

THE INFLUENCE OF ANXIETY SENSITIVITY ON SLEEP QUALITY

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DEDICATION

This thesis is dedicated to Margaret Rusceak Skelly, who always encouraged my academic pursuits and continues to inspire me every day.

ABSTRACT

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Sleep is important to overall wellbeing. Mental health and sleep likely have a bi-directional relationship, wherein sleep problems are both causal factors and consequences of psychiatric conditions (Krystal, 2012). This study specifically examined the relationship of anxiety sensitivity, conceptualized as a fear of anxiety symptoms (Reiss, 1991), to sleep problems. Those with higher anxiety sensitivity may be more worried about the negative effects of poor sleep quality, which could interfere with their ability to fall asleep (Baker et al., 2017; Harvey, 2002). Furthermore, the role of body-mass index (BMI) was examined; people who are overweight or obese may be at a greater risk for anxiety and other mental illness (Zhao et al., 2009). They also are at a greater risk for obstructive sleep apnea (Jehan et al., 2017), which in turn is related to higher anxiety (Rezaeitalab et al., 2014). To examine these relationships, participants were recruited from Ball State University and through social media to respond to measures assessing trait anxiety, anxiety sensitivity, BMI, sleep quality, and demographics. Those with higher BMIs, trait anxiety, and anxiety sensitivity were expected to report greater sleep dysfunction. It was hypothesized that anxiety sensitivity would moderate the trait anxiety–sleep quality and BMI – sleep quality relationships. While anxiety sensitivity and trait anxiety significantly predicted sleep quality in a hierarchical linear regression, anxiety sensitivity did not

moderate the trait anxiety – sleep quality relationship. Exploratory analyses revealed that anxiety sensitivity did moderate the trait anxiety-sleep quality relationship for the college participants, but not the non-college participants, suggesting that age may be an important factor in these relationships. Additionally, BMI was not found to be related to anxiety sensitivity or sleep quality, and anxiety sensitivity did not moderate the relationship between BMI and sleep quality.

Contents

Conceptualization of Anxiety Sensitivity	2
Anxiety, Health Behavior, and Sleep.....	6
Anxiety Sensitivity, Health Behavior, and Sleep.....	8
<i>Anxiety Sensitivity and BMI</i>	10
<i>Anxiety Sensitivity and Sleep</i>	11
Pilot Study Data	13
Figure 1: <i>Plot of Linear Regression of Anxiety Symptomology and Anxiety Sensitivity as Predictors of PSQI Global Sleep Quality</i>	15
Figure 2: <i>Plot of Linear Regression of Anxiety Sensitivity and Body-Mass Index as Predictors of PSQI Global Sleep Quality</i>	16
Table 1: <i>Correlational Relationships Between PSQI and ASI-3 Subscales</i>	18
Table 2: <i>Correlational Relationships Between ASI-3 and PSQI Components</i>	19
Table 3: <i>Correlational Relationships Between ASI-3 Subscales and PSQI Components</i>	20
Current Research.....	21
Method	22
Participants.....	22
Measures	23
<i>The Anxiety Sensitivity Index-3</i>	23
<i>The Pittsburgh Sleep Quality Index (PSQI)</i>	23
<i>The State-Trait Anxiety Inventory (STAI)</i>	24
Procedure	24
Results.....	25

Preliminary Analyses	25
Table 4: <i>Descriptive Statistics and Correlational Results</i>	26
Assumption Checks	27
Figure 3: <i>Scatterplot of Errors of Predicted and Actual PSQI Scores</i>	28
Figure 4: <i>Matrix Scatterplot of Linear Relationships Between Study Variables</i>	29
Primary Analyses	29
Table 5: <i>Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality From ASI and STAI</i>	30
Figure 5: <i>Plot of Linear Regression of Anxiety Sensitivity and Trait Anxiety as Predictors of PSQI Global Sleep Quality</i>	31
Table 6: <i>Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality from ASI and STAI – College Student Sample</i>	32
Figure 6: <i>Plot of Linear Regression of Anxiety Sensitivity and Trait Anxiety as Predictors of Global Sleep Quality – College Student Sample</i>	33
Table 7: <i>Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality From ASI and STAI – Non-College Student Sample</i>	34
Figure 7: <i>Plot of Linear Regression of Anxiety Sensitivity and Trait Anxiety as Predictors of Global Sleep Quality – Non-College Student Sample</i>	35
Table 8: <i>Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality from ASI and BMI</i>	36
Figure 8: <i>Plot of Linear Regression of Anxiety Sensitivity and BMI as Predictors of PSQI Global Sleep Quality</i>	37
Exploratory Analyses	38

