or below 45 total hours of total deprivation. Students are more likely to experience the partial deprivation of less than five hours of sleep in a 24-hour period. In this light, the findings of Pilcher and Huffcut’s meta-analysis have particular relevance to the functioning of undergraduate students.

**Sleep and Neurobehavioral and Cognitive Functioning**

Multiple studies have evaluated the impact of sleep on the behavioral and cognitive functioning of children and adolescents (Dahl, 1996; Lavigne et al. 1999; Randazzo, Muehlbach, Schweitzer, & Walsh, 1998; Sadeh et al., 2003; Touchette et al., 2007). Reinforcing the findings of the meta-analysis discussed above, Sadeh et al. (2003) found that even subtle changes in sleep can affect neurobehavioral functioning in children (mean age = 10.6). In this study, sleep habits were either altered by an average of 41 minutes decreased sleep over three nights (restricted sleep group) or by an average 35 minutes increased sleep over the same time period (extended sleep group). Individuals with an increased sleep time showed a better performance on neuropsychological tasks that include skills such as processing speed, attention, memory, and scanning.

Likewise, in another study addressing the relationship between sleep duration and behavioral/cognitive functioning in young children, Touchette et al. (2007) found that a one hour reduction in nightly sleep was correlated with a decreased performance on a picture vocabulary test (a measure of receptive vocabulary and verbal intelligence) and the Block Design subtest of the Wechsler Intelligence Scale for Children – Third Edition (WISC-III—a measure of visual/spatial skills and nonverbal intelligence). The authors postulate that decreased duration of sleep may influence language acquisition by impairing the integration of new words into memory. Similar findings by Randazzo et al. (1998) demonstrated in adolescents that restriction of sleep for just one night showed a decrease in executive function which they described as being involved in the “retrieval of knowledge from long-term memory” along with involvement in other functions (p. 866). In children,even small sleep deficits have been found to impair working memory tasks. In support of this notion, a study by Sadeh et al. (2003) documented increased memory performance in children with only a half hour sleep extension. Seventy-seven children in the fourth or sixth grade were evaluated using an actigraph watch (which measures motor activity and sleep-wake patterns in a child’s natural setting) and a sleep-wake diary (which documented self-reported assessments of daytime fatigue, perceived duration to fall asleep, etc.). The watch was worn by participants for five nights, two of which were meant to establish a baseline and three nights to evaluate the treatment conditions. In order to assess their neurobehavioral functioning, the children were given a series of six tests including three that involved working memory: symbol-digit substitution (where the child must identify a rearranged group of digits and symbols from a short presentation of a nine-figure sequence), visual digit span (where the child must recall a visually displayed sequence of numbers), and serial digit learning (where the child must recall verbally presented sequences of numbers). Neurobehavioral functioning was first assessed on the second morning to establish baseline and then again on the sixth morning (at the same time of day) after the treatment of either one hour sleep restriction or extension had been in effect for three nights. The study found that, with just a 35-minute sleep extension, children showed a significant improvement in memory related activities such as digit span forward as compared to children with no change in sleep duration or sleep restriction.

**Sleep and Academic Engagement/Achievement**

Sleep impairments have a profound influence on the functioning of students in various ways but possibly the most significant effect is in the academic setting. One aspect of student functioning that is significantly impacted by insufficient sleep, and is also essential for success in the classroom, is academic engagement. When transitioning to college, students acquire a new level of independence that often involves having changes in responsibility and new demands for self-motivation and self-control. Students need to be responsible for their own learning, academic engagement, and outcomes. As a result, identifying ways to maximize AE becomes essential to the support and success of college students.

Academic engagement is vital for academic learning and success, as it is comprised of variables essential to positive academic outcomes.A number of key variables that are impacted by stress and self-care practices, and that comprise the foundation for scholastic achievement, are found as part of the definition of AE (e.g. executive functioning such as attention, working memory, and organization; mood; grades).

Numerous studies have discussed the negative impact of impaired sleep on aspects related to achievement. Turner et al. (2007) found that the span of working memory is associated with total sleep deprivation. In another study, working memory scanning speed showed no learning improvement when the participant was sleep deprived, whereas performance improved over time when the subject got adequate sleep (Casement, Broussard, Mullington, & Press, 2006). Casement et al. (2006) found a 58% increase in learning for adults who had eight hours of sleep a night as compared to those that only had four hours. These findings are notable in that the lower sleep group did not show deficits when compared to their baseline. It was only over the course of days and in the context of progressive learning that there appeared to be a differential impact.

Sleep patterns and their relationship with academic performance have commonly been evaluated for children and adolescents. For example, several studies have found correlations between sleep behaviors and achievement (Dewald et al., 2010; Sadeh et al., 2003; Wolfson & Carskadon, 1998). Perfect, Levine-Donnerstein, Archbold, Goodwin, and Quan (2014) investigated the impact of sleep problems in children and adolescents and found that impaired sleep was predictive of lower reported grades and school problems. Based on a meta-analysis by Dewald et al. (2010) analyzing the impacts of sleep variables such as sleepiness, sleep quality, and sleep duration on cognitive functioning and academic performance in children and adolescents, it is clear that these influences are not necessarily the same across age groups and separate investigations are necessary to illuminate the specific impacts involved with older students. Accordingly, several researchers have focused on examining this relationship specifically in undergraduate students or across multiple age groups (Gilbert & Weaver, 2010; Gomes et al., 2011; Oginska & Pokorski, 2006; Pagel & Kwiatkowski, 2010; Trockel et al. 2002).

Gilbert and Weaver (2010) postulated that sleep quality may have a more robust impact on academic performance than psychopathology. They noted that few university psychologists are assessing sleep when working with college students and that “sleep quality is seldom a direct target of therapeutic interventions” (p. 298). Controlling for depression, the former authors evaluated the effects of sleep quality and sleep deprivation on the academic performance of university undergraduates. Participants (mean age = 19.46), screened to rule out depression, were provided multiple measures to determine a global sleep quality (GSQ) score. A significant negative correlation between GSQ and GPA was found, indicating that poorer sleep quality was associated with decreased performance. Sleep length was also found to be a predictor of GPA, in that lower sleep duration was also associated with lower GPA. Their findings suggest that impaired sleep significantly impacts academic performance independent of the influence of depression. The authors argue that sleep habits of undergraduate students are poor, and sleep education programs at the college level that focus on sleep hygiene may be beneficial.

A noted limitation of the aforementioned study by Gilbert and Weaver (2010) is the potential for mediating factors influencing the relationship between sleep quality and academic performance. As an example, they suggest that poor sleep may lead to other negative behaviors (e.g. truancy) that may be the true source of lower performance. In another study, Gomes et al. (2011) also evaluated the impact of sleep on undergraduate students. In this study, a broad swath of potential predictors of academic achievement were tested such as attendance, study time, substance usage, exercise, neuroticism, age, and sex, among others, to help determine the specific impact of aspects of impaired sleep on college students and whether sleep shows a significant impact when including other potential predictors of performance (total of 30 potential predictors, four of which were sleep related). Using stepwise multiple regression, five significant predictors of school marks were identified in order of magnitude: previous academic achievement, class attendance, frequency of getting enough sleep, night outings, and sleep quality. Interestingly, the association between exercise and GPA was found to have a non-significant association with school marks so exercise was not included in the final model. However, exercise was measured simply as number of hours of exercise per week, with no information regarding the level of intensity or duration of the exercise. Other studies have found an association between exercise and academic performance (e.g., Burton & VanHeest, 2007; Castelli, Hillman, Buck, & Erwin, H., 2007; Coe, Pivarnik, Womack, Reeves, & Malina, 2006; Fedewa & Ahn, 2011). Thus, findings from the previous study may relate more to an issue with dose threshold for physical activity as discussed later. Also, the other two potential sleep predictors evaluated (sleep phase and regularity of sleep schedule) were not found to be significant.

Decreased levels of rapid eye movement (REM) sleep, a stage of sleep characterized by increased dreaming, has also been shown to have detrimental effects on the consolidation of learning (De Koninck, Lorrain, Christ, Proulx, & Coulombe, 1989), which helps explain the findings of Gomes and colleagues (2011). Since this stage of sleep often occurs later in a night’s sleep, reductions in overall sleep or in the early morning when it occurs most, may have a detrimental effect on learning and retention of knowledge.

