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BEHAVIORALLY INDUCED INSUFFICIENT SLEEP SYNDROME AND INSOMNIA: PREVALENCE AND RELATIONSIHP TO DEPRESSION IN COLLEGE STUDENTS

A thesis proposal submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University

By

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Table of Contents

Abstract

Background: College students are at increased risk for general sleep issues as well as specific disorders, including Behaviorally Induced Insufficient Sleep Syndrome (BISS) and insomnia. These disorders can have deleterious daytime consequences, which can be compounded by exacerbating depression. The present study aims to establish college prevalence of BISS/insomnia, to characterize sleep characteristics in this sample, and to compare depression across BISS/insomnia.

Methods: Data from a college risk behaviors and health study (n=989) was used. Insomnia and BISS were defined as mutually exclusive disorders, using ICD-10/DSM-5 criteria, and Pittsburg Sleep Quality Index items.

Results: Overall, the results of this study characterize sleep in college students as commonly insufficient, with moderate sleep quality, normal sleep latency, and high levels of daytime sleepiness. A majority (~68%) of students were categorized as normal sleepers, followed by insomnia (~22%), and BISS (~10%). Insomnia was associated with the most depression, followed by BISS, and normal sleep, after controlling for gender and ethnicity. BISS and insomnia predicted depressive symptoms over and above potent risk and demographic factors, including ethnicity, gender, binge drinking, anxiety, and interpersonal trauma exposure.

Conclusion: These findings reinforce the importance of incorporating sleep screening into depression treatment (and vice-versa) in college students. Future research can extend the present study's findings by utilizing a longitudinal design, including additional measures, and evaluating screening/clinical interventions for this population.

Behaviorally Induced Insufficient Sleep Syndrome and Insomnia: Prevalence and Relationship to Depression in College Students

Overview

College represents a period of increased vulnerability to sleep problems (e.g., Behaviorally Induced Insufficient Sleep Syndrome and Insomnia), and depression, two problems that are both pervasive and associated with considerable negative consequences (see Table One). Insomnia and BISS represent distinct, mutually exclusive sleep disturbances. Insomnia includes: short sleep duration coupled with either 1) poor quality or 2) difficulties with sleep onset or maintenance, despite adequate opportunity for sleep (American Psychiatric Association, 2013). Behaviorally Induced Insufficient Sleep Syndrome's (BISS) includes short sleep duration accompanied by daytime sleepiness (World Health Organization, 2005). A key distinction from insomnia is that in BISS sleep restriction is *voluntary,* sleep quality is normal, and there are no difficulties with falling or staying asleep.

Table 1

Diagnostic characteristics of insomnia and BISS

	Insomnia	BISS
Duration	• ≤6.5 Hours	• ≤6.5 hours
Sleep Quality	• ***Either*** poor sleep quality	• Good sleep quality
Long Sleep Latency	• ***Or*** long sleep latency (≥30 minutes)	• Normal sleep latency (<30 minutes)
Daytime Sleepiness	• Can have daytime sleepiness but not needed for diagnosis	• Increased daytime sleepiness

College students are at risk for both BISS and insomnia, due to the convergence of biological and environmental changes associated with adolescence and emerging adulthood

(Baglioni et al., 2010). College students have recently undergone puberty-linked biological changes, including a preference for delayed sleep and wake times that make it difficult to obtain adequate sleep duration (Carskadon, Acebo, & Seifer, 2001; Crowley, Acebo, & Carskadon, 2007). Additionally, college introduces a host of unique environmental risk factors that contribute to both sleep issues, including: new peer groups, more rigorous academic responsibilities, loud sleep environments, homesickness, easy access to alcohol and increased exposure to traumatic events (Taylor et al., 2013).

Taken together, these environmental and biological factors may contribute to insomnia and BISS, which are both assumed to be highly prevalent in college students. Though insomnia is likely prevalent in college populations, there have been limited large-scale studies, and the prevalence estimates vary dramatically, from 14% to 47%, depending on diagnostic criteria (Gress-Smith, et al., 2015). Although no studies have established BISS' prevalence in college students, BISS is assumed to be highly common in adolescents because insufficient sleep and daytime sleepiness (two primary symptoms of BISS) are common (Academy of Sleep Medicine, 2005). For example, college students (or young adults ages 18-25) are recommended to receive between seven and nine hours according to new National Sleep Foundation guidelines (2015). While definitions for "insufficient" sleep are defined inconsistently throughout the literature (including anywhere from less than six through eight hours, insufficient sleep is common in college students: ~70% of college students received less than eight hours of sleep and that 25% received less than six-and-a-half hours (Lund, et al., 2010; Steptoe, Peacey, & Wardle, 2006). Further, daytime sleepiness is widespread in college students, with ~35-60% of college students reporting regular daytime sleepiness, compared to ~3-18% in the general population (American College Health Association, 2012; Oginska & Pokorski, 2006; Whittier, et al., 2014).

The high prevalence of BISS and insomnia in college students is important because insomnia and BISS are both associated with increased symptoms of depression, another problem endemic in college students. College is an critical time to screen for and understand depression given that: 1) depression rates increase with puberty, 2) 10% of college students are formally diagnosed with depression, and 3) another 30% of college students report depressive symptoms interfering with their daily functioning (American College Health Association, 2010). The relationship between insomnia and depression is well-established: insomnia is a risk and maintaining factor for depression, with more severe and chronic symptoms of insomnia predicting more severe depression (e.g., Riemann & Coderholzer, 2003). Additionally, insomnia predicts suicidal ideation, attempts, and completion (Nadorff, Nazem, & Fiske, 2010). To date, only two studies have explored the relationship between BISS and depression; both found that BISS predicted depressive symptoms and suicidal ideation in high school students. (Lee, Cho, Cho, & Kim, 2012; Sarchiapone et al., 2014). A more robust extensive body of research has consistently reported an association between insufficient sleep (without formal BISS diagnosis) and depression (e.g., Cappuccio et al., 2008).

There are several key psychological, behavioral and physiological pathways through which insomnia and BISS might relate to depression (Roane & Taylor, 2008). For example, insufficient sleep may impact quality of life, interpersonal relationships and occupational/academic functioning, which, in turn, might contribute to the onset or maintenance of depression. From a physiological perspective, circadian misalignment related to insufficient sleep might influence daytime mood and mood dysregulation (Taylor, 2008). Further, sleep loss may cause neurobehavioral alterations that contribute to depression (Taylor, 2008). Other theoretical models emphasize the psychological experience of insomnia in particular; lying

awake at night might increase rumination associated with depression or the inability to control sleep might that contribute to helpless/hopeless feelings frequently reported with depression (Taylor, 2008). Additionally, some of these proposed mechanisms are unique to the experience of insomnia, while others could be caused by short sleep duration, a symptom shared by both BISS and insomnia.). Of note, research has not yet parsed out which of the aforementioned cause(s) contribute most significantly to depression.

Further, sleep disturbances and depression share several risk and maintaining factors that may contribute to the onset and persistence of both issues, including: anxiety, traumatic experience, binge alcohol use, and female gender. For example, college students with co-morbid depression and sleep problems endorse more severe and frequent anxiety than those with sleep problems or depressive symptoms alone (Nyer et al., 2013). Similarly, alcohol misuse in college is correlated with sleep problems (e.g., insomnia; short sleep duration/daytime sleepiness associated with BISS) and predicts worse and more recurrent depression (Kenney et al., 2011). Although female gender is a risk factor for insomnia and depression, it is not yet known if female gender is a risk factor for BISS (Weissman et al., 1996). Further, trauma exposure is common in college students, exposure which is associated with the development of PTSD (Johnson, Roth, & Breslau, 2009; Germain, Shear, Hall, & Buysse, 2007). Because all of these risk and maintaining factors are particularly prevalent in college populations, it is important to understand the relationship between these risk/maintaining factors, sleep disturbances, and depression.

Additional research is needed to address some of the gaps in the extant literature, particularly differentiating between symptoms of BISS and insomnia, to provide a more nuanced understanding of the relationship of sleep problems to depression in college students. To date, it is difficult to establish prevalence rates of insomnia because it has been inconsistently

operationalized throughout the literature. Further, studies linking insufficient sleep duration with depression have failed to exclude participants with insomnia, making it impossible to determine whether it is the short sleep duration or the experience of insomnia that contributes to depressive symptoms. Similarly, studies that explore the relationship between sleep disturbances, depression, and other known risk or maintaining factors have not distinguished between BISS and insomnia. This limits our ability to understand if particular risk/maintaining factors are more common in BISS or insomnia sleep groups. A better understanding of whether sleep group moderates the relationship between known risk and maintaining factors (e.g. alcohol use) and depression is needed to provide more accurate screening in clinical practice and more nuanced future research on psychological well-being in college students.

Broadly, the present study will explore the relationship between BISS/insomnia and depressive symptoms in college students. To our knowledge, the present study represents the first to compare insomnia to BISS, as well as the first to compare their relationship to depression (and related risk/protective factors). To address these aims, survey data were divided into three sleep categories (i.e., insomnia, BISS, and sufficient sleep) to compare their depressive symptoms and several known risk factor pathways. The first aim is to establish prevalence rates for BISS and insomnia, which we expect to be commensurate with previous college student studies on insomnia and slightly inflated from adult studies on BISS. Further, this study aims to compare rates of depressive symptoms between insomnia, BISS, and normal sleep. It is hypothesized that insomnia will be associated with the highest depressive symptoms, followed by BISS and finally normal sleep. Finally, this study's third, exploratory aim will be to first determine if BISS and insomnia are associated with different pathways to depression. If BISS

and insomnia have different pathway models related to depression, then the study will compare which risk factors are more strongly associated with depression in BISS compared to insomnia.

Literature Review

Sleep in College Students

Sleep undergoes dramatic biological changes that begin with the onset of puberty and persist throughout the university years. Puberty creates profound changes in teenager's sleep-wake regulation and circadian biology that leads to a "phase delay" (i.e., a preference for later bed/wake times) (American Academy of Pediatrics, 2014). This "phase delay" shifts bed/wake times later by about two hours and is caused by changes in the two systems that regulate sleep: circadian rhythm and homeostatic sleep drive (Carskadon, Acebo, & Seifer, 2001; Crowley et al. 2007). In puberty, the circadian rhythms change to delay nocturnal melatonin secretion, which makes it more difficult to fall asleep at earlier bedtimes (Frey, Balu, Greusin, Rothen, & Cajochen C, 2009). Further, adolescents' homeostatic "sleep drive" shifts as well. Adolescents' sleep pressure builds more slowly, which further contributes to problems with falling asleep earlier (Colrain & Baker, 2011; Jenni, Achermann, & Carskadon, 2005).

These biologically-driven changes in adolescents' sleep create patterns of delayed, insufficient, and irregular sleep for high school students. Adolescents' biologically-rooted preference for later bed/wake times contributes to an "epidemic of insufficient sleep" and daytime sleepiness in high school students (American Academy of Pediatrics, 2014). Adolescents are recommended to sleep between 8.5 and 9.5 hours, but the average amount of sleep in high school seniors is less than seven hours (American Academy of Pediatrics, 2014; National Sleep Foundation, 2006). Environmental influences, like early school start times, may

partially account for high school students' insufficient sleep, given that it is difficult for adolescents to fall asleep before 11 pm and that 43% of high schools start before 8 am nationally. (American Academy of Pediatrics, 2014). Further, high school students are confronted with competing priorities that also delay bedtimes (e.g., social media, academics, other school activities). Daytime sleepiness is a common corollary to insufficient sleep: 28% of high school students report falling asleep in school once a week (National Sleep Foundation, 2006). Further, sleep habits become progressively worse throughout high school, with older students sleeping less and more irregularly. The pattern of progressively more erratic, insufficient and poorer quality sleep persists into college (Wolfson, 2010).

Sleep habits further deteriorate in the transition from high school to college, as college students sleep less, with more irregularity, and with poorer quality than high school students (Lund, et al., 2010; Pilcher, Ginter, & Sadowsky, 1997). According to new guidelines, young adults (ages 18-25) are recommended to receive between seven and nine hours, although there are no official parameters for what constitutes insufficient sleep in college students (National Sleep Foundation, 2015). Even when compared to the most liberal sleep recommendations, data indicates that college students are regularly receiving insufficient sleep: on average college students obtain around seven hours/night (Hicks, Fernandez, & Pellegrini, 2001; Lund, et al., 2010). In addition to shorter sleep duration, college students also have later bedtimes, going to sleep about an hour and 15 minutes later than high school adolescents (Lund, et al., 2010). Of note, college student sleep habits change throughout college as well; several studies have found that college students have later sleep/wake times until age 20 (around their junior year), at which point bed times/wake times begin to shift earlier again (Lund, et al., 2010; Roenneberg et al., 2004). Data indicates that college students have neither good quantity sleep nor quality, with

38.2% of college students reporting poor sleep as measured by the Pittsburgh Sleep Quality Index (Lund, et al., 2010). Additionally, the majority of college students have occasional sleep complaints, with nearly 75% reporting difficulty falling asleep, sleep disturbances, delayed sleep phase syndrome, and/or excessive daytime sleepiness (Brown, Buboltz, & Soper, 2001; Ohayon & Roberts, 2001). Moreover, college sleep issues appear to be a relatively recent phenomenon: when compared to students from the past several decades, current college students report two to five times as many sleep problems, go to sleep later and rise later, have poorer quality sleep, sleep an hour less than they did in the 1980's, and report more daytime sleepiness (American College Health Association, 2006; Hicks and Pellegrini, 1991; Lack, 1986; Moo-Estrella et al., 2005; Raybin and Detre, 1969; Webb and Agnew, 1975;).

College introduces unique environmental stressors that may increase students' susceptibility to sleep difficulties (Buboltz, Brown, & Soper. 2001). The transition from high school to college is associated with a plethora of new challenges, including new peer groups, increased academic responsibilities, easier access to drugs/alcohol, and homesickness (Taylor et al., 2013). In addition to the aforementioned environmental stressors, college students also have minimal adult supervision, maintain erratic sleep schedules, and sleep in sub-optimal sleep environments, which can exacerbate and maintain sleep issues (Taylor et al., 2013) Sleep habits are among some of the first daily habits to change in the transition from high school to college, changes which endure throughout college (Pilcher, Ginter, & Sadowsky, 1997). Although many students cope with these college-related stressors effectively, research indicates that many college students have issues with this shift; common transitional difficulties include decreased appetite, poor concentration, sleep difficulties and depression (Lee et al., 2009; Price et al., 2007). Taken collectively, the environmental stressors associated with college, coupled with

biological changes associated with adolescence, may contribute to the poor sleep habits of today's college students (Buboltz, Brown, & Soper, 2001).

The prevalence of sleep issues in college students is particularly troubling because college places new cognitive, emotional, and social demands on students that require healthy sleep habits. College academic coursework is often more rigorous than high school, requiring students to adapt by improving their attention, memory, flexibility and higher order thinking (Taylor, 2013). Sleep is necessary for this cognitive growth: insufficient/poor quality sleep is associated with deficits in attention, learning, memory, abstract thinking, and creativity, as well as with worse grades and test scores (Beebe, 2011). Further, college promotes social and emotional growth, including increased independence, navigating new peer groups, and exploring romantic relationships (Taylor et al., 2013). Sleep similarly plays a large role in these processes: insufficient/poor quality sleep is associated with emotional and affective dysregulation, less supportive peer relationships, and difficulties with impulsivity and disinhibition (Gregory & Sadeh, 2012; Harrison & Horne, 2000; Sarchiapone et al., 2014). Further, despite that college students may look physically mature, brains maturation continues until around age 25, well after the college years (National Institutes of Mental Health, 2015). In particular, neural circuitry related to emotional responses, stress reactions, perceptions of reward (and delayed gratification), and impulsivity are among the last regions to develop fully (National Institutes of Mental Health, 2015). Further, sleep directly influences these behaviors, so poor or insufficient sleep may compound these deficits in adolescents. In sum, healthy sleep habits would allow college students to meet the increased cognitive and emotional demands associated with this developmental period (Carskadon MA, Acebo C, & Seifer, 2001).