Table 9: <i>Correlational Relationships Between ASI and PSQI Components</i>	39
Table 10: <i>Correlational Relationships Between ASI Cognitive Concerns Subscale and PSQI Components</i>	40
Table 11: <i>Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality From Cognitive Subscale of ASI and STAI Scores</i>	41
Figure 9: <i>Plot of Linear Regression of ASI Cognitive Concerns Subscale and Trait Anxiety as Predictors of PSQI Global Sleep Quality</i>	42
Discussion	42
Purpose and Rationale.....	42
Findings.....	44
Problems and Limitations	49
Implications and Future Research.....	52
Conclusion	53
References.....	55
Appendix.....	66
Footnotes.....	69

The Influence of Anxiety Sensitivity on Sleep Quality

For optimal health and well-being, adults need at least 7 to 9 hours of continuous, quality sleep per night (Centers for Disease Control and Prevention, n.d.; Hirshkowitz et al., 2015). Yet, it is estimated that more than a third (35.2%) of U.S. adults sleep fewer than 7 hours per night (CDC, n.d.). Sleep quality has important implications for one's overall health. People who sleep less than 7 hours per night are more likely to be obese, physically inactive, current smokers, and consume excessive alcohol when compared to those who get sufficient sleep (CDC, n.d.). Chronic insufficient sleep may play a role in the development of cardiovascular disease and can lead to cognitive and motor performance deficits (Luyster et al., 2012). People with frequent sleep insufficiency are more likely to report fair or poor health, physical and mental distress, anxiety and depressive symptoms, and pain (Strine & Chapman, 2005). From this brief review, it is clear that sleep is an important factor in overall health.

Sleep quality is an important consideration in the study and treatment of psychological disorders, as people with mental illness may be at an additional risk for insufficient and disturbed sleep (Krystal, 2012). Sleep problems are frequently examined as both a symptom and as possible causal factors for psychological disorders. For example, insomnia may both pose as a risk factor for developing an anxiety disorder (Neckelmann et al., 2007) and a possible consequence of anxiety disorders (Ramsawh et al., 2009). Importantly, indicators of physical health very likely also play a role in the sleep – mental health relationship. For example, body weight is an important factor to consider when examining the interactive links between anxiety and sleep problems. Partial sleep deprivation, for instance, significantly increases food intake (Brondel et al., 2010). In turn, higher weight is a risk factor for obstructive sleep apnea; those

with sleep apnea syndrome often experience chronic partial sleep deprivation and report higher anxiety symptomology (Rezaeitalab et al., 2014).

To further elucidate the connections between sleep, anxiety, and overall health, it may be productive to examine specific facets of anxiety. One such promising facet is anxiety sensitivity, which is conceptualized as a fear of anxiety symptomology. Past research has shown interesting associations between anxiety sensitivity and physical health behaviors; the purpose of this thesis was to further examine these connections between anxiety and sleep, specifically examining the roles of anxiety sensitivity and body fat.