Previous research by Trockel et al. (2000) identified sleep habits as the top predictor of academic performance. By evaluating a set of health-related variables in college students, they found that sleep habits had the largest impact on grade point averages. However, unlike the findings from the study by Gomes et al. (2011), the variables with the highest predictive value were those related to wake-up times. In looking further into the aspects of sleep most impacted by disordered sleep behaviors, Pilcher et al. (1997) found that not only is sleep quantity a factor in influencing many of life’s functions, but that sleep quality is important with health, mood, life satisfaction, and even more influential on levels of sleepiness. This is significant because Singleton and Wolfson (2009) have shown that not only sleep quantity, but also factors such as daytime sleepiness are strong predictors of GPA.

The findings of Gomes et al. (2011) are in line with a review of the effects of sleep reduction by Banks and Dinges (2007) that discussed how sleep reductions of only a few hours per night, accumulated over several nights, can lead to neurobehavioral deficits similar to those found with full sleep deprivation. Specifically, they explained how research has shown that a reduction in sleep over the course of multiple nights can result in impairments in mood, alertness, cognitive functioning, and health factors including detrimental effects on endocrine (increased weight gain and BMI), immune, and cardiovascular responses/systems. In a summary of those aspects of sleep that are influencing achievement, Gomes and colleagues stated, “we may assume that four fundamental sleep patterns are expected to be associated with academic achievement: sleep quantity, sleep quality, sleep regularity, and sleep phase schedules” (p. 787).

Oginska and Pokorski (2006) also provide support for the negative impact of sleep deprivation, in the form of insufficient sleep, on cognitive and affective functioning. By addressing three age groups (adolescents age 14-16, university students age 20-27, and young employees age 30-45) they were able to determine that adolescents showed the biggest discrepancy between the amount of sleep they desired and the amount of sleep they were getting a night. When looking at the impact of sleep deficits across all groups, deficits resulted in universal decline in aspects such as daytime fatigue, apathy, feeling drowsy upon waking, concentration issues, fatigue upon awakening, overall weakness, and reduced inclination to put forth effort. Relating these deficits to the multi-faceted construct of academic engagement, it is clear that impaired sleep has a myriad of implications in the success and engagement of undergraduate students. Feeling fatigued, lacking concentration, and reduced effort were found to be the areas most correlated with sleep loss in university students. Issues of this kind can impact many of life’s functions, including academic engagement and subsequent scholastic success. More specifically, deficits in these areas may have the greatest impact on the “skills engagement” factor of academic engagement, which is defined by concepts such as “putting forth effort,” “listening carefully in classes,” and “coming to class every day.” Although a relationship was seen for the overall group, apathy was correlated with sleep loss in the adolescent group but was not one of the strongest correlates for the (university) student group. “Emotional engagement” is the factor most tied to the concept of apathy with items such as “finding ways to make the course interesting to me.” Reluctance to put forth effort and difficulties with daytime sleepiness and concentration were highly correlated in undergraduates. These results suggest that emotional engagement may not reflect the same impact of sleep loss as other areas of academic engagement in college students.Consequently, skills engagement characteristics of attendance and active engagement in the form of taking notes, completing homework, and being organized are likely the areas of engagement most influenced by issues with sleep quality and quantity.

**Sleep Habits in Adolescents and Young Adults**

Sleep difficulties are a growing problem, particularly with undergraduate students whose sleep schedules, sleep environments, increased autonomy, and circadian shifts result in circumstances of reduced sleep times and sleep quality (Brown & Buboltz, 2002; Brown, Buboltz, & Soper, 2001; Pilcher et al. 1997). In a study on the sleep habits of university students, Bulboltz, Brown, and Soper (2001) found that students averaged just over eight hours of sleep per night, regardless of it being a weekend or weekday and that students showed close to a two-hour shift to later sleep onset and wake times on the weekend. These findings suggest that sleep disturbances or problems with sleep were reported by 73% of the students. Additionally, issues regarding sleep quality versus sleep quantity were identified, with students reporting morning fatigue and difficulties with sleep onset latency (i.e., the time it takes to fall asleep). Notably, students perceived themselves as getting less sleep during the week than they actually received, perhaps impacting the level of perceived daytime sleepiness.

Adolescents show a phase shift in their sleeping habits, including later bedtimes and wake times. This phase delay has been documented in several studies and impacts the length and quality of sleep that adolescents receive (Brown et al., 2001; Crowley, Acebo, & Carskadon, 2007). Pair this with the responsibilities that come with independence during college, and many students struggle to have healthy sleep practices that promote academic achievement and engagement. For instance, undergraduate students show a pattern of reduced sleep quantity and quality (Gaultney, 2010; Gilbert & Weaver, 2010; Orzech, Salafsky, & Hamilton 2011). A study by Orzech et al. (2011) foundthat staying up all night was associated with lower GPAs. Interviews with students indicated experiences of impaired memory, concentration, and focus because of this sleep loss. Researchers saw improvements in the sleep length, latency, and other sleep practices of university students participating in a simple sleep education intervention. Other studies have found a link between reduced sleep and reduced academic performance. For example, a study by Gaultney **(**2010) examined sleep disorders in college students and found that 27% of students showed a risk for a sleep disorder and those students were more likely to have GPAs that fell in the range of academic jeopardy.

As compared to clinical populations who seek out support for sleep difficulties such as insomnia or other sleep disorders, college students may be less aware that their current functioning may be impaired because of sleep difficulties. For instance, sleep deprived students have been shown to rate themselves higher in cognitive performance when sleep deprived as compared to non-sleep deprived students, even though their performance was significantly more impaired (Pilcher & Walters, 1997). Consequently, it is important to teach and reinforce healthy sleeping habits for these students (Brown & Bulboltz, 2002). Additionally, students with misperceptions of positive sleep behaviors are more likely to have more impaired sleep habits (Hicks, Lucero-Gorman, & Bautista, 1999). Reducing sleep problems in these students can help reduce academic failure, and potentially improve school retention rates.

**Sleep Hygiene**

A student’s behaviors and choices are integral to the quality and quantity of sleep they receive. Certain conditions and practices have been found to be more conducive to sleeping well (Bootzin, & Stevens, 2005; Cho et al., 2013). For instance, light, noise, caffeine, alcohol, sleep schedules, delayed circadian phase, discomfort, rumination, naps, exercise near bedtime, and being upset at bedtime have all been associated with impaired sleep (Brown & Bulbotz, 2002; Brown et al. 2001; Mastin, Bryson, & Corwyn, 2006; Stepanski & Wyatt, 2003). There are various steps we can take to optimize our sleep and improve aspects of functioning that benefit from adequate sleep.

Sleep hygiene includes behaviors related to improved sleep conditions as well as sleep quantity and quality. According to Stepanski and Wyatt (2003) the aspects that are commonly associated with sleep hygiene include consistent/variable sleep bedtimes/waking; light and noise conditions; naps/homeostatic pressure; impact of stimulants/depressives including alcohol, caffeine, and prescription medications; exercising close to bed time; spending time in bed while not sleeping, for example, watching television, reading, etc.; performing mental activities, planning, etc. in bed or just before bedtime; and poor sleep conditions/bedding.

In a study looking at the impacts of sleep hygiene on infants and children, Mindell, Meltzer, Carskadon, and Chervin (2009) found that poor sleep hygiene practices were associated with reduced sleep quantity and quality. For instance, late bedtimes were associated with extended sleep latency times. Additionally, obtaining less sleep (i.e. shorter night’s rest) was associated with late bedtimes, caffeine consumption, lack of a consistent bedtime routine, and having a television in the bedroom.