Despite that health agencies and college students themselves regularly cite sleep issues as a paramount concern, relatively little research has focused on sleep issues for college students (Oginska & Pokorski, 2006; Wolfson, 2010). For example, in a 2006 survey of 80,000 college students, participants reported sleep, depression, and stress as the most significant issues impairing their academic performance, (American College Health Association, 2006). Further, for well over a decade, the National Institutes of Health has identified adolescents (ages 12-25 years) as a high risk population for sleep problems, both in terms of the prevalence of sleep issues and in their particularly debilitating consequences (National Institutes of Health, 1997). Healthy People 2020, a Center for Disease Control organization with a ten-year plan to improve the nation's health, selected sleep as a new topic to improve, recognizing that 25% of adults receive insufficient sleep each night, which damages mental and physical health (Office of Disease Prevention and Health Promotion, 2016). A recent review on adolescents and emerging adults' sleep patterns lamented that relatively few studies have explored sleep patterns over the transition from high school to college and throughout college (Wolfson, 2010). Of the publications on sleep issues in college, the majority are related to on sleep patterns, fatigue, and academic performance, despite the prevalence of stress and depression in college (Oginska & Pokorski, 2006; Tsai & LI, 2004). Additional research is warranted that explores the relationship between common sleep difficulties (e.g., insomnia, BISS) and common mental health problems that may be related to sleep (e.g., depression).

Insomnia

Insomnia is defined by insufficient or poor quality sleep, accompanied by difficulties with sleep onset or maintenance and/or early morning awakenings (American Psychiatric Association, 201). For diagnosis according to the Diagnostic and Statistical Manual of Mental

Disorders-5 (DSM-5), these symptoms must persist regularly during the week (at least three nights/week) and for at least three months (American Psychiatric Association, 2013). According to a consensus statement of clinical guidelines for insomnia, sleep duration in insomnia is 6.5 hours or less and sleep onset latency is 30 minutes or greater (Schutte-Rodin, Broch, Buysse, Dorsey & Sateia, 2008). Of note, the presence of daytime sleepiness is *not* a requirement for insomnia diagnosis, as many patients with insomnia experience hyperarousal such that they do not notice their daytime sleepiness. Meeting a clinical diagnosis according to DSM-5 criteria is recommended for insomnia research (Lichstein, Durrence, Taylor, Bush, & Riedel, 2003), although few studies use full insomnia diagnoses (Edinger et al., 2004). While a patient must meet all of these criteria to be formally diagnosed with insomnia, many patients may suffer from symptoms of sub-threshold insomnia by meeting any of the aforementioned criteria (Taylor, 2015). In practice, researchers have inconsistently operationalized insomnia, making it challenging to obtain consistent prevalence rates and correlates (Taylor, 2013).

Available research indicates that lifetime diagnosis rates for insomnia are high; however precise estimates across the lifespan are difficult to estimate, due to wide variation in diagnostic criteria implemented throughout the research literature (Bramoweth & Taylor, 2012; Buboltz, Brown, & Soper, 2001; Sing & Wong, 2011; Taylor et al., 2011). In a literature review of 50 epidemiological studies of insomnia, Ohayon (2002) evaluated insomnia diagnostic criteria and provided aggregate prevalence ratings for the most common diagnostic categorizations. Common diagnostic categorizations included: (1) difficulty with sleep initiation/maintenance or non-restorative sleep, regardless of duration or daytime sleepiness (~33% of adults present at least one); (2) any insomnia symptoms and daytime sleepiness (~9-15% of adults); (3) dissatisfaction with the quality or quantity of sleep (~8-18% of adults); (4) official ICD/DSM

diagnostic criteria (~6% of adults). All of these prevalence rates are higher in women than men, with greater than a two-fold likelihood of insomnia (Buysse, et al., 2008).

Similarly, for college students, insomnia symptom prevalence rates in college students vary widely across the literature, from (i.e., 8.7% to 69%) (Taylor, et al., 2013; Buboltz, Brown, & Soper, 2001; Sing & Wong, 2011; Taylor et al., 2011). Studies using the DSM-IV/DSM-5 criteria for insomnia symptoms are commensurate with the general population, with between 8.7-16% of students reporting insomnia symptoms (Bixler, Vgontzas, Lin, Vela-Bueno, & Kales, 2002; Cukrowicz et al., 2006; Hardison, Neimeyer, & Lichstein, 2005; Karacan et al., 1976). For example, 13% of Naroff et al.'s (2011) sample of 583 college students reported clinically significant symptoms of insomnia (as measured on the Insomnia Severity Index), and ~12% of Roberts, Lee, Hernandez et al.'s (2004) sample reported insomnia symptoms nearly every day for the past month. Additionally a study of 2,169 high school and college students, found that approximately 25% of participants had insomnia symptoms (Ohayon, et al., 2000). Finally, Bramoweth and Taylor (2012) used slightly more stringent criteria than the DSM-5 and reported that 8.7% of college students reported difficulty falling asleep or staying asleep at least 3 nights per week, with daytime impairment, for at least 6 months (i.e., slightly more conservative insomnia diagnosis than DSM-5). Of note, college students may actually under-report the presence of insomnia. For example, in Taylor et al.'s 2013 study of 1,039 college students, of the 9.5% students who met the severity, frequency and duration criteria for chronic insomnia, 26.9% did not report insomnia as a complaint in this survey.

In addition to being highly prevalent, insomnia is also persistent, often following a chronic course and with low natural remission rates. In one population-based study of adult participants with insomnia, insomnia persisted one year later in 74% of patients and in 46% of

patients over three years (Morin et al., 2009). This finding has been replicated in other studies, with an estimated 16-42.0% of incident insomnia patients developing chronic insomnia (Buysee et al., 2008; Hohagen et al., 1993; Skapinakis et al., 2012). Further, worse incident insomnia symptoms increased the likelihood of chronicity, underscoring the importance of early intervention and screening during adolescence (Roberts, Roberts, & Chen, 2002; Morin et al., 2009).

College may constitute a particularly opportune time for screening for insomnia symptoms, given the high prevalence and persistence of insomnia, coupled with the increased risk of insomnia after puberty. Insomnia symptoms in childhood and early adolescence are relatively lower (2.2%-10.7%) than insomnia rates in late adolescence (13-16%) (Ohayon et al., 2002; Johnson et al., 2006). Among a sample of adults with chronic insomnia, 20% of participants indicated that their insomnia symptoms started before age 20, while another 11.4% began manifesting symptoms between ages 21-30 (Kales et al., 1984).

Behaviorally-Induced Insufficient Sleep Syndrome (BISS)

Behaviorally-Induced Insufficient Sleep Syndrome (BISS) is a disorder that describes volitional, chronic sleep restriction (World Health Organization, 2005). The ICD-10 outlines three primary diagnostic criteria: 1) excessive sleepiness for at least three months; 2) habitual sleep episode is shorter than age-adjusted normative data, and 3) when the habitual sleep/wake schedule is disrupted (e.g., weekends or vacation), patients sleep longer than usual (World Health Organization, 2005). Notably, BISS differs from insomnia in that people with BISS *can* go to sleep if desired (unlike insomnia, where they struggle with sleep onset or maintenance) and sleep quality is unaffected in BISS (unlike insomnia which is associated with poor sleep quality). Further, people with BISS differ from people with natural sleep need in that people with BISS

are sleepy, while people with naturally short sleep duration do not endorse daytime sleepiness (Lee, Cho, Cho, & Kim, 2012; Pallesen, et al., 2011). BISS is assumed to be common among adolescents/college students, due to a variety of factors, including: active social lives that necessitate late bedtimes, irregular sleep/wake schedules, increased academic pressure, and decreased parental supervision to enforce bedtimes (Klerman & Dijk, 2005).

Prevalence rates for BISS have not yet been well-established, for either the general population or for college students. One of the few studies on BISS estimated that ~7% of an adult clinical sample met criteria for BISS. Despite that BISS is assumed to be common in adolescents and college students according to the American Academy of Sleep Medicine (2005), few studies have explored BISS prevalence rates in adolescents. Pallesen et al.'s (2011) study on 1,285 Norwegian high school students estimated that 10.4% of adolescents suffer from BISS (defined as obtaining less than seven hours, daytime sleepiness, and two hours weekend/weekday sleep difference). In Lee et al.'s (2012) study on 8,530 7^{th}-11^{th} grade students, 18.8% met criteria for BISS (defined as sleeping less than seven hours per night); daytime sleepiness, insomnia, and snoring were treated as covariates. To date, no studies have directly measured BISS in college students. Because data do not exist for the prevalence of BISS in college students, this study will review studies on that measured two primary criteria of BISS separately: 1) insufficient sleep and 2) daytime sleepiness.

Chronic sleep restriction (a key feature of BISS) is endemic to college students. Adolescents (as traditionally defined as between ages 12-18) are recommended to receive between eight-and-a-half to nine-and-a-half hours of sleep per night, and adults are supposed to receive eight hours (National Sleep Foundation, 2015). College students are not receiving adequate sleep, as defined by either adult or adolescent criteria. The average sleep duration for

United States adolescents ranges from 7.02- 7.17 hours, according to one study of 1,125 college students and a large-scale study of 17, 645 high school students from 24 countries (Lund, et al., 2010; Sarchiapone, et al., 2014). Other studies reported that ~70% of college students received less than eight hours of sleep and that 25% received less than six-and-a-half hours (Lund, et al., 2010; Steptoe, Peacey, & Wardle, 2006).

On college campuses, daytime sleepiness (another core symptom of BISS) is a common corollary to insufficient sleep. Operational definitions of excessive daytime sleepiness vary, including anything from drowsiness to falling asleep involuntarily (Bittencourt et al., 2005; Gupta, 2002). Between 2.5% and 18% of the general population report symptoms of daytime sleepiness, and 36% of high school students report daytime sleepiness (Bixler et al., 2005; Kaneita et al., 2005; Oginska &, Pokorski, 2006; Pallesen et al., 2007; Wanson LM, et al., 2008). Daytime sleepiness rates in college students may be higher than in the high school students or the general population: 35-60% of college students report regular daytime sleepiness (American College Health Association, 2012; Oginska H, Pokorski J, 2006; Whittier, et al., 2014; Hershner & Chervin, 2014). For college students, daytime sleepiness may be caused by physiologic reasons (e.g., delayed sleep/wake cycle associated with puberty), or behavioral causes which include inadequate sleep hygiene, use of stimulants/caffeine, technology, alcohol use, or academic coursework (Hershner & Chervin, 2014).

While both insomnia and BISS are associated with reduced sleep duration, they represent distinct disorders. In people with insomnia, people cannot initiate and/or maintain sleep, despite the opportunity to obtain sufficient nocturnal rest. Insomnia is also often associated with poor sleep quality and can be associated with daytime sleepiness, although daytime sleepiness is not a required symptom of insomnia for diagnosis. In contrast, in BISS, sleep restriction is volitional

(i.e., choosing not to sleep vs. inability to obtain restful sleep), and they are, by diagnostic definition, experiencing daytime sleepiness as a result of choosing to reduce their sleep. This study represents the first study to establish prevalence rates for BISS in college students, and represents the first comparison between insomnia and BISS in their relationship to depression.

Depression

Depressive disorders are characterized by depressed mood most days, with greater intensity than normal "low" mood for a period of time (ranging from two weeks to two years, depending on the specific disorder) (American Psychiatric Association, 2015). There are a wide range of specific depressive disorders (e.g., Major Depressive Disorder, Disruptive Mood Dysregulation Disorder, Persistent Depressive Disorder, Premenstrual Dysphoric Disorder), but the present thesis proposal focuses on depressive symptoms more broadly. For people with depressive symptoms, persistent low mood is accompanied by some of the following symptoms: anhedonia, change in weight, changes in sleep patterns, psychomotor agitation or retardation, fatigue, concentration difficulties, and thoughts of death. These symptoms must cause clinically significant distress and impairment in functioning. Finally, people can suffer from depressive symptoms without meeting the full diagnostic criteria for any particular diagnosis.

Young adulthood represents a time of increased risk for depression. According to epidemiological studies, 2% of children have depression (Kaufman et al. 2001), a risk that increases with the onset of puberty to between 5-8% of adolescents, and further increases to between 10 and 17% of college students (Eisenberg, Hunt, & Speer, 2013; Haarasilta et al. 2001; Lewinsohn et al. 1994). Sub-threshold depressive symptoms are even more prevalent in college students: the American College Health Association's survey (2011) estimated that 30% of college students reported feeling "so depressed that it was difficult to function" at some time in

the past year. An additional study reported that in a sample of 1338 students (ages 18–23 years), 19% of students endorsed mild symptoms of depression, and 14.5% reported moderate to severe symptoms. Of note, women are at increased risk for depression, with higher overall depression rates than men and a 2.75-fold increased depression risk among girls after the onset of menses (Eisenberg, Hunt, & Speer, 2013; Johnson et al. 2006b).

It is critical to address depressive symptoms in college students because depression in young adulthood has cascading negative consequences and a worse trajectory than later-onset depression. Early depressive symptoms predict repeated episodes of depression and more severe depressive symptoms (Klein, Taylor, Dickstein, & Harding,1988a; (Klein, Glenn, Kosty, Seeley, Rohde, & Lewinsohn, 2013). Further, depression is associated with risky behaviors (e.g., unsafe sex, alcohol abuse and), poorer academic performance, and detrimental health consequences (e.g. weight gain, pain) in college students. Finally, depression is one of the strongest predictors of suicidal ideation, completion and attempts: the risk of suicide is twenty times greater for people with depression than those that are not depressed (Emory, 2015). Further, one in ten college students has made a suicide plan, and suicide is the 3rd leading cause of death for people aged 15 to 24 (Centers for Disease Control, 2015; Emory, 2015).

In addition to the negative consequences associated with depression, it is important to note that college students are at particular risk for several risk and maintaining factors of depression, including substance use, trauma, sleep issues, and anxiety. Alcohol use is common for college students: 80% of students drink alcohol, and about half of college students binge drink, according to the National Institute on Alcohol Abuse and Alcoholism (2015). Alcohol use predicts future depressive symptoms and exacerbates symptoms as well. Thus, it is important to better understand sleep issues and substance use's relationship to depression in college students.

Further, college students are likely to experience traumatic events throughout college: studies estimate that between 67 and 84% of college students experience a potentially traumatic event (PTE) (Marx & Sloan, 2002; Scarpa et al., 2002; Vrana & Lauterbach, 1994). Further, college students frequently endorse symptoms of anxiety, symptoms which are frequently co-morbid with depression and represent a targeted treatment opportunity. Finally, college students receive poor quality sleep and insufficient sleep, both of which predict and worsen depression.

Sleep and Depression

Traditionally, sleep problems (like insomnia and BISS) were considered to be merely symptoms of depression, appearing after depressive symptoms emerge and remitting with depression treatment. However, substantial literature now debunks this view, suggesting that sleep problems can contribute to depressive symptoms, serving as both precipitating and perpetuating factors for the onset of depressive symptoms. Available data on both insomnia and BISS suggest that sleep issues: 1) may precede depressive symptoms (Johnson, Roth, & Breslau, 2006); 2) may increase the length and severity of depression (Staner, 2010); and 3) may remain even after depressive symptoms have subsided (Perlis, Giles, Buysse, Tu, & Kupfer, 1997). Evidence from studies on Cognitive Behavioral Therapy for Insomnia (CBT-I) supports targeting insomnia as a first line of treatment. A recent meta-analysis on studies of effects of CBT-I in individuals with comorbid psychiatric and medical conditions found that CBT-I was efficacious in reducing insomnia symptoms (36.0% of patients who received CBT-I achieved remission from insomnia, s well as psychiatric and medical symptom severity (Wu et al., 2015). Thus, it is critical to understand—and ultimately target—sleep issues, like insomnia and BISS, that may contribute to depression.

Sleep issues, like BISS and insomnia, share several key psychological, behavioral and physiological pathways that may contribute depression (Taylor, 2008). For example, short sleep duration sleep may impair interpersonal relationships and occupational/academic functioning, which contributes to reductions in quality of life that, in turn, may exacerbate depression. From a physiological perspective, circadian misalignment related to insufficient sleep (both in BISS and insomnia) might influence daytime mood, and mood dysregulation (Taylor, 2008). Further, sleep loss may cause neurobehavioral alterations that contribute to depression; for example sleep deprivation causes HPA dysfunction, which increases cortisol, which in turn may contribute to depression (McCall & Black, 2013; Taylor, 2008). Other theoretical models emphasize the psychological experience of insomnia in particular: lying awake at night might increase ruminative thoughts or may trigger feelings of helplessness and hopelessness (Taylor, 2008). To date, research has not yet parsed out which cause(s) contribute most to depression. Further, some of these proposed mechanisms are unique to the experience of insomnia while others could be caused by short sleep duration, a mechanism shared by both BISS and insomnia.