Conceptualization of Anxiety Sensitivity

Anxiety sensitivity was conceptualized as a better way to understand fear. According to Reiss' (1991) expectancy theory, humans are motivated to avoid things they fear through expectation and sensitivity. Expectation occurs when a person thinks of what will happen when they encounter the thing they fear; sensitivity, on the other hand, pertains to the reasons behind the fear. Anxiety sensitivity specifically refers to a person's "sensitivity to experiencing anxiety" (Reiss, 1991, p. 144). Reiss views anxiety sensitivity on a continuum; everyone has it in some way, with some at higher levels than others and to different effects. Those with higher anxiety sensitivity are afraid of the symptoms of anxiety because of its possible effects – that a pounding heart will lead to a heart attack, that racing thoughts associated with panic are a sign of a mental illness, or that experiencing anxiety in public will cause them to embarrass themselves. In contrast, people with lower anxiety sensitivity may be able to dismiss anxiety symptoms as harmless emotions. An easy way to conceptualize anxiety sensitivity is that it is a fear of fear. As a result, a person with high anxiety sensitivity may be alert to any stimuli that signals anxiety, may worry about becoming anxious, and may avoid anxiety-provoking situations (Reiss et al.,

1986). Anxiety sensitivity is one component of Reiss' Expectancy Model of Fear, in which he hypothesized that there are three fundamental fears or sensitivities (Reiss, 1991). One, of course, is fear of anxiety (anxiety sensitivity), while the other two are fear of injury and fear of negative evaluation.

There are several theories for how anxiety sensitivity develops. Investigating from a genetic standpoint, Stein et al. (1999) found strong heritability for anxiety sensitivity – the component accounted for almost half of the variance for total anxiety sensitivity scores – during a twin study. Stressful life experiences are also implicated in the etiology of anxiety sensitivity; stressful experiences related to health and family discord were found to predict increases in anxiety sensitivity in adolescents (McLaughlin & Hatzenbuehler, 2009). Other childhood experiences have been noted to predict anxiety sensitivity, such as parental threatening and hostile and rejecting behaviors (Scher & Stein, 2003). Anxiety sensitivity could also be related to attachment; Intrieri and Margentina (2019) studied 343 university students ($M = 21$ years old, 79% white), finding that insecurely attached participants had significantly higher levels of anxiety sensitivity, as measured by the Anxiety Sensitivity Index (Reiss et al., 1986).

Early research on anxiety sensitivity specifically focused on panic disorder, but anxiety sensitivity has also been linked to other internalizing disorders, such as generalized anxiety disorder. Reiss et al. (1986) found that participants with anxiety disorders had significantly higher anxiety sensitivity scores than a normative sample of college students, and proposed that it could be a causal mechanism for anxiety. Maller and Reiss (1992) found that people who had high anxiety sensitivity scores were five times as likely to have an anxiety disorder (panic disorder, generalized anxiety disorder, simple phobia, or social phobia) three years later, as compared to those with low anxiety sensitivity scores. There was also a significant association

between high anxiety sensitivity and frequency of panic attacks during that time period. These results were attributed to the “vicious circle” hypothesis (Reiss, 1987), in which high anxiety sensitivity increases the risk of panic attacks, which in turn increase anxiety sensitivity. Anxiety sensitivity as a causal factor has been further explored in the decades since. In a sample of children in early adolescence, anxiety sensitivity significantly predicted the future development of anxiety symptoms one year later, even when controlling for baseline anxiety and depressive symptoms (Schmidt et al., 2010). Marshall et al. (2010) found that anxiety sensitivity predicted PTSD symptoms at follow-up in people who had experienced a traumatic physical injury, and PTSD symptom severity predicted later anxiety sensitivity. Additionally, Grant et al. (2007) found that the physical concerns subscale of the Anxiety Sensitivity Index (assessing fearfulness when one’s heart beats fast, for example) predicted panic and depressive symptoms one year later.

The relationship between anxiety sensitivity and psychological disorders is further supported by meta-analyses. Naragon-Gainey (2010) conducted a meta-analysis of research into anxiety sensitivity and internalizing disorders, including anxiety disorders (generalized anxiety disorder, panic disorder, social phobia, obsessive-compulsive disorder, posttraumatic stress disorder, and specific phobia). The mean anxiety sensitivity score for those diagnosed with an anxiety disorder was significantly higher than the normative sample. People diagnosed with GAD, panic disorder, or PTSD had the overall highest levels of anxiety sensitivity when compared to other disorders and the normative sample. Olatunji and Wolitzky-Taylor (2009) also examined anxiety sensitivity’s relationship with anxiety disorders using a meta-analysis. People with generalized anxiety disorder typically reported higher levels of anxiety sensitivity than a

non-clinical control group. Overall, those with anxiety disorders had significantly greater anxiety sensitivity than non-clinical control groups.