Delayed Sleep Phase Syndrome (DSPS) is characterized by later sleep onset and wake times, and has been associated with negative academic performance (Brown et al., 2001; Trockel et al., 2000). Brown et al. (2001) studied how college students experience DSPS and found that 11.5% of participants had symptoms consistent with DSPS. The difference between weekday and weekend bedtimes and wake times was significant, indicating that students showed a phase delay in both cases. Additionally, students reported sleep disrupting behaviors such as napping during the day, issues with sleep latency, in addition to general sleep difficulties

While developing a sleep hygiene inventory, Mastin et al. (2006) assessed 632 university students to determine the relationship between sleep hygiene practices and adequate sleep. The Sleep Hygiene Index (SHI) correlated with all areas of poor sleep hygiene and sleep hygiene was related to sleep quality. Additionally, the SHI showed good test-retest reliability. The items included on the SHI were identified by looking at the sleep hygiene diagnostic criteria found in the International Classification of Sleep Disorders from the American Sleep Disorders Association (1990).

Specifically, the Sleep Hygiene Index (SHI) has been found to be significantly correlated to sleep quality, subjective daytime sleepiness, and other sleep hygiene indices (Brown, Buboltz, & Soper, 2002; Cho et al., 2013; Mastin et al., 2006). Based on an evaluation of the Sleep Hygiene Index, Cho et al. (2013) proposed that the SHI would be more appropriately broken down into two factors, including “sleep disturbing behavior” and “irregular sleep-wake schedule.”

Sleep hygiene is commonly used in the treatment of insomnia. In a non-clinical population of university students, Brown et al. (2002) found that sleep practices are associated with quality sleep for this population, as well, and that specific items showed more significance, such as variable sleep schedules, worrying at sleep onset, and being thirsty at bedtime. In addition, the aforementioned researchers discussed how, at the university level where students often live in dorms, noise in the environment was also significantly linked to sleep quality. However, it would be difficult to change this variable using positive sleep hygiene practices, as it is often outside of the student’s control.

**Exercise**

Physical exercise and fitness have been shown to have a plethora of beneficial impacts on cognition, executive control, learning, academic achievement, mood, self-esteem, attention, working memory, and general health (Budde, Voelcker-Rehage, Pieta, 2008; Colcombe & Kramer, 2003; Eveland-Sayers, Farley, Fuller, Morgan, & Caputo, 2009; Fedeway & Ahn, 2011; Hillman, Castelli, & Buck, 2005; Hillman, Erickson, & Kramer, 2008; Kall, Nilsson, & Linden, 2013; Kristjansson, Sigfúsdóttir, & Allegrante, 2010; Pontifex, Hillman, Fernhall, Thompson, & Valentini, 2009). In a meta-analysis looking at the effects of physical activity/fitness on children’s achievement, Fedewa and Ahn (2011) analyzed 59 studies from 1947 to 2009 and found a significant positive effect on both achievement and cognitive outcomes. These findings are similar to findings in previously conducted meta-analyses that established a similar relationship between exercise and cognitive outcomes (Etnier, Nowell, Landers, & Sibley, 2006; Sibley & Etnier, 2003). Although most areas of evaluated physical activity yielded significantly positive results, the meta-analysis showed that aerobic exercises resulted in the largest impact on cognitive functioning and academic achievement (Fedewa & Ahn, 2011). One area of physical activity that did not show significant results was that of flexibility. A study completed by Pontifex et al. (2009) also found positive effects of aerobic activity. In this study, aerobic exercise was found to result in a larger reduction in response time for working memory when compared to alternative experimental conditions that included resistance exercises or seated rest. Additionally, results from the study by Fedewa and Ahn suggest that as exercise activity levels increase so do academic achievement levels. It is also interesting to note that the area of achievement most affected in these children was mathematics, followed by positive effects on reading achievement and IQ.

As further evidence of the association between physical activity and academic performance, a study completed by Kall et al. (2013) utilized a school-based physical activity intervention: The “School in Motion Program” with a group of 5th graders to determine whether the program impacted the students’ academic achievement-related goals. Findings from this study indicate that academic achievement rates improved with the implementation of this intervention. Kall et al. (2013) discuss how physical activity is often seen as a competing entity against academic activities. However, as they explain, research has shown that time spent in exercise interventions does not show a negative impact on academic endeavors (Ahamed et al., 2007, Rasberry et al., 2011; Singh, Uijtdewilligen, Twisk, van Mechelen, & Chinapaw, 2012; Trudeau & Shephard, 2007). Moreover, Kall et al. (2013) identified potential benefits associated with physical activity as they related to academic achievement, which include improved concentration, attention, and other enhanced behaviors conducive to learning, as well as the potential for increasing self-efficacy, reducing stress, inducing arousal, and enhancing mental health.

Studies by Rasberry et al. (2011) and Singh et al. (2012) both investigated the relationship between physical activity and academic performance through a systematic review of the literature. Based on the review of 50 related research studies, Rasberry et al.’s study findings suggest an association between school-based physical activity and academic performance, including achievement, cognitive functioning, attitudes related to school, and academic behaviors such as organization, attendance, and on-task behaviors. Although they found a somewhat comparable number of studies reflecting no changes in academic performance as a result of physical activity, subsequent research by Singh et al. (2012) found a significant and positive relationship between activity and performance. In their review, they used inclusion standards allowing for longitudinal and intervention-based studies only, for which results are more reliable.

The prevailing evidence indicates that physical activity is essential to academic success at earlier stages in education. Consequently, it seems evident that it is important to examine the potential impacts of exercise as they pertain to university students. In their research, Nelson, Gortmaker, Subramanian, and Wechsler (2007) elucidated the tendency for vigorous physical activity (VPA) to decrease from adolescence to adulthood, showing that VPA decreases from high school to college. They also explained that “physical activity is understudied in the college setting,” which supports the need for more research on students of this age level (p. 495).

**Exercise Types and Dosages**

As mentioned above, all types of exercise do not affect academic performance equally. Various research studies have evaluated, or found as part of a larger study, the types and dosages at which exercise shows the most beneficial impacts (Coe et al., 2006; Fedewa & Ahn, 2011, Pontifex et al. 2009). For instance, Fedewa and Ahn (2011) described in their meta-analysis, “In terms of how much physical activity to provide students, a related finding of the current analysis revealed that physical activity provided three times per week exerted the strongest effect on children’s cognitive outcomes and achievement.” (p. 531).In looking at how activity levels affect achievement in children, Coe et al. (2006) found that moderate levels of physical activity did not impact academic performance, while vigorous exercise was significantly associated with higher achievement. They postulate that this may be based on a “threshold level of physical activity” at which the beneficial impacts of exercise occur (p. 1517).

In research by Galper et al. (2006) evaluating the impact of exercise on mental health, they classified physical activity into four groups including inactive (< 1), insufficiently active (1-10), sufficiently active (11-19), and highly active (>=20) based on miles per week of walking, jogging, and running. Although a dose-response was seen for the effects of physical activity level, they found no significant differences between the sufficiently active and highly active groups when it came to the impact on depressive symptoms and emotional well-being. They theorize that the dose-response reaches a plateau at the equivalent of 30 minutes of (almost) daily aerobic activity.

Buckworth and Nigg (2004) found that different sedentary behaviors were negatively correlated with exercise or physical activity. They found that utilization of discretionary time in university students is often based on gender, with females more likely to watch television and males more likely to spend time on the computer versus exercising. When looking at time spent studying, positive correlations were seen in females for strength training, and with average duration of exercise in both sexes.

Shephard (1996) proposed an explanation for the observed impact of physical activity on achievement, arguing that exercise promotes attention by reducing boredom and increasing arousal. He also raised the possibility that self-esteem may play a role, but argued it is an unlikely explanation in his research given the conditions of his study.

**Exercise and Self-Esteem**

One of the four factors of Academic Engagement identified by Handelsman et al. (2005) is “performance engagement” and a component of that is “being confident that I can learn and do well in the class.” Self-esteem is intrinsically linked to self-confidence. The effects of exercise on global self-esteem were evaluated in a study by Spence et al. (2005). They did a quantitative review of the literature and found a small but significant increase in self-esteem associated with exercise and a larger effect size when there were significant changes in physical fitness.

Kristjansson et al. (2008), showed not only a positive correlation between physical activity and academic achievement, but a similar link between physical activity and increased self-esteem in a study evaluating adolescents in Iceland. However, confirming the skepticism of Shephard (1996), they found that self-esteem was a weak mediator of the relationship between physical activity and increased academic performance, stating, “the influence that health behaviors have on academic achievement appears mostly to take place outside the impact of self-esteem” (p. 62). However, they claim that this lack of mediation on the part of self-esteem “supports the notion that adolescent engagement in healthy behavior remains important if societies wish to simultaneously improve both the health status and academic-achievement goals of young people” (p. 62).