Insomnia and Depression

The scientific literature has established that insomnia is related to depression, although the precise nature of this relationship and its theoretical framework are less understood. Insomnia has been demonstrated to instigate, maintain and/or exacerbate depression in longitudinal and cross-sectional analyses (Taylor, 2008). This thesis proposal will review the existing literature on prospective studies that explore the relationship between insomnia and depression and correlational studies establishing their co-morbidity.

Overall, longitudinal studies indicate that insomnia is a risk factor for the development of future depression in adolescents and young adults, although the time between insomnia symptoms and the onset of depressive symptoms varies by study (e.g., Baglioni, Battagliese, & Feige B, 2011). A meta-analysis of 21 adult studies indicated that non-depressed participants at baseline have a two-fold risk of later developing depression, compared to those without insomnia symptoms at baseline (Baglion, Battagliese, Feige, et al., 2011). An earlier meta-analysis Riemann and Voderholzer's (2002) on adults similarly reported that in seven of their eight studies, insomnia at baseline significantly predicted increased depression at follow-up; in the studies explored in this meta-analysis, patients were between 2.1-39.8 times more likely to develop depressive symptoms within three years. To date, less research has focused on adolescents/young adults; however existing literature suggests that insomnia in adolescence both predicts depression in adolescence to young adulthood (Buysse et al., 2008; Breslau, Roth, Rosenthal, & Andreski, 1996). For example, a study of ~4,500 adolescents demonstrated that insomnia symptoms during adolescence doubled the likelihood of depression in young adulthood (Roane & Taylor 2008). Self-reported symptoms of insomnia (even without meeting full criteria), coupled with poor sleep quality and sleeping under seven hours predicted future depression (Chang et al., 1997). Similarly, in a prospective study on young adults (21-30 year olds), risk for depression was four times higher in participants with a history of insomnia (Breslau et al., 1996). However, a study of ~3,000 adolescents found that the relationship between insomnia and depression symptoms was bidirectional (Roberts & Duong 2014). Thus, although there is more evidence for insomnia preceding depression than vice versa, directionality should still be interpreted cautiously (Riemann, Voderholzer, 2003; Taylor, 2008).

Forty years of research has established the comorbidity between insomnia and depression in adults (Benca & Peterson, 2008; Breslau, Roth, Rosenthal, & Andreski, 1996; Ford & Kamerow, 1989). Given that sleep issues (either too little sleep or excessive sleep) have been considered a symptom of depression since the DSM-II (1968), it is unsurprising that this comorbidity is extensively documented in adults. However, relatively few studies have explored comorbidities between the two within this population. One such study (Gress-Smith et al., 2015) reported that 29% of college students had comorbid depressive symptoms and mild to severe insomnia, rates which are consistent with studies that have separately explored the prevalence of insomnia and depression separately (Buboltz et al., 2001; Furr et al., 2001; Lund et al., 2010). Another study of 1,039 college students demonstrated that students with chronic insomnia symptoms reported more depression (26.3% vs. 8.6%) than normal sleepers. Data indicates a dose-response relationship between initial insomnia severity and subsequent depressive symptoms, wherein more severe initial insomnia symptoms are associated with increased risk for depression (Roberts, Roberts, & Chen, 2002).

Behaviorally Induced Insufficient Sleep and Depression

Currently, there is a paucity of studies exploring the relationship between BISS and depression. To date, there are only two available on BISS and depression (Lee, Cho, Cho, & Kim, 2012; Sarchiapone et al., 2014). In Lee et al.'s study (2012) of 8,530 South Korean students (grades 7-11), the adolescents with BISS endorsed higher depressive symptoms than normal sleepers. Sarchiapone et al.'s (2014) study reported similar findings: the study's 11,788 high school students (mean age 14.9, SD=0.9) across Europe found that BISS was associated with increased emotional and peer-related problem scales of the Strength and Difficulties Questionnaire scores, as well as increased suicidal ideation. Of note, BISS was more common in

older adolescents and female students. Because of the scarcity of the literature exploring directly evaluating the relationship between BISS and depression, it is necessary to extrapolate from existing studies on depression and BISS' primary diagnostic criteria (i.e., insufficient sleep and daytime sleepiness).

The cross-sectional literature on insufficient sleep (a key criterion of BISS) in adolescents has consistently demonstrated that insufficient sleep is associated with depression. Because there are no official parameters defining insufficient sleep in young adults, the literature operationalizes insufficient sleep inconsistently, most often somewhere between 8-6.5 or less (e.g., (Lund, Reider, Whiting, & Prichard, 2010; National Sleep Foundation, 2015; Steptoe, Peacey, & Wardle, 2006;). Cross-sectional studies on adults have consistently reported that insufficient sleep is associated with increased depression symptoms and suicidal ideation (McKnight-Eily et al. 2011;). Cross sectional data on high school students yields similar findings: sleep had a dose-response relationship to depression, with just one hour less of sleep per night related to significantly higher odds of depressive symptoms, suicidal ideation and suicide attempts (Winsler, Deutsch Vorona, Payne, & Szklo-Coxe, 2014). Finally, these findings are supported in college populations as well; in a study of female college students, restricted sleep was associated with greater depressive symptoms (Regestein et al., 2010).

Longitudinal studies demonstrate insufficient sleep, a key criterion of BISS, has a bi-directional relationship to depressive symptoms, (Dewald, et al. 2014; Gregory et al. 2009; Kelly and El Sheikh 2014; Roberts & Duong, 2014). For example, in Roberts & Duong's (2014) study of high school students, insufficient sleep predicted future depressive symptoms one year later, and vice versa. In addition to being a risk factor for depression, chronic sleep restriction may also serve as a maintaining factor or a factor that reduces the efficacy of treatment (e.g., Emslie et al.

2012; Hatzinger et al. 2004; Pigeon et al. 2008). In sum, the bulk of available scientific literature on adults and adolescents suggests that insufficient sleep is a risk factor that can contribute to the development of depression, worsen depressive symptoms, and even reduce the efficacy of pharmacological treatment (Baglioni et al. 2011; Benca and Peterson 2008; Riemann and Voderholzer 2003).

Daytime sleepiness (another central feature of BISS) is associated with increased depressive symptoms, although, there is less research on daytime sleepiness than on insufficient sleep. For example, in a study on adult women, daytime sleepiness was associated with an odds ratio of ~2 for both current depression and lifetime history of depression (Hayley, Williams, Berk, Kennedy, Jacka, & Pasco, 2013). Studies on adolescents similarly report a positive association between increased sleepiness and increased depressive symptoms (Lee et al., 2009; Moore et al, 2009). Finally, a cross-sectional study on college students reported that daytime sleepiness was correlated with increased depression scores (Regestein, et al., 2010). Of note, it can be quite difficult to parse out sleepiness due to insufficient sleep from depression-related fatigue, making it challenging to draw meaningful conclusions from studies on daytime sleepiness alone (Lessov-Schlaggar, Bliwise, Krasnow, et al., 2008; Tylee et al., 1999).

Other Risk Factors

BISS and insomnia share several risk/maintaining factors for depression, including interpersonal trauma exposure, anxiety, alcohol use, and female gender, all of which are highly prevalent in college students. For example, alcohol use is widespread in college, is correlated with sleep problems (e.g., insomnia, short sleep duration, daytimes sleepiness), and predicts more severe/chronic depression (Kenney et al., 2013). Similarly, anxiety is the most common mental disorder on college campus, and college students with co-morbid depression/sleep issues

endorse more severe and frequent anxiety than those with sleep problems or depressive symptoms alone (Nyer et al., 2013). Additionally, college students are likely to have significant trauma exposure, which is associated with increased insomnia and sleep issues (Breslau, 2009; Germain, Shear, Hall, & Buysse, 2007). Further, insomnia predicts more chronic and severe PTSD symptomology and is commonly comorbid with depression (Germain, Shear, Hall, & Buysse, 2007). Further, with the exception of substance use, female college students are at higher risk for virtually all of these risk factors, as well as for depression and insomnia (gender differences in BISS have not yet been studied). Finally, African Americans individuals are at increased risk for poor sleep quality, insufficient sleep, daytime sleepiness and insomnia (Baldwin et al., 2010; Petroy & Lichstein, 2016). Evidence is mixed regarding whether ethnicity influences risk for depression, with some studies reporting increased risk for African American or Hispanic individuals, while others finding no ethnic differences (Menselson, Rehkopf, & Kubzansky, 2008; Twenge & Nolen-Hoeksema, 2002; Williams, et al., 2007).

Binge Drinking. Binge drinking is common on college campuses, with significant implications for sleep and depression. According to the National Institute on Alcohol Abuse and Alcoholism (2015), 80% of students drink alcohol, and about half of college students binge drink. A dearth of literature has established that despite helping with sleep onset latency, alcohol disrupts sleep cycles, contributes to poor quality sleep, and exacerbates daytime sleepiness (Roehrs & Roth, 2001). Because alcohol is a sedative that shortens sleep onset latency, alcohol may be a particularly tempting panacea for people with sleep-onset related insomnia (Vitello, 1997). Studies on insomnia/alcohol use have yielded mixed results: some studies have demonstrated that insomnia in adolescence predicts alcohol use up to seven years later, (Roane & Taylor, 2009), while other studies have found no significant difference between normal sleepers and

students with insomnia in terms of alcohol use (Taylor et al., 2003). While no studies look at BISS specifically, literature on short sleep duration (a key criteria of BISS) in high school students has consistently demonstrated that short sleep duration (anywhere from 6.75 to 8 hours or less) significantly increased the odds of alcohol use (e.g., O'Brien & Mindell, 2005; McKnight-Eily et al., 2011; Yen, King, & Tang, 2010). Further, alcohol use relates bi-directionally to depression, as heavy drinkers have higher rates of depression (Midanik, Tam, & Weisner, 2007; Roberts, Roberts, & Xing, 2007). Of note, the relationship between insomnia, depression, and substance use may be dependent on gender: men with insomnia are more likely to develop substance use, while women are more likely to develop depression (Roane & Taylor, 2009).

Anxiety. Anxiety is the most prevalent mental disorder in college students and is highly comorbid with sleep difficulties and depression. According to a national epidemiologic survey of college students, around 12% are diagnosed with anxiety, with significantly more reporting subdromal symptoms. (Eisen-Blanco et al., 2008). Further, studies have demonstrated that insomnia may predict future anxiety and that between 24% and 36% of people with insomnia also have anxiety (Staner, 2003). Further, 36% of people with nighttime awakenings or difficulty with sleep onset report comorbid anxiety disorders (Jansson-Fröjmark and Lindblom 2008; Neckelmann et al. 2007; Breslau et al. 1996). Of people with comorbid anxiety/insomnia, ~16% also experienced depression (Roth et al., 2006). To date, no studies have explored BISS (or primary symptoms of BISS) and anxiety.

Interpersonal Trauma Exposure. In addition their risk for sleep disturbance and depression, college students are also at an elevated risk for interpersonal trauma exposure, which can exacerbate and maintain sleep difficulties and depression. Young adulthood is the highest risk

period for traumatic events across the lifespan, and between 67 and 84 percent of college students experience a traumatic event while in school (Bernat, Ronfeld, Calhoun, & Arias, 1998; Scarpa et al., 2002. Breslau, 2009). Even without PTSD, trauma exposure is associated with a two to three-fold risk of insomnia (Hall, Akeeb, & Mellman, 2015). Further, the experience of insomnia following a traumatic event may be a risk factor for the development of PTSD (Germain, 2013; Harvey, Jones, & Schmidt, 2003). To date, no literature has explored trauma-exposure and BISS (or key BISS criteria, like insufficient sleep or daytime sleepiness) (Babson & Feldner, 2010). Further, there is scant literature exploring the relationship between trauma exposure and depression, in the absence of PTSD (O'Donnell, Creamer, & Pattison, 2014). The few studies that have explored depression in trauma-exposed individuals report that trauma exposure predicts higher depression rates, even without PTSD (Mayou & Bryant, 2001; Schnyder et al., 2001). Of note, there are gender differences in trauma-exposure, with interpersonal trauma experienced more frequently by women and associated with greater risk for internalizing disorders (Amstadter, Aggen SH, Knudsen GP, Reichborn-Kjennerud, & Kendler, 2013; Pietrzak, Goldstein, Southwick, & Grant, 2011)

The Present Study

Specific Aims and Hypotheses

Broadly, this thesis proposal will explore the relationship between BISS/insomnia and depressive symptoms in college students, using data from the Virginia Commonwealth University's (VCU) "Spit for Science." To our knowledge, this thesis represents the first study to compare insomnia to BISS, as well as the first to compare their relationship to depression (and related risk/protective factors). To address these aims, survey data will be divided into three

sleep categories (i.e., insomnia, BISS, and sufficient sleep) to compare depressive symptoms and related risk factors. Specific aims include: 1a) to establish prevalence rates for BISS and insomnia; 1b) comparing sleep-related criterion between BISS/insomnia; 2) to compare rates of depressive symptoms between insomnia, BISS, and normal sleep; 3a) to first determine if BISS and insomnia are associated with different risk factors for depression, and 3b) if BISS/insomnia are associated with different risk factors for depression, to characterize these associations.

Aim 1. The first aim of the study is to examine the prevalence of BISS and insomnia among college students generally, as well as to characterize and compare BISS and insomnia on sleep-related criterion.

- *Hypothesis 1:* Prevalence rates will be commensurate with previous college student studies on insomnia and will be slightly inflated from adult studies on BISS.
- *Hypothesis 2:* BISS and insomnia will not significantly differ in terms of sleep duration.
- *Hypothesis 3:* BISS will be associated with greater daytime sleepiness than insomnia.
- *Hypothesis 4:* Insomnia will be associated with longer sleep onset latency than BISS.

Aim 2. The second aim of the study is to compare depression rates by sleep group membership, comparing across normal sleepers, people with BISS, and people with insomnia.

- *Hypothesis 5:* Insomnia will be associated with the highest symptoms of depression, followed by BISS, and, finally, normal sleep.

Aim 3. Finally, an exploratory aim of the study is to compare BISS and insomnia on demographic variables (gender, ethnicity) and common risk factors (anxiety, binge drinking, and interpersonal trauma exposure).

- *Hypothesis 6:* Sleep group membership (i.e., BISS and insomnia) will predict depressive symptoms over and above demographic variables (gender, ethnicity) and common risk factors (anxiety, binge drinking, and interpersonal trauma exposure).
- *Hypothesis 7:* If sleep group membership predicts depressive symptoms over and above gender and common risk factors, then BISS and insomnia will be associated with distinct risk factors from each other. For example, BISS might be more strongly associated with binge drinking and female gender, while insomnia might be more strongly associated with anxiety and interpersonal trauma exposure.

Method

Dataset

This thesis will utilize data from the 2011 junior cohort of Spit for Science, a longitudinal study on Virginia Commonwealth University (VCU) undergraduates (NIAA; Dick & Kendler, NIH R37 AA011408). Broadly, Spit for Science aims to examine substance use and related emotional factors. The study also includes measures of mental health, physical health, current environmental stressors, previous life experiences, and genetic influences. These constructs were measured using both self-report, survey data (offered every semester) as well as a one-time (saliva) DNA sample collected to examine genetic influences. This thesis used only the 2011 junior cohort because this is the only cohort that has received any questions pertaining to sleep.

Study Procedures

The study took place at Virginia Commonwealth University (VCU), an urban campus in Richmond, Virginia. For the cohort used in this thesis (Junior 2011 cohort), their initial recruitment began in the fall of 2011, two weeks prior to their matriculation to campus as

freshmen. At that time, all eligible freshmen (first time freshmen aged 18 years and older) were sent several email invitations to participate in an online survey, and flyers were placed around campus with details about participation. Interested and eligible students completed an online consent process, with details about participation. The online survey was designed to take 15-30 minutes, and participants were compensated $10. Study data were collected and managed using a secure, web-based application designed to support research data capture, Research Electronic Data Capture (REDCap), hosted at VCU (Harris et al, 2009). Students were also given the option to provide saliva for genetic analysis, which related to other study aims.