In the 1980s and 1990s, some researchers argued that rather than a separate construct, anxiety sensitivity might be indistinguishable from trait anxiety. Further research into the construct was prompted as a result, with a consensus that anxiety sensitivity is in fact distinct from trait anxiety. McNally (1999) wrote that trait anxiety is a higher-order construct reflecting a general tendency to respond fearfully to stressors; anxiety sensitivity, on the other hand, is more specific, reflecting a tendency to respond fearfully to one's own symptoms of anxiety. It could indeed be a facet of trait anxiety, as Lilienfeld (1996) theorizes; however, it is important to note the differences between the two. It is true that anxiety sensitivity is associated with trait anxiety. For example, Holloway (1986) found that anxiety sensitivity and trait anxiety scores had a strong correlation ($r = 0.55, p < 0.001$). However, in this same study, Holloway found that anxiety sensitivity accounted for a significant amount of variance in state anxiety scores after participants voluntarily hyperventilated, while trait anxiety scores did not. Anxiety sensitivity scores were more strongly related to post-hyperventilation anxiety and hyperventilation sensations than trait anxiety scores. While these two constructs are related, and anxiety sensitivity could be conceptualized as a factor of trait anxiety, they are still distinct. For example, Taylor et al. (1991) reviewed multiple studies that included measures of both anxiety sensitivity and trait anxiety, finding moderately high correlations (median $r = 0.46$) between the two. The Anxiety Sensitivity Index (Reiss et al., 1986) and the trait scale of the State-Trait Anxiety Inventory (Spielberger et al., 1983) were also found to be factorially distinct, indicating that they assessed separate constructs. From a review of the literature, it appears that this debate has been

somewhat laid to rest; most of the discussion of this topic seems to be confined to the end of the 20th century.

Anxiety, Health Behavior, and Sleep

The relationships between mental illness and health behaviors have long been of interest to researchers. For instance, exercise seems to serve as a possible protective factor against mental illness. Higher rates of physical activity are associated with lower rates of mental disorders in adults in the United States (Goodwin, 2003); adults who regularly exercise have a decreased likelihood of a current diagnosis of generalized anxiety disorder, major depressive disorder, agoraphobia, panic attacks, specific phobia, and social phobia. Moreover, maladaptive health behaviors are often observed in those diagnosed with mental disorders. For instance, people with anxiety and depression often have comorbid cigarette use (Morrell & Cohen, 2006), and reports of drinking to self-medicate for anxiety symptoms are associated with the development and persistence of alcohol dependence (Crum et al., 2013).

People diagnosed with mental illness frequently report co-occurring sleep difficulties, with sleep dysfunction included as diagnostic criteria for certain disorders, including Generalized Anxiety Disorder (American Psychiatric Association, 2013). More specifically, insomnia often co-occurs with anxiety (Uhde et al., 2009). Recently, researchers have begun to explore the possibility of a bidirectional causal relationship between sleep problems and mental health issues (Krystal, 2012). Some research has found that insomnia may pose as a risk factor for developing an anxiety disorder (Neckelmann et al., 2007); on the other hand, Johnson et al. (2006) found that anxiety disorders were associated with an increased risk of insomnia. Ramsawh et al. (2009) found that most anxiety disorders were significantly associated with sleep dysfunction, as measured by the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989). Specifically,

generalized anxiety disorder and social phobia had the strongest relationships with PSQI scores, with higher scores representing more sleep dysfunction. And in a random sample of Dutch adults, Spoormaker and van den Bout (2005) found that anxiety symptomology was associated with sleep apnea, insomnia, narcolepsy, circadian rhythm complaints, and sleepwalking.