**Exercise and Stress**

Exercise has been shown to reduce stress and improve emotional well-being. For instance, as a study by Manger and Motta (2005) indicated, a 12-session aerobic exercise intervention improved the symptoms of PTSD, anxiety, and depression. Moreover, a study by Puterman et al. (2010) found a significant moderating effect of exercise on the impact of perceived stress levels on telomere length. These researchers concluded that: “Vigorous physical activity appears to protect those experiencing high stress by buffering its relationship with telomere length” (p. 1). Another study by VanKim and Nelson (2013) showed that, in a sample of over 14,000 undergraduate students, participants who were most physically active were less likely to be stressed or have poor mental health.

The current study investigates how the self-care practices of sleep hygiene and physical activity mediate/moderate the relationship between stress and academic engagement, and which variables are most predictive of AE and its factors. Research has shown that academic engagement is correlated with positive outcomes for achievement and school completion (Finn & Rock, 1997; Fredricks, Blumenfeld, Paris, 2004). Stressful Life Events have been implicated in hindering various aspects of academic engagement, including specifically achievement. It is important to understand whether the impact of other protective factors such as positive sleep behaviors and regular exercise can improve academic engagement for university students who are experiencing elevated levels of stress. In other words, if faced with similar stressors, are these self-care practices associated with or impact the likelihood of improved academic engagement?

**CHAPTER 3**

**METHODOLOGY**

**Participants**

The current research is based on previously collected data. Participants included 203 undergraduate students who were part of the educational psychology research pool at a large southeastern university. Of the participants, 159 were female and 44 were male. The class status of the participants included 50 freshmen, 51 sophomores, 56 juniors, and 44 seniors. Two individuals did not report a class status. Ten individuals endorsed “Asian” as their ethnicity, 40 endorsed “Black,” 23 endorsed “Hispanic,” 129 endorsed “White,” and nine endorsed “Biracial.” The majority of the participants fell into the two youngest age groups 18-19-years-old (*N* = 88) and 20-21 (*N* = 88). Of the remaining participants, 25 were in the 22-25 age range, zero in the 26-30 age range, and two in the 31 and above group. Participant demographics are summarized in Table 1.

The participating students were provided the option of completing a research review paper or participating in this study to fulfill a research requirement for their course. This option was provided to students in 3-4 classes over the course of multiple semesters. Participants were also obtained from other psychology and education courses.

**Procedures**

The participants were asked to first complete a consent form and then multiple questionnaires either at home (if they were part of the educational psychology research pool), or for those students outside the research pool, during a period provided during their class period. Participants were asked to complete all questionnaire answers on a Scantron sheet and return them during the next class period. The participants were instructed to include their names only on the consent form, and on no other documents. All study procedures previously received IRB approval at the home university and at the current institution – add more once IRB complete.

**Measures**

The included questionnaires were meant to determine the following: student’s demographics including age, ethnicity, class standing, and gender; the Undergraduate Stress Questionnaire (USQ) to measure recent stressful life events, the Sleep Hygiene Index (SHI) to measure positive sleep practices, the Leisure Time Exercise Questionnaire (LTEQ) to evaluate exercise habits; and the Student Course Engagement Questionnaire (SCEQ) to determine self-reported levels of academic engagement.

**Undergraduate Stress Questionnaire (USQ).** Unlike other stress measures, the USQ is a self- report questionnaire specifically targeted toward university students, providing items relevant in the life of an undergraduate student such as “assignments in all classes due the same day,” “having roommate conflicts,” “working while in school,” “death (family member or friend),” “problems with your computer,” and “lack of money” (Crandall et al, 1992). It is comprised of 82 common stressful life events and students were asked to indicate which events have occurred within the last semester using a yes/no format of “it happened to me” or “it did NOT happen to me.” As indicated by the research on stress, the questionnaire likewise shows positive correlations with physical symptoms and negative correlations with mood (Crandall et al., 1992). In research by Crandall et al. (1992) the USQ showed adequate test-retest reliability, split-half reliability, and internal consistency. Each student’s score is a total sum of stressful life events ranging from 0-82.

**Sleep Hygiene Index (SHI).** In order to evaluate the use of sleep hygiene practices, the current study utilized the Sleep Hygiene Index (SHI). The SHI is a self-report measure comprised of 13 items rated on a five-point scale ranging from 0 (never) to 4 (always). It is a brief measure in comparison to previous, lengthier assessment instruments, showing satisfactory validity and reliability, including good test-retest reliability (r = .71, p < .001), internal consistency, and construct validity (Mastin et al. 2006; Cho et al., 2013). The SHI provides good rationale for item selection. In fact, “The Sleep Hygiene Index was positively correlated (p < 0.01) with all associated features of inadequate sleep hygiene” as based on “the diagnostic criteria for inadequate sleep hygiene in the International Classification of Sleep Disorders (American Sleep Disorders Association, 1990)” (Mastin et al., 2006; pg 226 -check how to cite the page #). Items include “I use alcohol, tobacco, or caffeine within 4 hours of going to bed or after going to bed,” I use my bed for things other than sleeping or sex (for example: watch television, read, eat, or study,” and “I go to bed at different times from day to day” (Mastin et al., 2006; pg. 226). Although in the original research high scores indicated more maladaptive sleep hygiene practices, while lower scores demonstrated better sleep hygiene, the current study presented the items with reverse rankings (Always = 1, Never = 4) in order to enhance interpretability: high scores in this study indicate more adaptive sleep hygiene practices. The total score ranges from 1-65.

**Leisure Time Exercise Questionnaire (LTEQ).** The LTEQ is a self-report questionnaire consisting of a 5-category rating range for three levels of physical activity: “Strenuous,” “Moderate,” and “Mild” exercise. Subjects are asked about their average weekly exercise and how often they complete 20 minutes or more minutes of either strenuous, moderate, or mild exercise during their free time. The ratings range from A through E indicating “Never,” “1-2 times,” “3-4 times,” “5-6 times,” and “7 or more times” (per week). For the three levels of exercise, the questionnaire provides both descriptions of physical states one would experience at that level and specific activity examples (i.e. running for strenuous exercise and bowling for mild exercise). The LTEQ provides information on activity patterns and physical fitness (Godin & Shephard, 1985). Jacobs, Ainsworth, Hartman, and Leon (1993) found evidence to support the test-retest reliability and construct validity of the measure in their research comparing 10 commonly used physical activity questionnaires. Additionally, a study by Miller, Freedson, and Kline (1994) found positive correlations when comparing the LTEQ scores against a Caltrac activity monitor.

**Student Course Engagement Questionnaire (SCEQ).**  Handelsman et al.’s (2005) SCEQ includes 23 items that are loaded onto four factors, including Factor 1 – Skills Engagement, Factor 2 – Emotional Engagement, Factor 3- Participation/Interaction Engagement, and Factor 4 – Performance Engagement. The measure shows reasonable reliability and internal consistency, including discriminant validity within the measure (Handelsman et al., 2005). In addition, each factor showed reliabilities above recommended levels. In a regression analysis looking at the SCEQ and midterm and final examination grades, significant predictors were seen in performance, participation/interaction, and skills engagement for midterm grades, and participation/interaction engagement for final examination grades. The questions on this measure focus on academic engagement at the “micro” scale, and, consequently, items focus on academic achievement, interest in course content, showing effort and completing work, studying, participating in class discussion, seeking help when needed, and other aspects of academic engagement. Items are rated on a 5-point rating scale, with the following instructions: “To what extent do the following behaviors, thoughts, and feelings describe you, in this course. Please rate each of them on the following scale: a = *not at all characteristic of me*, b = *not really characteristic of me*, c = *moderately characteristic of me*, d = *characteristic of me*, e = *very characteristic of me*.” Total engagement scores range from 23-115, while score ranges for the individual factors are as follows: skills = 9-45, emotional = 5-25, participation/interaction = 6-30, and performance = 3-15.