Subsequently, participants were invited to participate in follow-up surveys annually during subsequent spring semesters. Only students who participated in previous surveys were invited to participate in follow-up surveys, which were sent out via email. The junior 2011 cohort surveys (used in this thesis) were administered in Spring 2014. Participants completed the 15-30 minute survey online and were compensated $10. The VCU Institutional Review Board approved all study procedures, and informed consent was obtained from all study participants online. Dick and colleagues (2014) provides a full description of the project and procedures.

Participants

The sample includes participants from the 2011 cohort of juniors (n=989), the only cohort who has received sleep questions to date. Eligibility criteria included: 1) current status as a junior at VCU; and 2) completion of a survey during their freshman year (per the longitudinal study's inclusion criteria). Participants included ~66% women, and participants had a mean age of ~20.93 (SD=.69).. These demographics are similar to other college populations (Dick et al., 2013). For this wave of data, the response rate was 53%, considerably better than average

response rates (~39%) for web-based surveys in college samples, as identified by a meta-analysis (Dick et al., 2013).

Measures

Sleep

Sleep was assessed using the four available items from the Pittsburgh Sleep Quality Index (PSQI) which assessed sleep duration (free response), sleep onset latency (free response), sleep quality (1=very bad to 4=very good), daytime sleepiness ("during the past month, how often have you had trouble staying awake while driving eating meals or engaging in social activity": 1= not during the past month; 4=three or more times during the week) (Buysee, Reynolds & Monk, 1989). The full scale of the PSQI has adequate psychometric properties, including a reliability coefficient of 0.83 and specificity of .86 in distinguishing good vs. poor sleepers. Further, the PSQI has demonstrated high discriminant and convergent validity when compared to objective sleep parameters (e.g., polysomnography) and has been used in clinical and non-clinical samples. Using the PSQI items, the present study will create categorical variables for sleep group membership: insomnia, Behaviorally Induced Insufficient Sleep, and normal sleep, based on diagnostic criteria from the DSM-5 and the ICD-10 (American Psychiatric Association, 2013; World Health Organization, 2005).

Depression

Depressive symptoms were assessed with the depression subscale of the Symptom Checklist-90 (SCL-90), a self-report measure of psychological symptoms (Derogatis & Cleary, 1977). This eight-item scale assesses distress from specific depressive symptoms over the past month, with response options ranging from "not at all" (scored as 1) to "extremely" (scored as 5). The depression subscale has been demonstrated to have good reliability (Chronbach's

alpha=.87) and validity within subjects with affective disorders. (Koeter, 1992; Morgan, Wiederman, & Magnus, 1998; Printz, et al., 2013). Survey items did not include sleep-related depressive symptoms. The SCL-90 scale demonstrates high convergent validity with the Beck Depression Index (r=.8) (Beck, Steer, & Brown, 1996; Koeter 1992). Depression symptoms were summed and treated as a continuous variable.

Anxiety

The study assessed anxiety using four items from the six-item anxiety subscale of the SCL-90, a measure used in both clinical and research practices (Derogatis & Cleary, 1977). Response options ranged from "not at all" (scored as 1) to "extremely" (scored as 5), with higher scores representing worse severity. The full six-item subscale has good reliability (.82), although data for the four-item version of the scale is unavailable. Items will be summed and treated as continuous variables.

Binge Drinking

The study assessed history of binge drinking using two items developed from the Semi-Structured Assessment for the Genetics of Alcoholism (Bucholz et al., 1994). Binge drinking was treated dichotomously, with four drinks or more in a single episode for women and five or more drinks in a single episode considered binge drinking for men.

Demographics

Participants were asked to report gender, race/ethnicity, and age. Gender was coded as 0=male, 1=female). Caucasian was used as the reference group for ethnicity. We did not include age as a covariate, since there is a limited range within this student sample of juniors in college.

Interpersonal Traumatic Event Exposure

Items from the Life Events Checklist (LEC) was used to assess participants' exposure to interpersonal traumatic events (Gray et al., 2004). Assessed events included: physical assaults, sexual assaults, and other unwanted or uncomfortable sexual experiences experienced over the lifetime. Response options were dichotomized with yes/no responses. The full LEC has demonstrated adequate reliability in studies on undergraduate students, with a mean kappa coefficient of was .61, reliability of .82. The scale also demonstrates good convergent validity with the Traumatic Life Events Checklist (Gray et al., 2004). Items were summed and treated as continuous variables.

Statistical Analyses

Statistical analyses will be performed using SPSS v.22.0 (SPSS, Chicago, IL)

Data Preparation

Prior to analysis, descriptive statistics were calculated for all study variables, including: proportions, frequencies and confidence intervals for categorical variables, and means, standard deviations, and 95% confidence intervals (or medians and inter-quartile ranges if data is non-normal) for continuous variables. Subsequently, data were checked for univariate and multivariate outliers. Unless outliers reflected a data-entry error, they were included in analysis. Further, multicollinearity was examined using the variance inflation factor (values > 4 are typically considered problematic), and for the regression analyses, correlations between predictors greater than 0.80 were considered problematic. Additionally, normality, homogeneity of variance, and assumptions for regression analyses were assessed. As with previous waves of Spit for Science, there was very little low missingness included in this dataset (Dick et al., 2014). The present dataset included 51 missing participants (~5%), which is within the acceptable

parameters. For all proposed analyses, significance tests of <.05, confidence intervals of 95%, and effect size indices were reported.

Diagnostic Categorizations

Using sleep items, the present study created mutually-exclusive, categorical variables for sleep group membership: insomnia, Behaviorally Induced Insufficient Sleep (BISS), and normal sleep, based on diagnostic criteria from the DSM-5 and the ICD-10 (American Psychiatric Association, 2013; World Health Organization, 2005). While there are no official cutoffs to define "insufficient sleep," the American Academy of Sleep Medicine recommends 6.5 hours as a cutoff for insomnia and BISS (Shultte-Rodin, 2008). Per DSM-5 diagnostic criteria, insomnia was defined by the following criteria: 6.5 hours or less/ night accompanied by: (1) "very bad" or "fairly bad" sleep quality *or* (2) a sleep latency of 30 minutes or more (American Psychiatric Association, 2013). Per the ICD-10 diagnostic criteria, BISS was be defined by the following criteria: 6.5 hours or less/ night accompanied by: (1) sleep quality defined as "very good" or "fairly good," (2) a sleep latency of less than 30 minutes, *and* (3) excessive daytime sleepiness, defined as having trouble while driving, eating meals, or engaging in social activity three or more times a week (World Health Organization, 2005). BISS and insomnia are distinct, mutually-exclusive diagnostic categorizations (see Table One). Normal sleep includes participants that did not meet diagnostic criteria for BISS or insomnia.

Table 1

Diagnostic characteristics of insomnia and BISS

	Insomnia	BISS
Duration	• ≤6.5 Hours	• ≤6.5 hours
Sleep Quality	• ***Either*** poor sleep quality	• Good sleep quality
Long Sleep Latency	• ***Or*** long sleep latency (≥30 minutes)	• Normal sleep latency (<30 minutes)

Daytime Sleepiness	• Can have daytime sleepiness but not needed for diagnosis	• Increased daytime sleepiness

Statistical Analyses

Broadly, the present study examined the relationship between BISS/insomnia and depressive symptoms in college students. Specifically, this study aimed to: 1) to establish prevalence rates for BISS and insomnia (and to characterize sleep-related symptoms in each group); 2) to compare rates of depressive symptoms between insomnia, BISS, and normal sleep; 3a) to first determine if BISS and insomnia are associated with different risk factors; and 3b) to determine which risk factors are more closely linked to BISS/insomnia (if applicable).

Aim 1. **Sleep Group Characteristics and Prevalence.** To address the first aim of the study, frequency statistics were used to obtain prevalence rates of insomnia and BISS. Descriptive statistics was used to describe: (1) the percentage of respondents endorsing various sleep-related symptoms overall (e.g., the percentage reporting moderate daytime sleepiness, average sleep duration, etc.), and (2) the percentage of respondents in each of the designated sleep categories (i.e., normal sleep, BISS, and insomnia).

Further, three independent sample t-tests were conducted to determine if BISS and insomnia differ on key sleep criteria: sleep duration, daytime sleepiness, and sleep onset latency. The first (two-tailed) independent sample t-test compared BISS and insomnia in terms of sleep duration, with the hypothesis that there will not be significant between group differences. A second (one-tailed) independent sample t-test compared BISS and insomnia in terms of daytime sleepiness, with the hypothesis that BISS will have significantly higher daytime sleepiness. The final (one-tailed) independent sample t-test compared BISS and insomnia in terms of sleep latency, with the hypothesis that insomnia would have significantly greater sleep latency than

BISS. Levene's test was conducted to ensure homogeneity of variance for all t-tests.

Aim 2. **Compare Depressive Symptoms by Sleep Group.** To determine if depressive symptom severity varies significantly by the sleep types (insomnia, BISS, and normal sleep), a one-way Analysis of covariance (ANCOVA) was conducted, with ethnicity and gender treated as covariates and dummy-coded. Subsequently, paired contrasts were used to directly compare averages between the groups. Descriptive statistics for depressive symptoms were additionally calculated.

Aim 3. **Compare Risk factors for Depression across BISS and Insomnia.** Finally, two multiple hierarchical regression analyses were conducted to evaluate sleep group differences for various risk and demographic factors. The first regression compared people with insomnia to normal sleepers, while the second compared participants with BISS to normal sleep. In Step 1, demographic variables (gender, ethnicity) were added to examine the risk factors' relationship to depression. In Step 2, common risk factors (anxiety, binge drinking, and interpersonal trauma exposure) were added. In Step 3, sleep group membership (coded as either: 1) insomnia vs. normal sleep; 2) BISS vs. normal sleep) was added to determine if sleep group membership adds to the predictive value of depression above and beyond the other depression risk and demographic factors. Categorical variables were dummy-coded for these analyses. The BISS and insomnia regressions enabled us to: 1) determine if sleep group membership predicted depression over and above other risk/demographic factors and 2) compare the relative strength of the risk factors by sleep group.

Results

Descriptive Analyses

Sample participants' descriptive characteristics are displayed in Table Two. Participants were all juniors in college and ranged in age from 19 to 33 years of age (M=20.94, SD=0.69). The sample is predominantly female (N=495, 66.5%). The sample included the following racial composition: 47.1% Caucasian, 21.9% African American, 18.6% Asian, 5.3% multiracial, and 4.2% Latino.

Table 2

Participant Demographics

Variable	N	Percentage
Gender		
Female	647	65.6%
Male	332	33.6%
I choose not to answer	6	0.6%
Race		
White/Caucasian	466	47.1%
Black/African American	217	21.9%
Asian	184	18.6%
Hispanic/Latino	42	4.2%
More than one race	52	5.3%
American Indian/Native Alaskan	4	0.6%
Unknown	3	0.3%
I choose not to answer	11	1.1%
Age		
19	6	0.6%
20	595	60.16%
21	372	37.61%
22	11	1.1%
Over 22	5	0.5%

Aim 1a. **Sleep Group Characteristics and Prevalence**

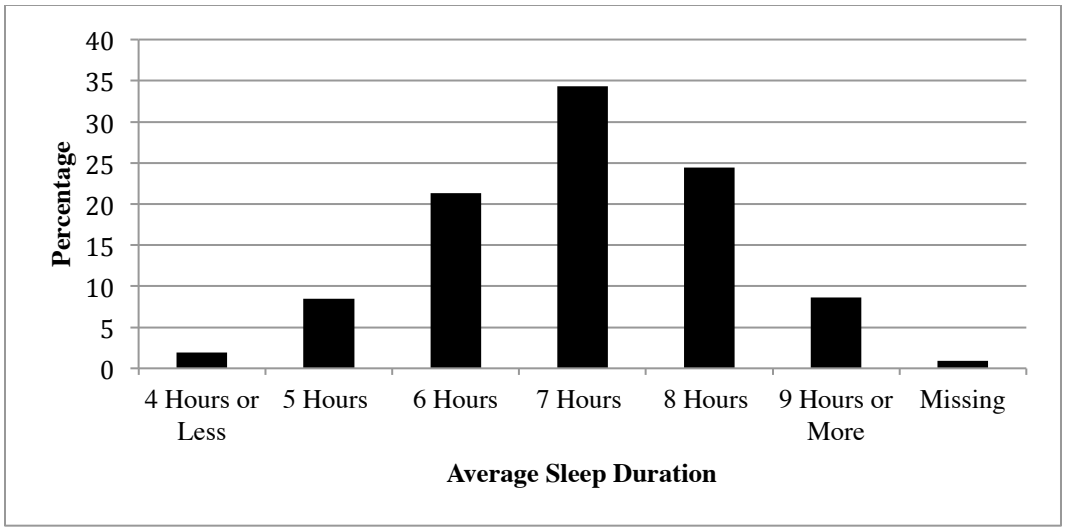
For the overall sample, key sleep characteristics and depressive symptoms were calculated. Participants commonly reported "fairly good" sleep quality (70.4%), followed by "fairly bad" (15.5%), "very good" (12.4%), and finally "very bad" (1.2%). Over the past month, 44.8% of students reported not having any trouble staying awake while driving, eating meals or engaging in social activities. An additional 31.9% reported trouble staying awake less than once a week, 16.9% reported once or twice a week, and 5.1% three or more times a week. The average sleep onset latency was 26.7 minutes (*SD*=24.9), and the majority of students (79.7%) reported falling asleep in 30 minutes or less (see Table 3). Overall, the average sleep duration was 6.9 hours, with a majority of participants (66.7%) receiving 8 hours or less. Full sleep duration results are presented in Figure 1.

Table 3.

Average Sleep Onset Latency in Minutes (min).

	Frequency	**Percent**	**Cumulative Percent**
0-15 min	417	42.2	44.8
16-30 min	324	32.8	79.7
31-45 min	61	6.2	86.2
46-60 min	92	9.3	96.1
61-75 min	4	0.4	96.6
76-90 min	14	1.4	98.1
90 or more min	18	1.8	100

Figure 1. Average Sleep Duration by Hour



Prevalence rates for BISS, insomnia, and normal sleep were calculated, along with by-group analyses of key sleep related-criterion. Of the study participants, *67.7% had normal sleep, 22.1% had insomnia symptoms, and 9.9% had BISS symptoms*. Selected sleep characteristics of interest for normal sleep, insomnia, and BISS are presented in Table 4.

Table 4

Sleep Characteristics by Group.

	Insomnia (n=218)	**BISS** (n=98)	**Normal** (n=663)
Sleep			
Duration	5.67 hrs (SD=45 min)	5.80 hrs (SD=36 min)	7.43 hrs (SD=56 min)
Quality	"Fairly bad quality" 2.45 (SD=.62)	"Fairly good quality" 3.16 (SD=.37)	"Fairly good quality" 3.07 (SD=.49)
Latency	44 min (SD=34.26)	13 min (SD-10.1)	23 min (*SD*=19.43)
Daytime Sleepiness	2.06 (SD=.98)	2.54 (SD=7.1)	1.64 (SD=.82)

Note. Min=minutes, Hrs=hours.

Aim 1b. **Comparison of BISS/Insomnia on Sleep-related Criterion**

An independent-samples t-test was performed to compare participants' average sleep duration between the insomnia subgroup (*m*=340.65, *SD*=45.45) and the BISS subgroup (*m*=347.92, *SD*=35.85). Findings indicated no significant difference between conditions,

$t(233.65)=-1.528$, $p=.128$.

A second (one-tailed) independent sample t-test compared BISS ($m=2.54$, $SD=.71$) and insomnia ($m=2.1$, $SD=.98$) in terms of daytime sleepiness, with the hypothesis that BISS will have significantly higher daytime sleepiness. There were statistically significant differences in daytime sleepiness between insomnia and BISS, $t(311)=-4.96$, $p<.001$, $d=.514$.

A third (one-tailed) independent sample t-test compared insomnia ($M=43.86$, $SD=34.23$) and BISS ($m=13.28$, $sd=10.14$) in terms of sleep onset latency with the hypothesis that insomnia would have significantly higher sleep onset latency. There were statistically significant differences in sleep onset latency between insomnia and BISS, $t(275.43)=11.83$, $p<.001$, $d=1.21$.