People with mental illness may also experience both underweight and overweight-related difficulties. For example, people who are underweight are more likely to have anxiety, current depression, and lifetime diagnosed depression than people in a normal weight range (Zhao et al., 2009). Likewise, women who are overweight or obese and men who are obese are also more likely to have anxiety, current depression, and lifetime diagnosed depression. Haghighi et al. (2016) found a non-linear correlation between anxiety symptomology and body-mass index (BMI), with people with lower and very high BMIs exhibiting lower anxiety scores. However, those with medium to high BMIs reported higher anxiety scores. The authors took a social mindset when interpreting these results, theorizing that underweight people may feel less anxiety over the possibility of social rejection. Likewise, those with very high BMIs may be surrounded by people with similar body shapes (such as their family members) and may not feel as much social rejection. Those with high BMIs may be most at risk for social rejection and may thus experience more anxiety.

The relationship between higher weight and anxiety symptomology may at least partially explain why people with mental illness are more likely to experience sleep dysfunction. For instance, higher BMIs are considered risk factors for developing obstructive sleep apnea syndrome, in which one's airway is obstructed during sleep (Jehan et al., 2017). Rezaeitalab et al. (2014) found that people with obstructive sleep apnea syndrome had a higher frequency of anxiety symptomology, as measured by the Beck Anxiety Inventory (Beck et al., 1988). Patients

with obstructive sleep apnea who experience higher anxiety symptomology are also less likely to comply with their continuous positive airway pressure (CPAP) regimen, which could make the syndrome worse (Kjelsberg et al., 2005). For people with extreme obesity, sleep quality was associated with anxiety and depression, with higher rates of dysfunction correlated with higher rates of anxiety and depressive symptomology (Araghi et al., 2013). Additionally, poor sleep quality, as measured by the Pittsburgh Sleep Quality Index (Buysse et al., 1989), was associated with poor quality of life in terms of physical function, self-esteem, sexual life, and distress. The PSQI ranges from 0 to 21, with scores at or above 5 signifying severe sleep problems. In this study, people with extreme obesity had a mean PSQI score of 8.59. In their recent review of sleep, obesity, and psychopathology, Tubbs et al. (2020) cited inflammation as a possible common denominator between all three. They recommended further research into how these three factors interact to impact health.

From this literature, it is clear that anxiety symptoms and disorders can have a significant impact on people's health. People with anxiety disorders have reported higher BMIs and experiencing sleep difficulties. As BMI is a risk factor for sleep problems, anxiety and BMI could interact to cause sleep dysfunction. Additionally, because sleep is an important factor in health and well-being, the link between anxiety and sleep dysfunction should be further explored. The field of psychology is moving towards a focus on transdiagnostic mechanisms to improve psychological and physical health. One mechanism that seems promising for sleep and other health behaviors is anxiety sensitivity.

Anxiety Sensitivity, Health Behavior, and Sleep

Research has found that anxiety sensitivity can have many implications for a person's health and well-being. In fact, anxiety sensitivity may at least partially explain the link between

mental illness and negative health consequences. Horenstein et al. (2018) proposed a model implicating different pathways for how anxiety sensitivity can affect health, reviewing 160 studies to support their theory. They found strong support in the literature that experiencing anxiety can induce a fear of medical symptoms like cardio or respiratory symptomology, causing either avoidance of healthy activities that cause those symptoms or engagement in unhealthy behaviors to reduce or alleviate the feared symptoms. This fear and subsequent avoidance of healthy behaviors and engagement in unhealthy behaviors may make someone more vulnerable to developing a chronic illness. Based upon their review of relevant literature, Horenstein et al. also speculated that anxiety sensitivity may lead to alterations in one's physiology, such as higher blood pressure, a decreased immune system, and increased stress levels, making someone more vulnerable to developing a chronic illness.