**Statistical Analyses**

Statistical analyses will be completed using R statistical version 3.4.1. R is a free, open source statistical software package for computing, plotting, etc. The statistical programming language R will be used to evaluate the specific aims and hypotheses as laid out in Chapter 1. Before addressing the specific questions of the present study, demographic differences in the data were evaluated as they are related to the dependent variable, including age, gender, ethnicity, and class standing. using either *t*-test, ANOVA, or linear regression modeling as appropriate.

**CHAPTER 4**

**RESULTS**

For all analyses described below, regression assumptions to include but not limited to issues regarding multicollinearity, high leverage data points (outliers), and homogeneity, normality, and independence of residuals were evaluated and addressed where relevant. In regard to high leverage data points, respondent #33 was removed from the data set before final analyses as it showed properties of a significant outlier. Demographic information for the removed participant indicate a white, female senior between the ages of 20-21. Talk about means of variables?

The Bonferroni method was used to account for multiple tests needed for multiple Ys, and subsequent alpha inflation, set p=.01 or lower would be equivalent to p=.05 with the five iterations of dependent variable (Y). Therefore, all analyses used the requirement of p<0.01 for significance.

**Demographic Variables of Participants**

Demographic variables for the participants are summarized in Table 1. Out of 203 participants there were 199 complete data sets used for analyses. Counter to methods outlined in the original questionnaire research, the Sleep Hygiene (SH) variable was collected with low scores indicating poorer hygiene practices in order to improve interpretability. Additionally, coding found on the stress factor (1=occurrence of the stressor and 2=NO occurrence of the stressor) was corrected post hoc so that the total stress amount reflected the total number of stressors (changed so that 0=NO occurrence of the stressor).

|  |  |
| --- | --- |
| Table 1  *Demographic Characteristics of the Sample.* | |
| Variable | N |
| Participants | 203 |
| Gender |  |
| Female | 159 |
| Male | 44 |
| Age |  |
| 18-19 | 88 |
| 20-21 | 88 |
| 22-25 | 25 |
| 26-30 | 0 |
| 30+ | 2 |
| Ethnicity |  |
| Asian | 10 |
| Black | 40 |
| Hispanic | 23 |
| White (Non-Hispanic) | 121 |
| Biracial/Mixed | 9 |
| Class Standing |  |
| Freshman | 50 |
| Sophomore | 51 |
| Junior | 56 |
| Senior | 44 |
| N/A | 2 |
| *Note.* | |

**Correlations of Independent and Dependent Variables**

The correlations of all main effects with Academic Engagement (AE)/factors can be found in Table 2. For total AE, sleep hygiene is the only significantly correlated independent variable (p<.001). When looking at the individual factors of AE, results show a significant, negative relationship of stress with the skills engagement factor (p<.01), and a highly significant positive association between sleep hygiene and skills AE (p<.0001). Sleep hygiene was also positively correlated with the performance AE factor (p<.01). No significant correlations were found for either the emotional factor or the participation/interaction factor when compared against the independent variables.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2  *Pearson product-moment correlations.* | | | | | | | | |  |
|  | AE | Skills | Emot | Part/int | Perf | Stress | SH | Exercise |
| Total Academic Engagement (AE) | -- |  |  |  |  | .055 | .254\*\* | .089 |
| Skills |  | -- |  |  |  | .242\*\* | .349\*\*\* | .072 |
| Emotional |  |  | -- |  |  | -.066 | .048 | .180! |
| Participation/interaction |  |  |  | -- |  | -.122 | .097 | .041 |
| Performance |  |  |  |  | -- | .112 | .212\* | -.113 |
| Stress | -.026 | -.205\* | .109 | .150! | -.109 | -- | -.306\*\*\* | .113 |
| Sleep Hygiene (SH) | .254\*\* | .349\*\*\* | .048 | .097 | .212\* | .327\*\*\* | -- | -.055 |
| Exercise | .089 | .072 | .180! | .041 | -.113 | -.054 | -.055 | -- |
| Mean | 45.92 | 17.30 | 9.99 | 10.54 | 8.19 | 43.04 | 41.33 | 46.86 |
| *SD* | 7.14 | 2.99 | 2.51 | 2.86 | 1.42 | 11.53 | 6.09 | 14.83 |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001; red numbers are the correct ones after correcting the stress data | | | | | | | | |  |

The independent variables of stress and sleep hygiene showed a highly significant intercorrelation (p<.0001). The scores from the three levels of physical activity (strenuous, moderate, mild) were combined using a weighted sum with the individual weights outlined in the work of Godin & Shephard (1985). Their formula attributes higher weights to exercise of greater intensity, which is consistent with the greater impact of high intensity exercise previously documented (Coe et al., 2006; Fedewa & Ahn, 2011). However, when run against overall academic engagement and each of the four factors of AE, no correlations were found between exercise and any of the included variables.

**Mediation Analyses of Sleep Hygiene**

To determine if sleep hygiene has a mediating effect on the relationship between stress and AE, a mediational approach as outlined by Baron & Kenny (1986 – cite in references) and further explained in a paper by Muller, Judd, and Yzerbyt (2005) was utilized. Using a linear model, the dependent variable (AE/factors) was first regressed on stress (independent variable) to determine if the effect was significant. A significant p-value (.003) was found on the estimate for skills engagement only (see Table 4). In a second step, sleep hygiene was regressed on stress and a significant, negative effect was found (β=-0.580, p-value = 0.000009).

In the third and final step, a linear model was utilized regressing AE on both stress and sleep hygiene. Sleep hygiene showed an independent effect on the outcome variable for total AE (β=0.312, p-value = 0.000157), skills engagement (β=-0.155, p-value = 0.000009), and performance engagement (β=-0.046, p-value = 0.007). The effect of stress on the dependent variable was reduced due to the addition of sleep hygiene for both the skills engagement factor (from β= -0.053 to β= -0.028) and performance engagement factor (from β= -0.013 to β= -0.006). Since an independent effect of stress on the dependent variable was only seen for the skills factor and not for the performance factor, it appears that a potential mediating effect of sleep hygiene is only occurring for the skills factor and not the other factors or total AE. The addition of sleep hygiene in the model resulted in what is referred to as the indirect effect via the mediator (βdifference for stress = -0.025).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Table 3  *Mediation analyses for effect of sleep as mediator in relationship between stress and AE/factors.* | | | | | |
|  | | β1 | | p-value | β2 | p-value |
| Step 1: Model Y = β0 + β1 Stress + ε | |  | |  |  |  |
| Total Academic Engagement (Y) | | -.006 | | .887 |  |  |
| Skills (Y) | | -.053 | | .003\* |  |  |
| Emotional (Y) | | | .024 | .122 |  |  |
| Participation/interaction (Y) | | | .037 | .033 |  |  |
| Performance (Y) | | | -.013 | .123 |  |  |
| Step 2: Model Sleep = β0 + β1 Stress + ε | | | -.580 | .000009\*\*\* |  |  |
| Step 3: Model Y = β0 + β1 Stress + β2 Sleep + ε | | |  |  |  |  |
| Total Academic Engagement (Y) | | | .045 | .299 | .312 | .000157\*\* |
| Skills (Y) | | | **-.028** | .120 | .155 | .000009\*\*\* |
| Emotional (Y) | | | .030 | .064 | .038 | .210 |
| Participation/interaction (Y) | | | .049 | .007\* | .073 | .032 |
| Performance (Y) | | | **-.006** | .505 | .046 | .007\* |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001 | | | | |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table 4  *Moderational analyses for effect of exercise as moderator in relationship between stress and AE/factors.* | | | | | | |  |
|  | β1 | p-value | β2 | p-value | β3 | p-value |
| Model Y = β0 + β1 Stress + β2 Exercise + β3 Stress\*Exercise + ε | | | | | | |
| Total Academic Engagement (Y) | .226 | .070 | .285 | .020 | -.006 | .042 |
| Skills (Y) | -.034 | .520 | .042 | .426 | -.0005 | .666 |
| Emotional (Y) | .094 | .037 | .105 | .018 | -.002 | .077 |
| Participation/interaction (Y) | .171 | .0008\*\* | .141 | .005\* | -.003 | .005\* |
| Performance (Y) | -.019 | .477 | -.020 | .448 | .0002 | .733 |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001 | | | | | |