Aim 2. **Compare Depressive Symptoms by Sleep Group**

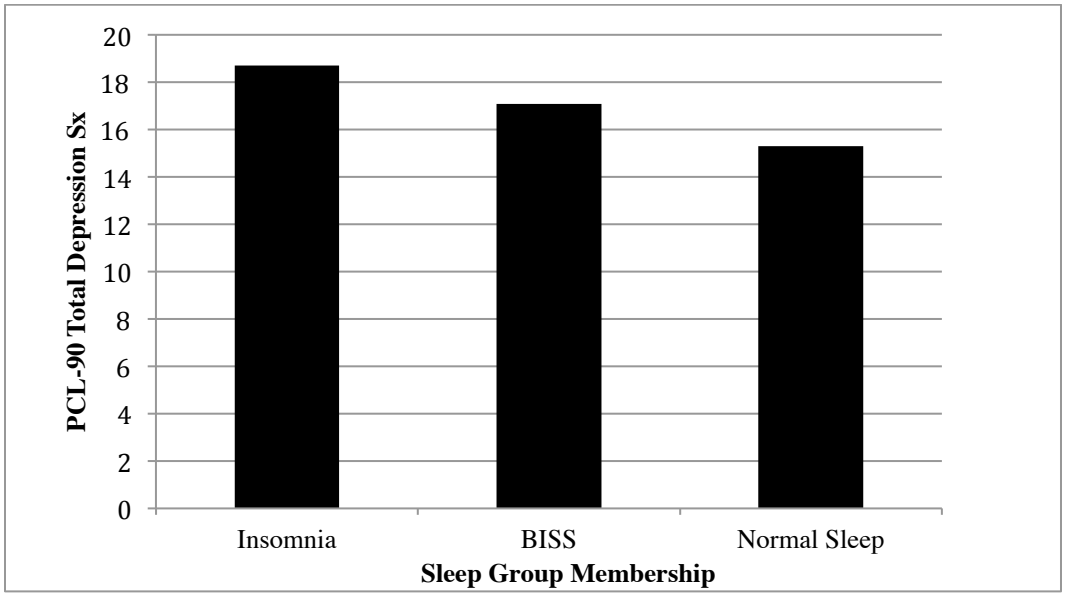
To determine if depressive symptom severity varies significantly by the sleep types (insomnia, BISS, and normal sleep), a one-way analysis of variance (ANCOVA) was conducted, controlling for ethnicity and gender. Analysis of covariance revealed a statistically significant effects of sleep group membership (insomnia, BISS, and normal sleep) on depression, $F(2,906)=20.57$, $p<.001$, which accounted for 6.7% of the variance in depression scores after controlling for gender and ethnicity (Figure 2). Prevalence for depressive symptoms are listed in Table 5

Depression Items in the Overall Sample

SCL-90 Depression Items Endorsed by Participants					
			Frequency (Percent)		
Item	*Not at all*	*A little bit*	*Moderately*	*Quite a bit*	*Extremely*
Feeling blue	*n*=236, (23.9%)	*n*=358, (36.3%)	*n*=206 (20.9%)	*n*=120 (12.2%)	*n*=44 (4.5%)
Feeling no interest in things	*n*=408, (41.3%)	*n*=293, (29.7%)	*n*=128 (13.0%)	*n*=95 (9.6%)	*n*=38 (3.9%)

Feeling hopeless about the future	*n*=477, (48.3%)	*n*=274 (27.8%)	*n*=100 (10.1%)	*n*=74 (7.5%)	*n*=39 (4.0%)
Loss of sexual interest or pleasure	*n*=640 (64.8%)	*n*=187 (18.9%)	*n*=76 (7.7%)	*n*=24 (2.4%)	*n*=17 (1.7%)
Feeling low in energy or slowed down	*n*=269 (27.3%)	*n*=340 (34.4%)	*n*=202 (20.5%)	*n*=103 (10.4%)	*n*=51 (5.2%)
Blaming yourself for things	*n*=265 (26.8%)	*n*=299 (30.3%)	*n*=209 (21.2%)	*n*=132 (13.4%)	*n*=57 (5.8%)
Feeling everything is an effort	*n*=387 (39.2%)	*n*=298 (30.2%)	*n*=136 (13.8%)	*n*=97 (9.8%)	*n*=38 (3.9%)
Feeling of worthlessness	*n*=535 (54.2%)	*n*=210 (21.3%)	*n*=105 (10.6%)	*n*=74 (7.5%)	*n*=38 (3.9%)
Overall	*n*=3217 (40.79)	*n*=2259 (28.65%)	*n*=1368 (17.35%)	*n*=719 (9.12%)	*n*=322 (4.08%)

Figure 2. Depressive Symptoms by Sleep Group



Paired contrasts were used to directly compare average depression scores between sleep groups. Planned contrasts indicated that insomnia (*m*=18.77, *SD*=.47) was associated with significantly more depression than BISS (*m*=17.16, *SD*=.70), $f(1, 170)=3.80$, $p=.05$. Further, insomnia was associated with significantly more depression than normal sleep (*m*=15.36

$f(1,1752)=39.98$, $p<.01$. Finally, BISS was associated with significantly more depression than normal sleep $f(1,239.05)=5.32$, $p=.02$.

Aim 3. **Compare Risk factors for Depression across BISS and Insomnia**

Two hierarchical linear regressions were conducted to examine whether insomnia or BISS individually predicted depression score severity above and beyond other depression risk/demographic factors (i.e., recent interpersonal trauma exposure, current anxiety symptoms, binge drinking, ethnicity, and gender). Conducting separate regressions for BISS (compared to normal sleepers) and for insomnia (compared to normal sleepers) allowed for comparison of the relative strength of the risk factors by sleep group. Assumptions for univariate and multivariate normality, linearity, and normally distributed errors were checked and met.

As shown in Table 6, the hierarchical regression for insomnia revealed that at stage one, the demographic risk factors examined initially (gender and ethnicity) were significant predictors of depression symptoms and accounted for a statistically significant 2.6% of the variance in depression symptoms. Adding other key risk factors (binge drinking, interpersonal trauma history, and anxiety) to the model significantly increased the explained variance for depression symptoms ($R^2=.56$) and contributed a statistically significant additional 54% of the variance, $F(1,878)=153.48$, $p<.001$, $d=1.21$. Adding insomnia to the hierarchical regression model contributed a statistically significant 2% of the variance, $p<.001$, $d=.009$.

Table 6. *Hierarchical Regression Model Examining the Relations Among Risk Factors, Insomnia, and Depression Symptoms*

	Beta	T	Sig.	Adjusted R Square	F Change	Sig. F Change
Step 1:				.03	6.55	.00
Female gender	.11	3.25	.00			
Ethnicity						
AA	-.14	-3.89	.00			
Asian	-.03	-.70	.49			
Other	.01	.34	.74			
Step 2:				.54	153.48	.00
Female gender	-.04	-1.67	.10			
Ethnicity:						
AA	.00	.14	.17			
Asian	.01	.49	.63			
Other	.03	1.37	.17			
Interpersonal Trauma	.11	4.56	.00			
Binge Drinking	-.04	-1.52	.13			
Anxiety	.74	30.92	.00			
Step 3:				.56	136.50	.00
Female gender	-.04	-1.60	.11			
Ethnicity:						
AA	-.01	-.13	.90			
Asian	.01	.51	.61			
Other	.03	1.17	.24			
Interpersonal	.10	4.23	.00			
Binge Drinking	-.04	-1.54	.13			
Anxiety	.73	30.43	.00			
Insomnia	.07	2.88	.00			

As shown in Table 7, the hierarchical regression for BISS revealed that at stage one, the demographic risk factors examined initially (gender and ethnicity) were significant predictors of depression symptoms and accounted for a statistically significant 2.6% of the variance in depression symptoms. Adding other key risk factors (binge drinking, interpersonal trauma history, and anxiety) to the model significantly increased the explained variance for depression symptoms (R^2=.559) and contributed a statistically significant additional 56% of the variance, f(1,759)=153.48, p<.001, d=1.209. Adding BISS to the hierarchical regression model contributed a statistically significant 4% of the variance, f(6,759)= 114.78, p=.002, .d=007.

Table 7. *Hierarchical Regression Model Examining the Relations Among Risk Factors, BISS, and Depression Symptoms*

	Beta	T	Sig.	Adjusted R Square	F Change	Sig. F Change
Step 1:				0.03	6.55	.00
Female gender	0.11	3.25	0.001			
Ethnicity						
AA	-.14	-3.89	.00			
Asian	-.03	-.70	0.49			
Other	0.01	0.34	0.74			
Step 2:				0.56	153.48	.00
Female gender	-.040	-1.67	0.10			
Ethnicity:						
AA	0.00	0.14	0.89			
Asian	0.01	0.49	0.63			
Other	0.03	1.37	0.17			
Interpersonal Trauma	0.11	4.56	.00			
Binge Drinking	-.04	-1.52	0.13			
Anxiety	0.74	30.92	.00			
Step 3:				0.60	136.10	.00
Female gender	-.04	-1.77	0.08			
Ethnicity:						
AA	0.00	0.11	0.91			
Asian	0.01	0.38	0.71			
Other	0.03	1.37	0.17			
Interpersonal	0.11	4.59	0			
Female gender	-.04	-1.77	0.08			
Binge Drinking	-.036	-1.53	0.13			
Anxiety	0.74	30.92	0			
BISS	0.06	2.63	0.01			

Discussion

Overall, the results of this study characterize sleep in college students as commonly insufficient, with moderate sleep quality, normal sleep latency, and high levels of daytime sleepiness. Further, this study found that both BISS and insomnia were prevalent in this sample, with approximately one-third of students having one of the two disorders. Additionally, depressive symptoms were common in college students, and both BISS and insomnia were associated with differentially increased risk for depression. Finally, BISS and insomnia both predicted depressive symptoms over and above demographic and other risk factors.

Sleep Characteristics

This study provided insight into the general sleep habits of college students, including their sleep duration, quality, daytime sleepiness, and sleep onset latency. Many adults in this sample received insufficient sleep. Young adults (ages 18-25) are recommended to receive between seven and nine hours per night (National Sleep Foundation, 2015). In the present study, students had an average sleep duration of 6.9 hours, which is consistent with other studies' findings for college students (Hicks, Fernandez, & Pellegrini, 2001; Lund, et al., 2010). A vast majority of students in this sample (91%) received eight hours or less, and ~67% received seven hours or less, which was slightly worse than previous findings that ~70% of college students received less than eight hours of sleep (Lund, et al., 2010; Steptoe, Peacey, & Wardle, 2006). Sleep duration influences students' overall mental and physical health, underscoring the clinical significance of the finding that students are chronically receiving insufficient sleep in the present sample and throughout the empirical literature.

On average, students described their sleep quality as "fairly bad" to "very good." Notably, a substantial minority endorsed "fairly bad" (15.5%) or "very bad" sleep quality (1.2%). While this is a considerable portion of students, these findings are better than might be anticipated based on the extant literature. Previous studies reported that ~38% of college students endorsed poor sleep quality, as measured by the Pittsburgh Sleep Quality Index (Lund, et al., 2010). While there is limited literature on how sleep quality changes throughout college, existing studies have demonstrated that sleep habits improve during junior year of college, with weekend/weekday bedtimes becoming more consistent and bed/wake times shifting earlier (Lund, et al., 2010). It is conceivable that the marginally better sleep quality found in the present study may be attributable to sample's status as juniors in college.

As may be expected due to the prevalence of insufficient sleep and/or low quality sleep, daytime sleepiness was common in this sample. Over the past month, 44.8% of students reported not having any trouble staying awake while driving, eating meals or engaging in social activities. An additional 31.9% reported trouble staying awake less than once a week, 16.9% reported difficulty once or twice a week, and 5.1% reported difficulty three or more times a week. Previous studies have found a similar proportion (35-60% of college students) reported regular daytime sleepiness (American College Health Association, 2012; Hershner & Chervin, 2014; Oginska H, Pokorski J, 2006; Whittier, et al., 2014;). Operational definitions of excessive daytime sleepiness vary, including anything from drowsiness during non-stimulating activities to falling asleep involuntarily (Bittencourt et al., 2005; Gupta, 2002). Of note, the level of daytime sleepiness assessed by this study reflects high impairment, particularly when compared to other common measures. For example, the Epworth Sleepiness Scale (considered the gold standard self-report for daytime sleepiness assessment) measures the chance of dozing during less

engaging activities, like sitting and reading, watching television, sitting as a passenger for an hour, sitting after lunch, etc. (Johns, 1991). The proportion of students who reported trouble staying awake during the much more engaging activities assessed in this survey may be experiencing more substantial daytime sleepiness.

The majority of students (79.7%) reported sleep onset latencies of 30 minutes or less. American Academy of Sleep Medicine (2008) consensus guidelines consider a sleep latency of more than 30 minutes to be clinically significant. The average sleep onset latency was 26.7 minutes, which may be inflated due to a substantial portion (13.8%) of participants stating that it took them 45 minutes or more to fall asleep. Few studies have estimated sleep latency in college students, so comparisons are limited. However, long sleep onset latency is associated with rumination, feelings of hopelessness, and lack of control, all of which can perpetuate or maintain depressive symptoms (Taylor, 2008).

Insomnia and BISS

For the present study, prevalence rates for insomnia (~22%) were consistent with the existing literature on college students (Schutte-Rodin, Broch, Buysse, Dorsey & Sateia, 2008). Previous research estimated that 12% to 25% of college students experience insomnia, with studies on the lower end of this range reflecting more stringent DSM-5 diagnostic criteria (Naroff et al.'s 2011; Ohayon, et al., 2000; Roberts, Lee, Hernandez et al.'s 2004). Notably, the present study's insomnia estimate is considerably lower than the upper range of adult studies' insomnia estimates, which vary drastically, from 33% to 85% (Buyssee et al., 2008). Studies with these higher prevalence estimates had less stringent diagnostic criteria (e.g., presenting difficulty with sleep initiation/maintenance or non-restorative sleep, regardless of duration), did

not exclude BISS from their estimations, or included intermittent insomnia (vs. chronic insomnia).

Prevalence rates for BISS (~10%) were slightly lower than anticipated, based on existing adolescent studies. As this is the first study to evaluate the prevalence of BISS in college students, direct comparisons are limited. Extant literature estimated BISS to affect 10-19% of adolescents and 7% of adults (Lee et al., 2012; Pallensen et al., 2011). Given college students' sleep biology, their proclivity to stay up late/sleep late, and the college pressures to curtail sleep for academics or social activities, it was hypothesized that BISS' rates would be more similar to adolescent than adult studies (Hershner & Chervin, 2014; Klerman & Dijk, 2005). The present study's prevalence rate of ~10% is on the lower end of previous findings for adolescents and most similar to adult rates for BISS. The slightly lower than anticipated rate may be attributable to the present study's conservative daytime sleepiness measure and/or that other studies on insufficient sleep rarely excluded participants with insomnia in their estimations.

Insomnia and BISS did not significantly differ on sleep duration, sleeping respectively an average of 5.67 hours vs. 5.80 hours. It was hypothesized that there would not be between group differences on sleep duration, given that shortened sleep duration (≤6.5 hours) was diagnostic criteria for both BISS and insomnia. Because insufficient sleep duration alone has been consistently linked to increased depressive symptoms, it was imperative to confirm that there were not significant between-group differences in sleep duration that might be driving differential depressive symptoms (McKnight-Eily et al. 2011; Winsler, Deutsch Vorona, Payne, & Szklo-Coxe, 2014; Regestein et al., 2010). The similar sleep durations between insomnia and BISS indicates that between-group differences depressive symptoms were not attributable to sleep duration alone and may have been related to symptoms unique to BISS or insomnia.

Daytime sleepiness was significantly more common in students with BISS than in students with insomnia, which was consistent with the study's hypothesis. Daytime sleepiness was a requisite diagnostic criterion for BISS; however daytime sleepiness was neither a requirement nor was it an exclusionary criterion for insomnia. Further, some subtypes of insomnia are not associated with daytime sleepiness. For example, for some patients with insomnia, their hypothalamic-pituitary-adrenal axis system is hyper-aroused, which makes sleep difficult at night and limits sleepiness during the day (Wollweber & Wetter, 2011). Differences in daytime sleepiness between insomnia and BISS are meaningful because daytime sleepiness—even in the absence of other sleep-related symptoms—predicts depression (Hayley, Williams, Berk, Kennedy, Jacka, & Pasco, 2013). Thus, for participants with BISS, it is a possible that daytime sleepiness may be a driving force for depressive symptoms.