The study of anxiety sensitivity and health is important because it can be applied to several different domains, such as eating habits, medication adherence, and sleep disturbance. For instance, Hearon et al. (2014) found that women with high anxiety sensitivity who had experienced a shift in affect towards negative affectivity reported eating more calories. In patients with hypertension, which could be a risk factor for cardiovascular disease, Alcántara et al. (2014) found that nearly twice as many patients with high anxiety sensitivity did not adhere to their medication schedule for high blood pressure as those with lower anxiety sensitivity. Those with high anxiety sensitivity were also more likely to report experiencing side-effects from the medication. The researchers theorized that those with higher anxiety sensitivity, who are more sensitive to interoceptive cues, may blame their bodily sensations on their medication, leading to avoidance. They may also be more vigilant or sensitive towards possible side effects like dizziness. People with elevated anxiety sensitivity may in fact be more prone to experiencing

pain, as Ocañez et al. (2010) found in their meta-analysis. High levels of anxiety sensitivity were strongly associated with a greater fear of pain, with a more moderate relationship between elevated anxiety sensitivity and pain tolerance or pain-related disability. If those with anxiety sensitivity are more afraid of pain, they could avoid things that could potentially cause them pain – such as exercise, medication, or medical procedures.

Anxiety Sensitivity and BMI

People who are overweight or obese may experience higher anxiety sensitivity, which could have detrimental effects on their health. A phenomenon that has received particular attention recently is the relationship between anxiety sensitivity and exercise habits. Broman-Fulks et al. (2018) surveyed 955 people ($M = 45.8$ years) and found that those with higher anxiety sensitivity scores, and more anxiety, depression, and somatization symptoms, exercised less frequently. Anxiety sensitivity was positively correlated with anxiety, depression, and somatization scores. Hearon et al. (2014) recruited 32 participants who were either in the normative or obese Body Mass Index (BMI) range and had either high or low anxiety sensitivity. These participants monitored their eating, their affectivity, and their exercise over three days. The researchers found that obese people with high anxiety sensitivity were less likely to engage in moderate physical activity than the other groups. Smits et al. (2010) found a similar relationship for those with higher BMI, and suggested that extra weight could lead to greater somatic symptoms, resulting in greater distress during exercise. In their study, participants were assigned to an exercise condition on a treadmill or a rest condition sitting quietly, both for 20 minutes. Fear was assessed at 4-minute intervals in both conditions. Researchers found that there was a greater interaction between exercise, BMI, and anxiety sensitivity scores, suggesting that the greatest fear levels were observed during exercise among participants with high body mass,

but only if they had elevated anxiety sensitivity. The relationship between BMI and anxiety sensitivity could have important implications for not only exercise, but other health behaviors, and should be explored further.

Anxiety Sensitivity and Sleep

Anxiety sensitivity has been found to be related to sleep problems in several recent studies. In a sample of people with anxiety disorders (panic disorder, generalized anxiety disorder, or social anxiety disorder), Baker et al. (2017) found that anxiety sensitivity was a significant predictor of Pittsburgh Sleep Quality Index scores (PSQI; Buysse et al., 1989). The PSQI is a commonly used self-report measure of sleep quality and sleep disturbance, as reported over the past 1 month. There are seven subscales which measure specific sleep components, which when added together yield a global sleep quality score. The cognitive concerns subscale of the Anxiety Sensitivity Index – which assesses fear of loss of cognitive function because of anxiety symptoms – was the strongest predictor of global PSQI scores across all three disorders, which fits Harvey's (2002) cognitive model of insomnia. Namely, those with higher anxiety sensitivity scores may be more fearful of the effects of sleep dysfunction on their cognitive function and mental faculties. This worry, especially if it took place immediately preceding sleep, could interfere with one's ability to fall asleep, thus leading to increased sleep latency and possible insomnia. Vincent and Walker (2001) found similar effects, as those with higher levels of anxiety sensitivity reported more sleep impairment, especially those with higher fear of cognitive dyscontrol (e.g., that anxiety symptomology will impact their mental faculties). Vincent and Walker also posited that those with higher anxiety sensitivity may be more sensitive to the effects (or the potential effects) of sleep deprivation, leading to greater day-time

impairment. Weiner et al. (2015) found similar results in children, with higher anxiety sensitivity significantly predicting prolonged sleep onset latency.

In a study of anxiety sensitivity's impact on sleep in those with panic disorder, Hoge et al. (2011) found that anxiety sensitivity was associated with poor sleep quality, as measured by the PSQI. More specifically, those with panic disorder had a significantly higher mean anxiety sensitivity score (36.7 out of a possible 64 points) as compared to the control group (12.2). Those with panic disorder also reported poorer sleep quality when compared to the control group. For those with panic disorder, high anxiety disorder was specifically associated with sleep latency.