**Moderation Analyses of Exercise**

To evaluate exercise as a moderator of the relationship between stress and AE/factors, a moderation model was employed (Muller et al., 2005). The individual and interaction estimates are outlined in Table 4. Significance for the influence of exercise and the interaction of stress and exercise was only seen in the model for participation/interaction engagement. In that model, participation/interaction engagement was high when one or the other independent variables was high. The significant, albeit small, interaction effect between stress and exercise lowered performance in participation/interaction when both levels were high or low, instead of resulting in the expected additive effect of the two variables on participation/interaction. The interaction shows a negative relationship on participation/interaction, depressing participation/interaction when both variables are either high or low together. No other influences of exercise were seen. (Add plot)

**Predictive Model using Random Forest Analyses and Nested Model Comparisons**

In order to determine the variables that would explain the most variance in AE and the factors of AE, a Random Forest approach was utilized. Results of the Random Forest analysis can be found in Table 5, including variable importance measures for all potential predictor variables. Variable importance was measured by the average increase in residual sum of squares (RSS) across all regression trees when each variable was omitted. Generally, when looking at the RSS measure, the demographic variables showed the least importance, with ethnicity and class variably showing the most among demographic variables. The variables used in a final multiple regression model to predict AE were subsequently determined through a nested model, forward selection process with variables added in order of importance as determined through the random forest analysis. Nested model likelihood ratios were utilized to determine whether added variables improved the predictive ability of the model. If the addition of a variable resulted in a non-significant likelihood-ratio test, that variable and all subsequent variables were left out of the final model. For total AE the best fit model included only sleep hygiene (β=0.286, p-value=0.0002) since the addition of the variable deemed of secondary importance in the Random Forest analysis (stress) did not add to the explained variance when comparing the nested model through an ANOVA likelihood ratio (p-value=0.299).

Notably, the model for skills included both stress (β=-0.053, p-value=0.003) and sleep hygiene (likelihood-ratio p-value = 0.000009) before showing no added explanation of variance with the addition of exercise (likelihood-ratio p-value = 0.113). In the final model the estimate for stress changed from β=-0.053 to β=-0.028 and lost significance, while the estimate for sleep hygiene was significant at β=0.155, p-value = 0.000009. This effect is likely a result of the relationship between the independent variables of stress and sleep hygiene as outlined in the mediation analysis described above.

For the emotional and participation/interaction factors of AE there was only one variable fit to the final model, with stress (β=-0.024, p-value=0.122) for emotional engagement and also stress (β=-0.037, p-value=0.033) for participation/interaction engagement. Adding sleep hygiene in the emotional model and exercise in the participation/interaction model did not significantly improve fit (explanation of variance).

The performance factor of AE was similar in model specification as found in that of skills engagement. (“The addition of ------ added significantly to the prediction of ---, resulting in the --- percent of variance. The direct path from ----- to blank, controlling for ----, was non-significant whereas the other paths were sign.”) The inclusion of both stress (β=-0.013, p-value=0.123) in the initial model and sleep (β=0.045, p-value=0.007) in the combined model improved the explanation of variance (likelihood-ratio p-value = 0.007), but the model was not improved by the addition of exercise (likelihood-ratio p-value = 0.156). Notably, the stress variable was not significant in either the stand-alone model (β=-0.013, p-value=0.123) or the final, combined model (β=-0.006, p-value=0.505), while the estimate for sleep was significant when added. Table 6 includes all final predictive models with estimates for the variance explained by each included independent variable.

**Confirmatory Factor Analysis for Academic Engagement Measure (SCEQ)**

A Confirmatory Factor Analysis (CFA) was completed to test the factor loadings as outlined in findings by Handelsman and colleagues (2005) in their development of the Student Course Engagement Questionnaire (SCEQ). They found evidence for the initial validation of the measure and a breakdown into four factors: skills engagement, emotional engagement, participation/interaction engagement, and performance engagement. Results of the CFA employed here show that the user model versus the baseline model have a Comparative Fit Index (CFI) = 0.826, a Tucker-Lewis Index (TLI) = 0.804, a Root Mean Square Error of Approximation (RMSEA) = 0.090 (90% Confidence Interval 0.081-0.098), and a Standardized Root Mean Square Residual (SRMR) = 0.088, which demonstrate limited fit. The factor loadings from the original research and the current study are outlined in Table 7.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TABLE 7. |  |  |  | | |  | |  | | |  | |  | |  | | |
| *Confirmatory Factor Analysis of Factor Structure of Student Course Engagement Questionnaire* | | | | | | | | | | | | | | | | | |
|  | Factor 1  (Skills) | | | Factor 2  (Emotional) | | | | Factor 3  (Part/int) | | | | | Factor 4 (Performance) | | | | |
| Items | *Orig* | *New* | | *Ori* | | *New* | | *Orig* | *New* | | | | *Orig* | | *New* | | |
| Making sure to study on a regular basis | .64 | .63 | |  | |  | |  |  | | | |  | |  | | |
| Putting forth effort | .59 | .54 | |  | |  | |  |  | | | |  | |  | | |
| Doing all homework problems | .57 | .61 | |  | |  | |  |  | | | |  | |  | | |
| Staying up on the readings | .55 | .55 | |  | |  | |  |  | | | |  | |  | | |
| Looking over class notes between classes to  make sure I understand the material | .53 | .51 | |  | |  | |  |  | | | |  | |  | | |
| Being organized | .53 | .58 | |  | |  | |  |  | | | |  | |  | | |
| Taking good notes in class | .53 | .66 | |  | |  | |  |  | | | |  | |  | | |
| Listening carefully in class | .51 | .55 | |  | |  | |  |  | | | |  | |  | | |
| Coming to class every day | .47 | .53 | |  | |  | |  |  | | | |  | |  | | |
| Finding ways to make the course material  relevant to my life |  |  | | .86 | | .87 | |  |  | | | |  | |  | | |
| Applying course material to my life |  |  | | .86 | | .81 | |  |  | | | |  | |  | | |
| Finding ways to make the course interesting  to me |  |  | | .54 | | .73 | |  |  | | | |  | |  | | |
| Thinking about the course between class  meetings |  |  | | .46 | | .65 | |  |  | | | |  | |  | | |
| Really desiring to learn the material |  |  | | .43 | | .52 | |  |  | | | |  | |  | | |
| Raising my hand in class |  |  | |  | |  | | .82 | .97 | | | |  | |  | | |
| Asking questions when I don’t understand  the instructor |  |  | |  | |  | | .64 | 1.02 | | | |  | |  | | |
| Having fun in class |  |  | |  | |  | | .57 | .50 | | | |  | |  | | |
| Participating actively in small-group  discussions |  |  | |  | |  | | .55 | .77 | | | |  | |  | | |
| Going to the professor’s office hours to  review assignments or tests or to ask questions |  |  | |  | |  | | .50 | .60 | | | |  | |  | | |
| Helping fellow students |  |  | |  | |  | | .45 | .41 | | | |  | |  | | |
| Getting good grades |  |  | |  | |  | |  |  | | | | .77 | | .62 | | |
| Doing well on the tests |  |  | |  | |  | |  |  | | | | .68 | | .69 | | |
| Being confident that I can learn and do well  in the class |  |  | |  | |  | |  |  | | | | .64 | | .66 | | |
|  |  |  | |  | |  | |  |  | | | |  | |  | | |
| *Note. Orig = original study, New = new data set*  All factor loadings are significant, *p*< .01. (check this) | | | | | | | | | | | | | | | | | |
|  |  |  | |  |  | |  |  | |  | |  | |  | |  |  | |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Table 6  *Final predictive models for each dependent variable (AE/factors).* | | | | | |
|  | | β1 | | p-value | β2 | p-value |
| Total Academic Engagement (AE) | |  | |  |  |  |
| Model: AE = β0 + β1 Sleep Hygiene + ε | | 0.286 | | 0.0002 |  |  |
| Skills Engagement (Skills) | |  | |  |  |  |
| Model: Skills = β0 + β1 Stress + β2 Sleep + ε | | | -0.028 | 0.120 | 0.155 | 0.000009 |
| Emotional Engagement (Emot) | | |  |  |  |  |
| Model: Emot = β0 + β1 Stress + ε | | | -0.024 | 0.122 |  |  |
| Participation/interaction Engagement (Part) | | |  |  |  |  |
| Model: Part = β0 + β1 Stress + ε | | | -0.037 | 0.033 |  |  |
| Performance Engagement (Perf) | | |  |  |  |  |
| Model: Skills = β0 + β1 Stress + β2 Sleep + ε | | | -0.006 | 0.505 | 0.045 | 0.007 |
|  | | |  |  |  |  |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001 | | | | |