As hypothesized, students with insomnia experienced significantly greater sleep onset latency than those with BISS. Students with insomnia reported taking an average of 44 minutes to fall asleep, compared to 12 minutes for students with BISS. Sleep onset latency (SOL) is a key criterion for insomnia diagnosis (as well as an exclusionary criteria for BISS), so these between-group differences were expected. Long sleep onset latency was expected to be unique to insomnia and posed a possible mechanism through which insomnia might contribute to depression. While there have been limited papers experimentally linking long SOL to depression, theoretical papers posit several explanations for how long SOL in insomnia may influence depression (Taylor, 2009). For example, the experience of lying awake in bed at night is linked to increased rumination, feelings of hopelessness, and lack of control that may exacerbate or precipitate depressive symptoms (Taylor, 2008).

Sleep and Depression

Depressive symptoms were endorsed on average “moderately” to “extremely” by a substantial minority (~31%) of college students in this sample. Overall, ~41% participants endorsed depressive symptoms “not at all,” ~29% endorsed symptoms “a little bit,” ~17% endorsed symptoms “moderately,” ~9% endorsed symptoms “quite a bit,” and ~4% endorsed “extremely.” These findings are consistent with previous research on college students, which purports that 30% of college students reported feeling "so depressed that it was difficult to function" at some time in the past year (American College Health Association, 2011). Although the present study treated depressive symptoms continuously (rather than as discrete categories of depression severity), the sample’s overall symptom endorsement appears consistent with existing literature. For example, a study reported that in a sample of 1338 students (ages 18–23 years), 19% of students endorsed mild symptoms of depression, and 14.5% reported moderate to severe symptoms (Eisenberg, Hunt, & Speer, 2013; Johnson et al. 2006b). The overall high prevalence of depressive symptoms in the present sample underscores the importance of increased screening for depression (and related risk factors) for college students.

In the present study, insomnia was associated with the worst depression, followed by BISS and then normal sleep, after controlling for ethnicity and gender. Between group differences (e.g., comparing insomnia to BISS, BISS to normal sleep, etc.) were statistically significant. These findings are partially consistent with previous research, which suggested that insomnia/BISS would both have worse depression than normal sleepers (Baglion, Battagliese, Feige, et al., 2011; Lee, Cho, Cho, & Kim, 2012; Riemann & Voderholzer, 2002; Sarchiapone et al., 2014; Taylor, 2008). The increased risk for depression associated with BISS/insomnia highlights sleep issues as a potential screening and treatment target to address depressive symptoms in college students. The present study is the first to compare depression symptoms

between insomnia and BISS, making depression differences between BISS/insomnia a novel finding. Given that sleep duration did not significantly differ between groups, it is likely that something related to the unique experience of having insomnia (e.g., hopelessness, lack of control, laying awake and ruminating) contributes to greater depressive symptoms, compared to BISS (Taylor, 2008).

Sleep, Depression, and Other Risk Factors

Both insomnia and BISS predicted depressive symptoms over and above demographic and concurrent risk factors. In two separate hierarchical linear regressions, demographic risk factors (ethnicity and gender) were added as the first step. For both regressions, female gender was associated with significantly increased depression symptoms. An increased depression risk associated with female gender is consistent with the extant literature, which purports that women are twice as likely to experience both sleep difficulties and depression (Johnson, et al., 2006; Roane & Taylor, 2009; Weissman et al., 1996). African American ethnicity was associated with significantly lower depression than Caucasians. Asian American, Hispanic, and other ethnicities were not significantly related to depression. The literature on ethnicity suggests that African Americans are at increased risk for poor sleep quality, insufficient sleep, daytime sleepiness and insomnia, compared to other ethnic groups (Baldwin et al., 2010; Petroy & Lichstein, 2016). However, evidence is more mixed regarding whether ethnicity influences risk for depression, as some studies report increased risk for African American or Hispanic individuals, while others find no ethnic differences (Menselson, Rehkopf, & Kubzansky, 2008; Twenge & Nolen-Hoeksema, 2002; Williams, et al., 2007).

The second step of both the insomnia/BISS regressions added several significant predictors of depression including, binge drinking, anxiety, and interpersonal trauma exposure. For both regressions, anxiety was most related to depression, followed by interpersonal trauma. These findings are also consistent with the literature, which has found that anxiety is highly comorbid with depression and sleep issues (Nyer et al., 2013). Additionally, a history of interpersonal trauma exposure has been consistently linked to psychopathology, including sleep issues and depression, which is congruous with the present study's findings (Krakow, et al., 2000). The study's analyses also found that binge drinking was inversely related to depression, a surprising result, given that binge drinking has been associated with increased depression and sleep difficulties (Cranford, Fisenberg, & Serras, 2009). This finding may be attributable to several factors. First, binge drinking was relatively common in the present sample. The incorporation of either higher per binge episode criteria for "problematic" binge drinking or the assessment of frequency of binge episodes may have better identified problematic binge drinkers. Finally, for both BISS/insomnia analyses, the combined risk factors and demographic factors were potent predictors of depressive symptoms.

For both analyses, insomnia and BISS predicted depressive symptoms over and above demographic and other risk factors. Of note, the present study controlled for more demographic and risk factors than in previous research, which has largely selected one or two key risk/demographic factors for analysis. For example, Lee et al.'s (2012) study found that BISS predicted suicidal ideation, after controlling for age, gender, and depressive symptoms but did not account for comorbid risk factors. Thus, it may be important to consider this study's small effect sizes for BISS/insomnia within the context of being added to models that already included

comprehensive risk/demographic factors. The study also indicated that the insomnia regression and the BISS regression were similar in predicting depression scores.

Limitations

This study includes several methodological limitations, many of which are inherent to its secondary dataset design. First, the dataset consists of entirely of self-report items and may have benefited from the inclusion of objective measures. Further, because the study assesses an array of risk behaviors, many measures are abridged. It would have been preferable to include the full version of the scales, particularly for key variables, like sleep and depression. Finally, because only one cohort of data is available, it is not possible to establish directionality or causality between sleep issues and depression.

Additionally, there are limitations related to the present study's assessment of sleep. First, this study is not intended to formally diagnose participants with BISS or insomnia. The Pittsburg Sleep Quality Index (PSQI) alone is insufficient for the diagnosis of insomnia or BISS, so the sleep groups should be interpreted as "BISS symptoms" and "insomnia symptoms," rather than as formal clinical diagnoses. The American Academy of Sleep Medicine (AASM) recommends that insomnia diagnosis should include self-report measures that are corroborated by prospective sleep-logs (Shultte-Rodin, et al., 2008). The use of objective monitoring (e.g., actigraphy) is an optional corroborative measure that would strengthen the study, according to AASM guidelines (Shultte-Rodin, et al., 2008). To date, there are no parallel measurement recommendations for formal BISS diagnosis. Finally, the study would have benefited from the incorporation of questions regarding sleep timing (bed/wake times), as eveningness has been linked to increased depression (Hildago et al., 2009;).

Finally, there are limitations related to the study's statistical methods, including the reported small effect sizes and exploratory analyses. While statistically significant, the hierarchical regressions that purported that insomnia/BISS predicted depression above and beyond other risk factors had small effect sizes, which may reflect limited clinical significance. Additionally, there were virtually no differences in the magnitude of demographic or risk factors between BISS/insomnia. This may be attributable to unequal sample size. The normal sleep category (*n*=663) was so much larger than the insomnia (*n*=218) or BISS (*n*=98) categories that it was difficult to detect differences in magnitude between the BISS and insomnia hierarchical regressions.

Clinical Implications

The present study's high prevalence of sleep problems, including BISS/insomnia symptoms, highlights a need for more sleep problem screenings in college students. As demonstrated in the present sample, college students' sleep is insufficient, with common daytime sleepiness and low-quality sleep. Additionally, this study showed that insomnia and BISS symptoms are common in college students. Despite the widespread sleep issues inherent in this population, sleep-related screenings in student healthcare centers are not part of routine care. Thus, it may be beneficial to more regularly include a brief screener, assessing for both BISS and insomnia, into college student health centers. For example, several items from the Pittsburgh Sleep Quality Index (as used in the present study) could be directly incorporated into existing routine patient screeners to minimize physician burden (Buysse et al., 1989). These brief screeners may help to identify students needing additional intervention, whether that entails the provision of basic sleep hygiene information or whose issues may warrant more intensive, behavioral treatment.

As delineated in this study, the relationship between BISS/insomnia and depression highlights an opportunity for more targeted screenings for college students, both for sleep issues as well as depressive symptoms. For patients who endorse any sleep difficulties, a brief depression screen may be warranted, given this study's finding that sleep issues are significantly associated with depression. Several brief instruments have been effective in identifying depressive symptoms, like the Patient Health Questionnaire, in primary care settings (Kroenke, Spitzer, & Williams, 2001). Conversely, students with depression may benefit from a brief assessment of sleep difficulties. Better screening for comorbid depression and sleep issues may be particularly critical for college students, given that sleep issues and depression both follow chronic courses, with low natural remission rates, beginning post-puberty (Johnson et al., 2006; Klein, Glenn, Kosty, Seeley, Rohde, & Lewinsohn, 2013; Ohayon et al., 2002). Further, both depression and sleep issues are associated with other risky behaviors (e.g., unsafe sex, alcohol abuse), poor academic performance, detrimental health consequences (e.g. weight gain, pain), and increased suicide risk in college students, which makes early intervention imperative (Centers for Disease Control, 2015; Emory, 2015).

Population-based interventions, like educational sleep health campaigns, may be beneficial, given the prevalence of sleep issues found in this study. The present study demonstrated that a substantial minority of students (~32%) meet criteria for either insomnia or BISS, and that poor quality sleep (~17%) and daytime sleepiness (~22%) were common, which highlights a need for university-wide intervention. Similarly, health agencies, including the National Institutes of Health and the Center for Disease Control, have identified adolescents (ages 12-25 years) as a high-risk population for sleep issues and created initiatives to more broadly promote positive sleep habits within that population (e.g., the Healthy Sleep 2020)

(Centers for Disease Control and Prevention; National Sleep Foundation, 2015). Despite these high level calls for action, college campus efforts have focused health campaigns on other issues, like sexual assault prevention and binge drinking reduction (Karjane, Fisher, & Cullen, 2005; Rothman & Silverman, 2007; Wechsler et al., 2002). Further, there is currently limited national data on the frequency of sleep-related campaigns, despite that sleep educational campaigns have been demonstrated to improve sleep and mental health in university students (Orzech, Salafsky, & Hamilton, 2011).

In addition to promoting healthy sleep habits for all college students, more targeted treatments may be implemented for students with BISS or insomnia. Psychoeducation, sleep hygiene tips, and self-monitoring sleep habits may be effective for students who are choosing to get insufficient sleep (i.e., those with BISS). Students with insomnia may benefit from more targeted treatment, like Cognitive Behavioral Therapy for Insomnia (CBT-I). CBT-I is the recommended first line of treatment for insomnia and includes psychoeducation, sleep restriction, stimulus control, cognitive restructuring, and sleep hygiene (Kaplan & Harvey, 2014). CBT-I has been demonstrated to be effective for college students, including those with psychiatric comorbidities (Taylor et al., 2014; Wu, Appleman, Salazar, & Ong, 2015) Additionally, CBT-I treatment protocol has been effectively adapted in in abbreviated administrations (~2 sessions) and across a variety of settings and providers, making it conducive to college health settings (Bothelius et al., 2013; Edinger & Sampson, 2003; Epsie et al., 2007; Epsie et al., 2008; Epstein, Sidani, Bootzin, & Belyea, 2012).

Research Implications and Future Directions

The present study present study contributes to a greater empirical understanding of the complex, dynamic relationship between insomnia/BISS and depression in college students. First,

the present study is the first to separate and compare BISS/insomnia within the same sample. Parsing out BISS/insomnia allowed for comparison on a number of key sleep criteria, including sleep duration, sleep onset latency, sleep quality, and daytime sleepiness. Further, the creation of these mutually-exclusive, diagnostic categories within the same sample ensured that definitional issues related to sleep group membership did not cloud the findings. For example, in other studies on short sleep duration, people with insomnia are rarely excluded from estimates of short sleepers, which can mean that people with insomnia might be muddying the relationship between depression and short sleep duration. By separating out BISS, insomnia, and normal sleep, the present study was able to demonstrate that insomnia is most related to depression, followed by BISS, and finally normal sleep. The present study's finding that insomnia is more linked to depression than BISS indicates that there may be something unique about the experience of insomnia (e.g., poor quality sleep, long sleep latency that can lead to distress, rumination and hopelessness) that contributes to depression differently than short sleep duration alone. Further, the present study controlled for substantial risk/demographic factors related to depression, making the finding that BISS/insomnia predicted depression over and above the other risk factors particularly notable.

Future research can extend and improve the present study by implementing a longitudinal design, including additional measures, and evaluating screening/clinical interventions for this population. A longitudinal design would help to parse out directionality between sleep issues, depression, and other related risk/demographic factors. Further, a longitudinal design, starting with college freshman through senior year, could elucidate any differences in sleep/depression attributable to age or year in school. Additionally, future research could incorporate more measures for sleep, depression and other risk factors. Specifically, it may also be beneficial to

incorporate more detailed diagnostic criteria and full-length measures in defining BISS/insomnia. For example, the inclusion of prospective sleep logs, as well as other key sleep items (e.g., sleep bed/wake times, night wakings), and clinician interview would provide more diagnostic specificity. Similarly, depression could be more comprehensively assessed using an instrument designed to formally diagnose depression and to qualify depression severity (e.g., the Beck Depression Inventory-II) in addition to a clinical interview (Beck, Steer & Carbin, 1988). Further, the addition of full length measures for risk/demographic factors would help to more comprehensively evaluate risk behaviors. Finally, future research is needed to evaluate the effectiveness of population-based screenings for insomnia/BISS and depression in college students as well as more targeted interventions.

References

American Academy of Sleep Medicine. (2005). *International Classification of Sleep Disorders, 2nd ed: Diagnostic and Coding Manual*. Westchester, IL: American Academy of Sleep Medicine.

American College Health Association. (2006). National College Health Assessment Fall 2006 Reference Group executive summary. Retrieved from http://www.acha-ncha. org/docs/ACHA-NCHA_Reference_Group_Executive Summary_Fall2006.pdf

American College Health Association (2009). National College Health Assessment Fall 2009 reference group report. Retrieved from: http://www.acha-ncha.org

American College Health Association. (2012). *American College Health Association-National College Health Assessment II: Reference Group Executive Summary Fall 2011*. American College Health Association.

American Psychiatric Association (APA). (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Washington, DC: Author.

Amstadter, A. B., Aggen, S. H., Knudsen, G. P., Reichborn-Kjennerud, T., & Kendler, K. S. (2013). Potentially traumatic event exposure, posttraumatic stress disorder, and Axis I and II comorbidity in a population-based study of Norwegian young adults. *Social Psychiatry and Psychiatric Epidemiology*, *48*(2), 215-223.

Baglioni C, Battagliese G., Feige B, (2011). Insomnia as a predictor of depression: A meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders,135*:10-19.

Baldwin, C. M., Ervin, A. M., Mays, M. Z., Robbins, J., Shafazand, S., Walsleben, J., & Weaver, T. (2010). Sleep disturbances, quality of life, and ethnicity: the Sleep Heart Health Study. *Journal of Clinical Sleep Medicine*, *6*(2), 176-183.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). Manual for the beck depression inventory-II.

Beck, A. T., Steer, R. A., & Carbin, M. G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review*, *8*(1), 77-100.

Beebe, D. W. (2011). Cognitive, behavioral, and functional consequences of inadequate sleep in children and adolescents. *Pediatric Clinics of North America*, *58*(3), 649-665.

Benca R.M. & Peterson, M.J. (2008) Insomnia and depression. *Sleep Medicine, 9* (Suppl.):S3-S9.

Bernat, J. A., Ronfeldt, H. M., Calhoun, K. S., & Arias, I. (1998). Prevalence of traumatic events and peritraumatic predictors of posttraumatic stress symptoms in a nonclinical sample of college students. *Journal of Traumatic Stress*, *11*(4), 645-664.

Bittencourt, L.R., Silva, R.S., Santos, R.F., Pires, M.L., Mello, M.T. (2005). Excessive daytime sleepiness. *Rev Bras Psiquiatr,* 27(Suppl1):16-21.

Bixler E.O., Vgontzas, N., Lin, H.M., et al. (2005) Excessive daytime sleepiness in a general population sample: The role of sleep apnea, age, obesity, diabetes, and depression. *Journal of Clinical Endocrinology and Metabolism, 90*:4510–4515.

Bixler, E. O., Vgontzas, A. N., Lin, H. M., Vela-Bueno, A. and Kales, A. (2002). Insomnia in central Pennsylvania. *Journal of Psychosomatic Research, 53,* 589–592.

Bothelius, K., Kyhle, K., Espie, C. A., & Broman, J. E. (2013). Manual-guided cognitive–behavioural therapy for insomnia delivered by ordinary primary care personnel in general medical practice: a randomized controlled effectiveness trial. *Journal of Sleep research*, *22*(6), 688-696.

Bramoweth, A. D., & Taylor, D. J. (2012). Chronic insomnia and health care utilization in young

adults. *Behavioral Sleep Medicine*, *10*(2), 106-121.

Breslau, N., Roth, T., Rosenthal, L., & Andreski, P. (1996) Sleep disturbance and psychiatric disorders: A longitudinal epidemiological study of young adults. *Biological Psychiatry*, *39*:418.

Bryant, R. A., Creamer, M., O'Donnell, M., Silove, D., & McFarlane, A. C. (2010). Sleep disturbance immediately prior to trauma predicts subsequent psychiatric disorder. *Sleep*, *33*(1), 69-74.

Bucholz, K. K., Cadoret, R., Cloninger, C. R., Dinwiddie, S. H., Hesselbrock, V. M., Nurnberger Jr, J. I., ... & Schuckit, M. A. (1994). A new, semi-structured psychiatric interview for use in genetic linkage studies: a report on the reliability of the SSAGA. *Journal of Studies on Alcohol*, *55*(2), 149-158.

Buboltz, W.C., Brown, F., & Soper, B. (2001). Sleep habits and patterns of college students: a preliminary study. *Journal of American College Health, 50*:131–135.

Buysse, J.D., Angst, J., Gamma, A., Ajdacic, V., Eich, D., & Rössler, W. (2008). Prevalence, course and comorbidity of insomnia and depression in young adults. *Sleep, 4*, 473-480.

Cappuccio, F. P., Taggart, F. M., Kandala, N., Currie, A., Peile, E., Stranges, S., & Miller, M. A. (2008). Meta-analysis of short sleep duration and obesity in children and adults. *Sleep*, *31*(5), 619.

Carskadon MA, Acebo C, Seifer R. (2001). Extended nights, sleep loss, and recovery sleep in adolescents.Arch ives Italiennes de Biologie. 139:301–312.

Centers for Disease Control and Prevention (2016). *Healthy People 2020*. Accessed at: https://www.healthypeople.gov/2020/topics-objectives/topic/sleep-health

Chang PP, Ford E, Mead LA, Cooper P, Klang MJ. (1997). Insomnia in young men and

subsequent depression. *American Journal of Epidemiology*, *146*, 105–114.

Colrain, I. M., & Baker, F. C. (2011). Changes in sleep as a function of adolescent development. *Neuropsychology Review*, *21*(1), 5-21.

Cranford, J. A., Eisenberg, D., & Serras, A. M. (2009). Substance use behaviors, mental health problems, and use of mental health services in a probability sample of college students. *Addictive Behaviors*, *34*(2), 134-145.

Crowley, S. J., Acebo, C., & Carskadon, M. A. (2007). Sleep, circadian rhythms, and delayed phase in adolescence. *Sleep Medicine*, *8*(6), 602-612.

Cukrowicz, K. C., Otamendi, A., Pinto, J. V., Bernert, R. A., Krakow, B., & Joiner Jr, T. E. (2006). The impact of insomnia and sleep disturbances on depression and suicidality. *Dreaming*, *16*(1), 1.

DeJong, W. (2002). The role of mass media campaigns in reducing high-risk drinking among college students. *Journal of Studies on Alcohol, Supplement*, (14), 182-192.

Derogatis. L. R., & Cleary, P. A. (1977). Confirmation of the dimensional structure of the SCL-90: A study in construct validation. *Journal of Clinical Psychology, 33*(4), 981- 989.

Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, Bögels SM. (2010). The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: a meta-analytic review. *Sleep Medicine Review, 14,* 179-189.

Dick, D. M., Nasim, A., Edwards, A. C., Salvatore, J. E., Cho, S. B., Adkins, A., ... & Kendler, K. S. (2014). Spit for Science: launching a longitudinal study of genetic and environmental influences on substance use and emotional health at a large US university. *Frontiers in Genetics*, *5*: 47.

Edinger JD, Bonnet MH, Bootzin RR, et al. (2004). Derivation of research diagnostic criteria for

insomnia: report of an American Academy of Sleep Medicine Work Group. *Sleep, 24, 1567-1596*.

Edinger, J. D., & Sampson, W. S. (2003). A primary care" friendly" cognitive behavioral insomnia therapy. *Sleep, 26*(2), 177-184.

Eisenberg, D., Hunt, J., & Speer, N. (2013). Mental health in American colleges and universities: variation across student subgroups and across campuses. *The Journal of Nervous and Mental Disease*, *201*(1), 60-67.

Emory (2016). Suicide Statistics. *Emory Cares for You*. Retrieved from: http://www.emorycaresforyou.emory.edu/resources/suicidestatistics.html

Espie, C. A. (2009). "Stepped care": a health technology solution for delivering cognitive behavioral therapy as a first line insomnia treatment. *Sleep*, *32*(12), 1549-1558.

Espie, C. A., Fleming, L., Cassidy, J., Samuel, L., Taylor, L. M., White, C. A., ... & Paul, J. (2008). Randomized controlled clinical effectiveness trial of cognitive behavior therapy compared with treatment as usual for persistent insomnia in patients with cancer. *Journal of Clinical Oncology*, *26*(28), 4651-4658.

Ford DE, Kamerow DB. (1989). Epidemiologic study of sleep disturbances and psychiatric disorders. An opportunity for prevention? *Journal of the Medical Association*, *262*:1479-1484.

Frey, S., Balu, S., Greusing, S., Rothen, N., & Cajochen, C. (2009). Consequences of the timing of menarche on female adolescent sleep phase preference. *Public Library of Science One 4*(4), e5217.

Furr, S. R., Westefeld, J. S., McConnell, G. N., & Jenkins, J. M. (2001). Suicide and depression among college students: A decade later. *Professional Psychology: Research and*

Practice, 32(1), 97–100.

Germain, A. (2013). Sleep disturbances as the hallmark of PTSD: where are we now? *American Journal of Psychiatry*, *170,* 372-382.

Germain, A., Shear, M. K., Hall, M., & Buysse, D. J. (2007). Effects of a brief behavioral treatment for PTSD-related sleep disturbances: a pilot study. *Behaviour Research and Therapy*, *45*(3), 627-632.

Gray, M. J., Litz, B. T., Hsu, J. L., & Lombardo, T. W. (2004). Psychometric properties of the life events checklist. *Assessment*, *11*(4), 330-341.

Gregory, A. M., Rijsdijk, F. V., Lau, J. Y., Dahl, R. E., & Eley, T. C. (2009). The direction of longitudinal associations between sleep problems and depression symptoms: a study of twins aged 8 and 10 years. *Sleep*, *32*(2), 189-199.

Gregory, A. M., & Sadeh, A. (2012). Sleep, emotional and behavioral difficulties in children and adolescents. *Sleep Medicine Reviews*, *16*(2), 129-136.

Gress-Smith, J. L., Roubinov, D. S., Andreotti, C., Compas, B. E., & Luecken, L. J. (2015). Prevalence, severity and risk factors for depressive symptoms and insomnia in college undergraduates. *Stress and Health*, *31*(1), 63-70.

Haarasilta, L., Marttunen, M., Kaprio, J. & Aro, H. (2001). The 12-month prevalence and characteristics of major depressive episode in a representative nationwide sample of adolescents and young adults. *Psychological Medicine, 31,* 1169–1179.

Hall, B. T., Akeeb, A., & Mellman, T. A. (2015). The Role of Trauma Type in the Risk for Insomnia. *Journal of Clinical Sleep Medicine, 11,* 735-739.

Hatzinger, M., Hemmeter, U. M., Brand, S., Ising, M., & Holsboer-Trachsler, E. (2004). Electroencephalographic sleep profiles in treatment course and long-term outcome of

major depression: association with DEX/CRH-test response. *Journal of Psychiatric Research*, *38*(5), 453-465.

Harvey, A. G., Jones, C., & Schmidt, D. A. (2003). Sleep and posttraumatic stress disorder: a review. *Clinical Psychology Review*, *23*(3), 377-407.

Harrison, Y., & Horne, J. A. (2000). The impact of sleep deprivation on decision making: a review. *Journal of Experimental Psychology: Applied*, *6*(3), 236-239.

Hardison, H. G., Neimeyer, R. A., & Lichstein, K. L. (2005). Insomnia and complicated grief symptoms in bereaved college students. *Behavioral Sleep Medicine*, *3*(2), 99-111.

Hayley, A. C., Williams, L. J., Berk, M., Kennedy, G. A., Jacka, F. N., & Pasco, J. A. (2013). The relationship between excessive daytime sleepiness and depressive and anxiety disorders in women. *Australian and New Zealand Journal of Psychiatry*, *47*(8), 772-778.

Hershner, S. D., & Chervin, R. D. (2014). Causes and consequences of sleepiness among college students. *Nature and Science of Sleep*, *6*, 73-84.

Hicks, R.A., Pellegrini, R.J., (1991). The changing sleep habits of college students. *Perceptual and Motor Skills 72,* 1106.

Hidalgo, M. P., Caumo, W., Posser, M., Coccaro, S. B., Camozzato, A. L., & Chaves, M. L. F. (2009). Relationship between depressive mood and chronotype in healthy subjects. *Psychiatry and Clinical Neurosciences*, *63*(3), 283-290.

Hohagen, F., Rink, K., Kappler, C. et al. (1993). Prevalence and treatment of insomnia in general practice: a longitudinal study. *European Archives of Psychiatry and Clinical Neurosciences, 242*, 329–336.

Jansson-Frojmark, M. and Linton, S. J. (2008). The course of insomnia over one year: a longitudinal study in the general population in Sweden. *Sleep, 31*, 881–886.

Jenni, O. G., Achermann, P., & Carskadon, M. A. (2005). Homeostatic sleep regulation in adolescents. *Sleep, 28*(11), 1446-1454.

Johns MW. (1991) A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep*, *14*(6):540-5.

Johnson, E.O., Roth, T. & Breslau, N. (2006a) The association of insomnia with anxiety disorders and depression: exploration of the direction of risk. *Journal of Psychiatric Research, 40*, 700–708.

Johnson, E.O., Roth, T., Schultz, L. & Breslau, N. (2006b). Epidemiology of DSM-IV insomnia in adolescence: lifetime prevalence, chronicity, and an emergent gender difference. *Pediatrics*, *117*, e247–e256.

Kales, J.D. & Healey, S. (1979). Prevalence of sleep disorders in the Los Angeles metropolitan area. *American Journal of Psychiatry, 36*(10), 1257-1262.

Kaneita Y, Ohida T, Uchiyama M, et al. (2005). Excessive daytime sleepiness among the Japanese general population. *Journal of Epidemiology, 15*:1-8.

Kaplan, K.A., & Harvey, A.G. (2014). Treatment of Sleep Disturbance. In D.H. Barlow (Ed.), *Clinical handbook of psychological disorders: A step-by-step treatment manual* (640-669). Guilford publications.

Karjane, H. M., Fisher, B., & Cullen, F. T. (2005). *Sexual assault on campus: What colleges and universities are doing about it*. Washington DC: US Department of Justice, Office of Justice Programs, National Institute of Justice.

Karacan, I., Thornby, J. I., Anch, M., Holzer, C. E., Warheit, G. J., Schwab, J. J., & Williams, R.L. (1976). Prevalence of sleep disturbance in a primarily urban Florida county. *Social Science & Medicine*, *10*(5), 239-244.

Kaufman, J., Martin, A., King, R.A. & Charney, D. 2001. Are child-, adolescent-, and adult-onset depression one and the same disorder? *Biological Psychiatry, 49*, 980–1001.

Kelly, R. J., & El-Sheikh, M. (2014). Reciprocal relations between children's sleep and their adjustment over time. *Developmental Psychology*, *50*(4), 1137.

Kenney, S. R., LaBrie, J. W., Hummer, J. F., & Pham, A. T. (2012). Global sleep quality as a moderator of alcohol consumption and consequences in college students. *Addictive Behaviors*, *37*(4), 507-512.

Kenney, S. R., Lac, A., LaBrie, J. W., Hummer, J. F., & Pham, A. (2013). Mental health, sleep quality, drinking motives, and alcohol-related consequences: a path-analytic model. *Journal of Studies on Alcohol and Drugs*, *74*(6), 841-851.

Klein, D. N., Glenn, C. R., Kosty, D. B., Seeley, J. R., Rohde, P., & Lewinsohn, P. M. (2013). Predictors of first lifetime onset of major depressive disorder in young adulthood. *Journal of Abnormal Psychology*, *122*(1), 1-6.

Klein, D. N., Taylor, E. B., Harding, K., & Dickstein, S. (1988). Double depression and episodic major depression: demographic, clinical, familial, personality, and socioenvironmental characteristics and short-term outcome.*American Journal of Psychiatry*, *145*(10), 1226-1231.

Klerman EB, Dijk DJ. (2005). Interindividual variation in sleep duration and its association with sleep debt in young adults. *Sleep, 28*:1253–1259

Kobayashi, I., Boarts, J. M., & Delahanty, D. L. (2007). Polysomnographically measured sleep abnormalities in PTSD: a meta-analytic review. *Psychophysiology*, *44*(4), 660-669.

Kobayashi, I., Huntley, E., Lavela, J., & Mellman, T. A. (2012). Subjectively and objectively measured sleep with and without posttraumatic stress disorder and trauma

exposure. *Sleep*, *35*(7), 957-965.

Koeter, M. W. (1992). Validity of the GHQ and SCL anxiety and depression scales: a comparative study. *Journal of Affective Disorders*, *24*(4), 271-279.

Koren, D., Arnon, I., Lavie, P., & Klein, E. (2002). Sleep complaints as early predictors of posttraumatic stress disorder: a 1-year prospective study of injured survivors of motor vehicle accidents. *American Journal of Psychiatry*, *159(*5), 855-857.

Krakow, B., Artar, A., Warner, T. D., Melendrez, D., Johnston, L., Hollifield, M., ... & Koss, M. (2000). Sleep disorder, depression and suicidality in female sexual assault survivors. *Crisis: The Journal of Crisis Intervention and Suicide Prevention*, *21*(4), 163.

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The Phq-9. *Journal of General Internal Medicine*, *16*(9), 606-613.

Lack, L.,1986. Delayed sleep and sleep loss in university students. *Journal of American College Health 35*, 105–110.

Lee, R. W., Caruso, M. E., Goins, S. E., & Southerland, J. P. (2003). Addressing sexual assault on college campuses: Guidelines for a prevention/awareness week. *Journal of College Counseling*, *6*(1), 14-24.

Lee, Y. J., Cho, S. J., Cho, I. H., & Kim, S. J. (2012). Insufficient sleep and suicidality in adolescents. *Sleep, 35*(4), 455-460.

Lessov-Schlaggar, C. N., Bliwise, D. L., Krasnow, R. E., Swan, G. E., & Reed, T. (2008). Genetic association of daytime sleepiness and depressive symptoms in elderly men. *Sleep*, *31*(8), 1111-7.

Lewinsohn, P. M., Hops, H., Roberts, R. E., Seeley, J. R., & Andrews, J. A. (1993). Adolescent psychopathology: I. Prevalence and incidence of depression and other DSM-III—R

disorders in high school students. *Journal of Abnormal Psychology*, *102*(1), 133-144.