Table 5

*Random Forest Variable Analyses with Variables Bolded for Importance*



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2  *Pearson product-moment correlations.* | | | | | | | | |  |
|  | AE | Skills | Emot | Part/int | Perf | Stress | SH | Exercise |
| Total Academic Engagement (AE) | -- |  |  |  |  | .055 | .254\*\* | .089 |
| Skills |  | -- |  |  |  | .242\*\* | .349\*\*\* | .072 |
| Emotional |  |  | -- |  |  | -.066 | .048 | .180! |
| Participation/interaction |  |  |  | -- |  | -.122 | .097 | .041 |
| Performance |  |  |  |  | -- | .112 | .212\* | -.113 |
| Stress | -.026 | -.205\* | .109 | .150! | -.109 | -- | -.306\*\*\* | .113 |
| Sleep Hygiene (SH) | .254\*\* | .349\*\*\* | .048 | .097 | .212\* | .327\*\*\* | -- | -.055 |
| Exercise | .089 | .072 | .180! | .041 | -.113 | -.054 | -.055 | -- |
| Mean | 45.92 | 17.30 | 9.99 | 10.54 | 8.19 | 43.04 | 41.33 | 46.86 |
| *SD* | 7.14 | 2.99 | 2.51 | 2.86 | 1.42 | 11.53 | 6.09 | 14.83 |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001; ! should I report p<.05? – no do Bonferroni adjustment and only use .01 and below; red numbers are the correct ones after correcting the stress data | | | | | | | | |  |

**CHAPTER 5**

**CONCLUSIONS/DISCUSSION**

**Research Question 1**

In the study’s first research question it was hypothesized that increased levels of life stressors would be associated with lower levels of academic engagement in undergraduate students. A significant correlation was not found for total AE, but was seen for the skills engagement factor (see Table 2). The skills factor involves engagement behaviors such as taking good notes, studying regularly, attending class regularly, putting forth effort, and listening in class. Consequently, the negative association seen suggests that the influence of high stress events may be isolated to the behaviors of engagement most highly associated with executive functioning ability. Students experiencing high levels of stressful life events may be less likely to be actively engaged in class in a manner often associated with these successful classroom behaviors (i.e. poor organization, lowered attention, missing class).

**Research Question 2**

As postulated, lower academic engagement was associated with undergraduate students who exhibit reduced levels of healthy sleep hygiene practices. The largest effects of poor sleep hygiene practices were seen in relation to skills engagement and performance engagement; factors based in executive functioning and achievement, which is consistent with the research linking sleep hygiene, and, in turn, poor sleep quality (Cho et al., 2013), with reduced achievement and impaired executive functioning (Gomes, Tavares, & de Azevedo, 2011; Gilbert & Weaver, 2010; Pilcher, Ginter, & Sadowsky, should I change to et al. for 3 authors - check? 1997). These results suggest that sleep hygiene practices may play an important part in various aspects of academic engagement which lead to successful academic outcomes such as high test scores and good grades.

**Research Question 3**

It is argued here that sleep hygiene may play a mediational role in the relationship between stress and academic engagement. More specifically, it was proposed that the influence of stress on academic engagement may be a result of the influence of sleep hygiene and not the increased stress. For instance, the effect of sleep hygiene was argued to be the true variable responsible for impacting engagement (add the MEDIATIONAL argument to the intro and lit review). In order to differentiate the specific impact of stress on academic engagement from that of sleep hygiene practices, a mediational model was employed. First, it was determined that stress and sleep hygiene are significantly, negatively correlated. In fact, stressful life events and sleep hygiene behaviors showed the highest and most significant association when looking at all the possible variable correlations. It was proposed that the negative relationship between stressful life events and academic engagement would be mediated by good sleep hygiene practices in undergraduate students. Similar to the results of the stress correlations discussed above, in the first step of the mediational process it was found that stressful life events only explained significant variance in the skills model. Consequently, skills engagement was highlighted for further mediational analysis. The second step of the process indicated a significant negative effect, in line with the correlation for sleep hygiene and stress found above. Although a mediating effect (sleep hygiene resulted in a reduced effect of stress) was seen for both skills and performance engagement, the skills engagement is the only variable that clearly shows this effect. Stressful life events did not show significance in effecting performance engagement on its own.

Sleep hygiene practices such as reducing arousing activities before bedtime, avoiding substances (caffeine, alcohol, drugs) in the hours before bed, optimizing bedroom conditions by avoiding noise/heat/etc. can be particularly relevant to the lives of younger adults such as undergraduate students who not only are at higher risk for these behaviors (Cho et al., 2013)) but often don’t realize that sleep hygiene practices can affect their sleep, and, in turn, their performance in the classroom (Pilcher & Walters, 1997). Research has shown that improved sleep hygiene is associated with improved sleep quality (Cho et al., 2013) and the results of this study show that sleep hygiene can also act to mediate the effects of stress on important engagement skills within the classroom, including potentially improving attendance, concentration, note-taking, and work effort. Consequently, it would behoove universities to look at sleep hygiene practices when providing interventions for struggling students or when evaluating programmatic planning aimed at optimizing student performance and engagement. Although performance engagement did not show the same impact from stressful life events as was seen for skills engagement, the mediation of sleep hygiene seen poses the question of whether sleep hygiene needs to be evaluated further as a significant influence on the areas of engagement related to good grades and doing well on tests.

**Research Question 4**

In addition to sleep hygiene and stress, the self-care practice of exercise was evaluated to determine its effects on academic engagement in undergraduate students. Interestingly, no associations were seen between exercise and sleep hygiene, stress, or any of the areas of academic engagement. (LOOK AT EXERCISE BROKEN DOWN INTO LEVELS AND DO ANALYSIS TO SEE IF THERE IS AN EFFECT – may not have to do this because I outlined that I would use the weighted sum.). However, when looking at the linear model as used for the moderational model described below, significant variance was explained by stress and exercise when both were included in an interaction model for participation engagement.

**Research Question 5**

Surprisingly, not only was an interaction effect seen for exercise, at least in the area of participation/interaction engagement, but the independent variables of stress and exercise both individually showed significance in increasing participation/interaction engagement. For instance, when either stress or exercise was high so was the participation/interaction factor. The hypotheses presented in this study predicted that high levels of physical activity would be associated with high levels of participation/interaction engagement as was seen with these results; however, the effects of high levels of stress on participation/interaction engagement are more surprising. It appears that increased arousal through stress may not lead to a debilitating effect on participation/interaction, but instead may be resulting in the tendency to actively pursue academic support in the form of reaching out to professors during class or office hours, asking more questions, and engaging more in discussions in the classroom.

Also surprising is the depression seen in participation/interaction scores resulting from the interaction effect of stress and exercise. Exercise was postulated as potentially moderating the impact of stressful life events on participation/interaction engagement by reducing the negative impact of stress on academic engagement. The fact that stress is seen here to have a positive impact on part eng runs counter to that theory.

These results indicate that exercise may play a different role than anticipated.

Miss-specification bias - so if model is mis-specified the coefficients are often biased toward zero, as can be seen for exercise and stress when looking at the correlations on participation/interaction factor. In this analysis, one might dismiss exercise after seeing insignificant correlations in the analysis. However, doing so would lead to missing the interaction effect seen for the participation factor. Potentially missing an important variable is the problem with variable selection and why the Random Forest method was employed to help determine appropriate model specification in the final predictive model. Does exercise moderate the relationship between stressful life events and academic engagement?

**Hypothesis 5:** I hypothesize that students with higher levels of stressful life events will experience lower academic engagement, specifically in the area of participation, if they show low levels of physical activity. Due to the fact that the positive impacts of exercise seemed to be based on a dosage-threshold, I postulate that high levels of strenuous activity will reduce the effect of stressful life events on academic engagement.