Lichstein, K. L., Durrence, H. H., Taylor, D. J., Bush, A. J., & Riedel, B. W. (2003). Quantitative criteria for insomnia. *Behaviour Research and Therapy*, *41*(4), 427-445.

Lund, H. G., Reider, B. D., Whiting, A. B., & Prichard, J.R. (2010). Sleep patterns and predictors of disturbed sleep in a large population of college students. *The Journal of Adolescent Health, 46(*2), 124–132.

Luxton, D.D., Greenburg, D., Ryan, J., Niven, A., Wheeler, G., & Mysliwiec. (2011). Prevalence and impact of short sleep duration in redeployed OIF soldiers. *Sleep, 34(9),* 1189-95.

McCall, W. V., & Black, C. G. (2013). The link between suicide and insomnia: theoretical mechanisms. *Current Psychiatry Reports*, *15*(9), 1-9.

McKnight-Eily, L. R., Eaton, D. K., Lowry, R., Croft, J. B., Presley-Cantrell, L., & Perry, G. S. (2011). Relationships between hours of sleep and health-risk behaviors in US adolescent students. *Preventive Medicine*, *53*(4), 271-273.

Mayou, R., & Bryant, B. (2001). Outcome in consecutive emergency department attenders following a road traffic accident. *The British Journal of Psychiatry*, *179*(6), 528-534.

Marx, B. P., & Sloan, D. M. (2003). The effects of trauma history, gender, and race on alcohol use and posttraumatic stress symptoms in a college student sample. *Addictive Behaviors*, *28*(9), 1631-1647.

Mellman, T. A., Bustamante, V., Fins, A. I., Pigeon, W. R., & Nolan, B. (2002). REM sleep and the early development of posttraumatic stress disorder. *American Journal of Psychiatry*, *159(*10), 1696-1701.

Menselson, T., Rehkopf, D.H., & Kubzansky, L.D. (2008) Depression among Latinos in the

United States: A meta-analytic review. *Journal of Consulting and Clinical Psychology, 76*:355–366.

Midanik, L. T., Tam, T. W., & Weisner, C. (2007). Concurrent and simultaneous drug and alcohol use: results of the 2000 National Alcohol Survey. *Drug and Alcohol Dependence*, *90*(1), 72-80.

Moo-Estrella, J., Perez-Benitez, H., Solis-Rodriguez, F., Arankowsky-Sandoval, G., (2005). Evaluation of depressive symptoms and sleep alterations in college students. *Archives of Medical Research, 36*(4), 393–398.

Moore, M., Kirchner, H. L., Drotar, D., Johnson, N., Rosen, C., Ancoli-Israel, S., & Redline, S. (2009). Relationships among sleepiness, sleep time, and psychological functioning in adolescents. *Journal of Pediatric Psychology*, *34*(10),1175-1183.

Morin CM, Belanger L, LeBlanc M, et al. (2009). The natural history of insomnia: a population-based 3-year longitudinal study. *Archives of Internal Medicine, 169*:447-453.

Nadorff, M. R., Nazem, S., & Fiske, A. (2011). Insomnia symptoms, nightmares, and suicidal ideation in a college student sample. *Sleep*, *34*(1), 93-98.

National Institute on Alcohol and Alcoholism. (2015). *College Fact Sheet*. Retrieved from: http://www.niaaa.nih.gov/alcohol-health/special-populations-co-occurring-disorders/college-drinking

National Institute of Mental Health. (2011). *The Teen Brain: Still Under Construction*. Retrieved from: http://www.nimh.nih.gov/health/publications/the-teen-brain-still-under-construction/index.shtml.

National Sleep Foundation. (2006). *Sleep in America poll*. Washington, DC: National Sleep Foundation.

National Sleep Foundation (2015). *National Sleep Foundation Recommends New Sleep Durations*. Retrieved from: https://sleepfoundation.org/media-center/press-release/national-sleep-foundation-recommends-new-sleep-times

Nyer, M., Farabaugh, A., Fehling, K., Soskin, D., Holt, D., Papakostas, G. I., ... & Mischoulon, D. (2013). Relationship between sleep disturbance and depression, anxiety, and functioning in college students. *Depression and Anxiety*, *30*(9), 873-880.

O'Brien, E. M., & Mindell, J. A. (2005). Sleep and risk-taking behavior in adolescents. *Behavioral sleep medicine*, *3*(3), 113-133.

O'Donnell, M. L., Creamer, M., & Pattison, P. (2014). Posttraumatic stress disorder and depression following trauma: understanding comorbidity. *American Journal of Psychiatry*, *161*(8), 1390-1396.

Office of Disease Prevention and Health Promotion (2016). *Sleep Health*. Retrieved from: http://www.healthypeople.gov/2020/topics-objectives/topic/sleep-health.

Oginska, H., & Pokorski, J. (2006). Fatigue and mood correlates of sleep length in three age social groups: School children, students, and employees. *Chronobiology International*, *23*(6), 1317-1328.

Ohayon, M. M. (2002). Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Medicine Reviews, 6*, 97–111.

Ohayon, M. M., & Roberts, R. E. (2001). Comparability of sleep disorders diagnoses using DSM-IV and ICSD classifications with adolescents. *Sleep*,*24*(8), 920-925.

Orzech, K. M., Salafsky, D. B., & Hamilton, L. A. (2011). The state of sleep among college students at a large public university. *Journal of American College Health*, *59*(7), 612-619.

Owens, J., Au, R., Carskadon, M., Millman, R., Wolfson, A., Braverman, P. K., ... & Murray, P. J. (2014). Insufficient sleep in adolescents and young adults: an update on causes and consequences. *Pediatrics*, *134*(3), e921-e932.

Pallesen, Saxvig, Molde, Sorensen, Wilhelmsen-Langeland, & Bjorvatn. (2011). Brief report: Behaviorally induced insufficient sleep syndrome in older adolescents: Prevalence and correlates. *Journal of Adolescence, 34*(2), 391-395.

Pietrzak, R. H., Goldstein, R. B., Southwick, S. M., & Grant, B. F. (2011). Prevalence and Axis I comorbidity of full and partial posttraumatic stress disorder in the United States: results from Wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. *Journal of Anxiety Disorders*, *25*(3), 456-465.

Pigeon WF, Hegel M, Unützer J, et al. (2008). Is insomnia a perpetuating factor for late-life depression in the IMPACT cohort? *Sleep, 31*; 481-488.

Perlis, M. L., Giles, D. E., Buysse, D. J., Tu, X., & Kupfer, D. J. (1997). Self-reported sleep disturbance as a prodromal symptom in recurrent depression. *Journal of Affective Disorders*, *42*(2), 209-212.

Petrov, M. E., & Lichstein, K. L. (2016). Differences in sleep between black and white adults: an update and future directions. *Sleep Medicine*, *18*, 74-81.

Pilcher, J. J., Ginter, D. R., & Sadowsky, B. (1997). Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. *Journal of Psychosomatic Research*, *42*(6), 583-596.

Potter, S. J. (2012). Using a multimedia social marketing campaign to increase active bystanders on the college campus. *Journal of American College Health*, *60*(4), 282-295.

Prins, A., Ouimette, P., Kimerling, R., Cameron, R., Hugelshofer, D., Shaw-Hegwar, J., Trallkill,

A., Gusman, D. & Sheikh, J. (2003). The primary care PTSD screen (PC-PTSD): development and operating characteristics. *Primary Care Psychiatry*, *9*(1), 9-14.

Raybin, J.D., Detre, T.P., 1969. Sleep disorder and symptomatology among medical and nursing students. *Journal of Comparative Psychology, 10,* 452–462.

Regestein, Q., Natarajan, V., Pavlova, M., Kawasaki, S., Gleason, R., & Koff, E. (2010). Sleep debt and depression in female college students. *Psychiatry Research*, *176*(1), 34-39.

Riemann, D., & Voderholzer, U. (2003). Primary insomnia: a risk factor to develop depression?. *Journal of Affective Disorders*, *76*(1), 255-259.

Roane, B. M., & Taylor, D. J. (2008). Adolescent insomnia as a risk factor for early adult depression and substance abuse. *Sleep*, *31*(10), 1351-1356

Roberts, R.E. & Duong, H.T. 2014. The prospective association between sleep deprivation and depression among adolescents. *Sleep, 37(2)*, 239–244.

Roberts, R.E., Lee, E.S., & Hemandez, M., et al. (2004). Symptoms of insomnia among adolescents in the lower Rio Grande Valley of Texas. *Sleep, 27*, 751–760.

Roberts, R. E., Roberts, C. R., & Chen, I. G. (2002). Impact of insomnia on future functioning of adolescents. *Journal of Psychosomatic Research*, *53*(1), 561-569.

Roberts, R. E., Roberts, C. R., & Xing, Y. (2007). Comorbidity of substance use disorders and other psychiatric disorders among adolescents: Evidence from an epidemiologic survey. *Drug and Alcohol Dependence*, *88*, S4-S13.

Roenneberg, T., Kuehnle, T., Pramstaller, P. P., Ricken, J., Havel, M.,Guth, A. and Merrow, M. (2004). A marker for the end of adolescence. *Current Biology, 14,* 1038–1039.

Roehrs, T., & Roth, T. (2001). Sleep, sleepiness, sleep disorders and alcohol use and abuse. *Sleep Medicine Reviews*, *5*(4), 287-297.

Roth, T., Jaeger, S., Jin, R., Kalsekar, A., Stang, P. E., & Kessler, R. C. (2006). Sleep problems, comorbid mental disorders, and role functioning in the national comorbidity survey replication. *Biological Psychiatry*, *60*(12), 1364-1371.

Rothman, E., & Silverman, J. (2007). The effect of a college sexual assault prevention program on first-year students' victimization rates. *Journal of American College Health*, *55*(5), 283-290.

Saltz, R. F., Welker, L. R., Paschall, M. J., Feeney, M. A., & Fabiano, P. M. (2009). Evaluating a comprehensive campus-community prevention intervention to reduce alcohol-related problems in a college population. *Journal of Studies on Alcohol and Drugs, Supplement*, (16), 21-27.

Sarchiapone, M., Mandelli, L., Carli, V., Iosue, M., Wasserman, C., Hadlaczky, G., ... & Wasserman, D. (2014). Hours of sleep in adolescents and its association with anxiety, emotional concerns, and suicidal ideation. *Sleep Medicine, 15*(2), 248-254.

Scarpa, A., Fikretoglu, D., Bowser, F., Hurley, J. D., Pappert, C. A., Romero, N., & Van Voorhees, E. (2002). Community Violence Exposure in University Students A Replication and Extension. *Journal of Interpersonal Violence*, *17*(3), 253-272.

Schnyder, U., Moergeli, H., Klaghofer, R., & Buddeberg, C. (2001). Incidence and prediction of posttraumatic stress disorder symptoms in severely injured accident victims. *American Journal of Psychiatry*, *158*(4), 594-599.

Schutte-Rodin, S., Broch, L., Buysse, D., Dorsey, C., & Sateia, M. (2008). Clinical guideline for the evaluation and management of chronic insomnia in adults. *Journal of Clinical Sleep Medicine*, *4*(5), 487-504.

Sing, C. Y., & Wong, W. S. (2010). Prevalence of insomnia and its psychosocial correlates among college students in Hong Kong. *Journal of American College Health*, *59*(3), 174-182.

Skapinakis, P., Rai, D., Anagnostopoulos, F., Harrison, S., Araya, R., & Lewis, G. (2013). Sleep disturbances and depressive symptoms: an investigation of their longitudinal association in a representative sample of the UK general population. *Psychological Medicine*, *43*(02), 329-339.

Smyth, J. M., Hockemeyer, J. R., Heron, K. E., Wonderlich, S. A., & Pennebaker, J. W. (2008). Prevalence, type, disclosure, and severity of adverse life events in college students. *Journal of American College Health*, *57*(1), 69-76.

Staner, L. (2010). Comorbidity of insomnia and depression. *Sleep Medicine Reviews, 14,* 35–46.

Steptoe, A., Peacey, V., & Wardle, J. (2006). Sleep duration and health in young adults. *Archives of Internal Medicine*, *166*(16), 1689-1692.

Taylor, D. J., Bramoweth, A. D., Grieser, E. A., Tatum, J. I., & Roane, B. M. (2013). Epidemiology of insomnia in college students: Relationship with mental health, quality of life, and substance use difficulties. *Behavior Therapy*, *44*(3), 339-348.

Taylor DJ, Gardner CE, Bramoweth AD, et al. (2011) Insomnia and mental health in college students. *Behavioral Sleep Medicine, 9*, 107–116

Tsai, L.L. & Li, S.P. (2004) Sleep patterns in college students: gender and grade differences *Journal of Psychosomatic Research, 56,* 231–237

Twamley, E. W., Hami, S., & Stein, M. B. (2004). Neuropsychological function in college students with and without posttraumatic stress disorder. *Psychiatry Research*, *126*(3),

265-274.

Twenge, J.M. & Nolen-Hoeksema S. (2002). Age, gender, race, socioeconomic status, and birth cohort difference on the children's depression inventory: A meta-analysis. *Journal of Abnormal Psychology*, *111*:578–588.

Tylee A, Gastpar M, Lepine JP, Mendlewicz J. (1999). DEPRESS II (Depression Research in European Society II): a patient survey of the symptoms, disability and current management of depression in the community. *International Clinical Psychopharmacology*, *14*(3):139-51.

Vitello, M. V. (1997). Sleep, alcohol and alcohol abuse. *Addiction Biology*,*2*(2), 151-158.

Vrana, S., & Lauterbach, D. (1994). Prevalence of traumatic events and post-traumatic psychological symptoms in a nonclinical sample of college students. *Journal of Traumatic Stress*, *7*(2), 289-302.

Webb, W.B., Agnew, H.W. (1975). Are we chronically sleep deprived? *Bulletin of the Psychonomic Society 6,* 47–48.

Wechsler, H., Lee, J. E., Kuo, M., Seibring, M., Nelson, T. F., & Lee, H. (2002). Trends in college binge drinking during a period of increased prevention efforts: Findings from 4 Harvard School of Public Health College Alcohol Study surveys: 1993–2001. *Journal of American College Health*, *50*(5), 203-217.

Wechsler, H., Nelson, T. E., Lee, J. E., Seibring, M., Lewis, C., & Keeling, R. P. (2003). Perception and reality: a national evaluation of social norms marketing interventions to reduce college students' heavy alcohol use. *Journal of Studies on Alcohol*, *64*(4), 484-494.

Whittier, A., Sanchez, S., Castañeda, B., Sanchez, E., Gelaye, B., Yanez, D., & Williams, M. A.

(2014). Eveningness chronotype, daytime sleepiness, caffeine consumption, and use of other stimulants among Peruvian university students. *Journal of Caffeine Research*, *4*(1), 21-27.

Williams, D.R., González, H., Neighbors, H., et al. (2007). Prevalence and distribution of major depressive disorder in African Americans, Caribbean Blacks, and Non-Hispanic Whites: Results from the National Survey of American Life. *Archives of General Psychiatry; 64*:305–315

Winsler, A., Deutsch, A., Vorona, R. D., Payne, P. A., & Szklo-Coxe, M. (2015). Sleepless in Fairfax: the difference one more hour of sleep can make for teen hopelessness, suicidal ideation, and substance use. *Journal of Youth and Adolescence*, *44*(2), 362-378.

Wolfson, A. R. (2010). Adolescents and emerging adults' sleep patterns: New developments. *Journal of Adolescent Health*, *46*(2), 97-99.

Wollwebera, B. T., & Wettera, T. C. (2011). A brief review of neurobiological principles of insomnia. *Coronary Artery Disease*, *95*, 96.

Wu, J.Q., Appleman, E.R., Salazar, R.D., & Ong, J.C. (2015). Cognitive Behavioral Therapy for Insomnia Comorbid with Psychiatric and Medical Conditions: A Meta-Analysis. (2015). *Journal of the American Medical Association, 175*(9), 1461-1472.

Yen, C. F., King, B. H., & Tang, T. C. (2010). The association between short and long nocturnal sleep durations and risky behaviors and the moderating factors in Taiwanese adolescents. *Psychiatry Research*, *179*(1), 69-74.