**Research Question 6**

What is the hierarchical influence of the effects of stressful life events, sleep hygiene, and exercise on academic engagement?

**Hypothesis 6:** Since self-care practices have been shown to improve various elements of engagement, an exploratory process will be used to determine how these self-care practices differentially impact academic engagement in order to further identify the aspects that have the greatest impact in influencing academic engagement in undergraduate students.

**Data Analysis 6:**I will model academic engagement as a function of the demographic variables that showed statistical significance in the initial evaluation along with stressful life events, sleep hygiene, and exercise. I will perform an exploratory analysis using multiple regression to explore the hierarchical relationship between stressful life events, sleep hygiene, and exercise, including any relevant demographic variables, as they predict academic engagement, as well as the robustness of these relationships.

**Limitations/Future Research**

Future research on screen time and sleep hygiene specific to use with electronics/cell phones/tablets.

-Misra and McKean (2000) noted not only relationships between stress and anxiety, but also stress and time management, albeit directionality between these variables was not established. – check this and talk about the aspects of increased anxiety causing better performance and anxiety and stress as an area for future research.

Can look at individual responses to stress such as coping style, etc. in future research, since research by Cameron et al. (2010) indicates that response to stressors was not a product of the level of intensity of the stressor but had more to do with the individual response to that stressor. Furniss, Beyer, Muller, 2009 also discusses how the response of parents to the stress for young children is more indicative of outcomes from stress – quantity versus quality of stressors is more important too.

Mastin – look at “more complete models of sleep hygiene in an effort to understand and explain the precipitation and maintenance of sleep hygiene related behaviors.” (pg226)

Only 2 subjects in the older group, choice of assessment measures was not under control of the researcher – pre-existing data.

**Talk about generalizability**

**APPENDIX D**

Please indicate the appropriate stressors in your life that have affected you during the past semester. Use the following scale for each item:

**It happened to me It did NOT happen to me**

**a b**

1. Death (family member or friend)
2. Had a lot of tests
3. It’s finals week
4. Applying to graduate school
5. Victim of a crime
6. Assignments in all classes due the same day
7. Breaking up with boy/girlfriend
8. Found out boy/girlfriend cheated on you
9. Lots of deadlines to meet
10. Property stolen   
    11. You have a hard upcoming week   
    12.  Went into a test unprepared   
    13.  Lost something (especially wallet)   
    14.  Death of a pet   
    15.  Did worse than expected on test   
    16.  Had an interview   
    17.  Had projects, research papers due   
    18.  Did badly on a test   
    19.  Parents getting divorce   
    20.  Dependent on other people   
    21.  Having roommate conflicts   
    22.  Car/bike broke down, flat tire   
    23.  Got a traffic ticket   
    24.  Missed your period and waiting   
    25.  Thoughts about future   
    28.  Lack of money   
    27. Dealt with incompetence at the Register's Office   
    28. Thought about unfinished work   
    29. No sleep   
    30. Sick, Injury   
    31. Had a class presentation   
    32. Applying for a job   
    33. Fought with boy/girlfriend   
    34.  Working while in school   
    35.  Arguments, conflicts of values with friends   
    36. Bothered by having no social support of family   
    37. Performed poorly at a task   
    38. Can't finish everything you needed to do   
    39. Heard bad news  
    40. Had confrontation with an authority figure  
    41. Maintaining a long-distance boy/girlfriend  
    42. Crammed for a test  
    43. Feel unorganized  
    44. Trying to decide on major  
    45.  Feel isolated  
    46.  Parents controlling with money  
    47. Couldn't find a parking space  
    48. Noise disturbed you while trying to study  
    49. Someone borrowed something without permission  
    50. Had to ask for money  
    51. Ran out of toner while printing  
    52. Erratic schedule  
    53. Can't understand your professor  
    54. Trying to get into your major or college  
    55. Registration for classes  
    56. Stayed up late writing a paper  
    57. Someone you expected to call did not  
    58. Someone broke a promise  
    59. Can't concentrate  
    60. Someone did a "pet peeve" of yours  
    61. Living with boy/girlfriend  
    62. Felt need for transportation  
    63. Bad haircut today  
    64. Job requirements changed  
    65. No time to eat  
    68. Felt some peer pressure  
    67. You have a hangover  
    68. Problems with your computer  
    69. Problem getting home from bar when drunk  
    70. Used a fake ID  
    71. No sex in a while  
    72. Someone cut ahead of you in line  
    73. Checkbook didn't balance  
    74. Visit from a relative and entertaining them  
    75. Decision to have sex on your mind  
    76. Spoke with a professor  
    77. Change of environment (new doctor, dentist, etc.)  
    78. Exposed to upsetting TV show, book, or movie  
    79. Got to class late  
    80. Holiday  
    81. Sat through a boring class  
    82. Favorite sporting team lost

You should fill in ONE circle for each item below to indicate to what extent the following behaviors, thoughts, and feelings describe you, in your courses on the following scale:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Not at all characteristic of me | **Not really characteristic of me** | **Moderately characteristic of me** | **Characteristic of me** | | **Very characteristic of me** |
| **a** | **b** | **c** | | **d** | **e** |

1. Making sure to study on a regular basis
2. Putting forth effort
3. Doing all the homework problems
4. Staying up on the readings
5. Looking over class notes between classes to make sure I understand the material
6. Being organized
7. Taking good notes in class
8. Listening carefully in class
9. Coming to class every day
10. Finding ways to make the course material relevant to my life
11. Applying course material to my life
12. Finding ways to make the course interesting to me
13. Thinking about the course between class meetings
14. Really desiring to learn the material
15. Raising my hand in class
16. Asking questions when I don’t understand the instructor
17. Having fun in class
18. Participating actively in small-group discussions
19. Going to the professor’s office hours to review assignments or tests or to ask questions
20. Helping fellow students
21. Getting a good grade
22. Doing well on the tests
23. Being confident that I can learn and do well in the class

You should fill in ONE circle for each item below to indicate how frequently you engage in each behavior on the following scale:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Always | **Frequently** | **Sometimes** | **Rarely** | | **Never** |
| **a** | **b** | **c** | | **d** | **e** |

1. I take daytime naps lasting two or more hours.
2. I go to bed at different times from day to day.
3. I get out of bed at different times from day to day.
4. I exercise to the point of sweating within 1 hour of going to bed.
5. I stay in bed longer than I should two or three times a week.
6. I use alcohol, tobacco, or caffeine within 4 hours of going to bed or after going to bed.
7. I do something that may wake me up before bedtime (for example: play video games, use the internet, or clean).
8. I go to bed feeling stressed, angry, upset, or nervous.
9. I use my bed for things other than sleeping or sex (for example: watch television, read, eat, or study).
10. I sleep on an uncomfortable bed (for example: poor mattress or pillow, too much or not

enough blankets).

1. I sleep in an uncomfortable bedroom (for example: too bright, too stuffy, too hot, too cold, or too noisy).
2. I do important work before bedtime (for example: pay bills, schedule, or study).
3. I think, plan, or worry when I am in bed

Considering a 7-day period (a week) how many times on the average do you do the following kinds of exercise **for more than 20 minutes** during your free time?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Never | **1-2 times** | **3-4 times** | **5-6 times** | | **7 or more times** |
| **a** | **b** | **c** | | **d** | **e** |

1. Strenuous exercise (heart beats rapidly). Examples: running, jogging, hockey, football, soccer, basketball, judo, roller skating, vigorous swimming, vigorous long distance bicycling
2. Moderate exercise (not exhausting). Examples: fast walking, baseball, tennis, easy bicycling, volleyball, easy swimming, dancing
3. Mild exercise (minimal effort): yoga, bowling, golf, easy walking

**1. Class Standing (Please fill in one bubble)**:

1. Freshman
2. Sophomore
3. Junior
4. Senior

**2. Ethnicity (Please fill in one bubble)**:

1. Asian
2. Black
3. Hispanic
4. White (Non-Hispanic)
5. Biracial/Mixed

**3. Gender (Please fill in one bubble)**:

1. Female
2. Male

# 4.Age (Please fill in one bubble):

1. 18-19
2. 20-21
3. 22-25
4. 25-30
5. 31 and above

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