Working off of previous research about the roles of cognitions in sleep dysfunction, Calkins et al. (2013) studied the effect of dysfunctional beliefs about sleep, neuroticism, and anxiety sensitivity on sleep quality. They hypothesized that faulty beliefs and excessive worry about sleep could perpetuate and exacerbate existing sleep problems. There were significant relationships between PSQI scores and anxiety sensitivity, dysfunctional beliefs about sleep, and neuroticism. A regression analysis showed that the cognitive concerns subscale of the Anxiety Sensitivity Index and neuroticism were significant predictors of global sleep quality. Anxiety sensitivity and intolerance of uncertainty were both found to influence insomnia severity in a sample of undergraduate students (Lauriola et al., 2019). Both factors appeared to interact with symptoms of anxiety and depression in these students, altogether predicting more sleep dysfunction.

Those with higher anxiety sensitivity are hypothesized to be more aware and fearful of symptoms of anxiety because these symptoms could signify cognitive, physical, or social problems. This can more specifically be observed in the link between anxiety sensitivity and sleep dysfunction. As seen from this research, it seems that people with high anxiety sensitivity

may be excessively attuned to and fearful of sleep disturbance and its effect on their physical and cognitive well-being. This could in turn lead to more worries about their lack of sleep, which interferes with sleep itself – another “vicious cycle,” as described by Harvey’s (2002) cognitive model of insomnia. Mental disorders and sleep disorders frequently co-occur, and anxiety sensitivity is increased in those with anxiety disorders. Thus, it seems that anxiety sensitivity may be an important moderating variable and target for interventions for people experiencing sleep dysfunction and co-occurring psychological disorders. Indeed, Short et al. (2015) found that an anxiety sensitivity-focused intervention had an indirect effect on insomnia symptoms a month later.

Pilot Study Data

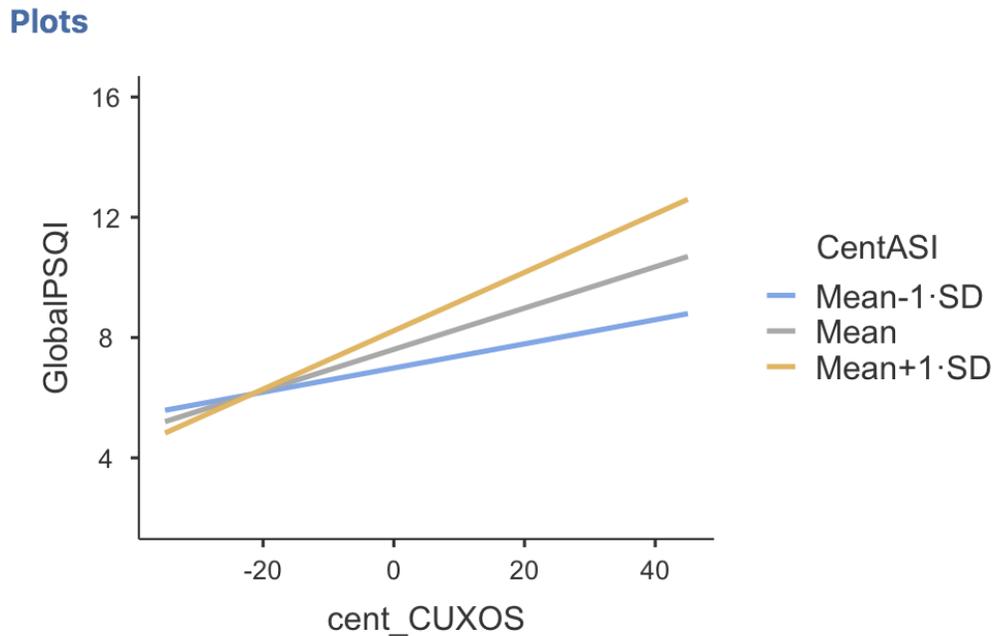
In a pilot study conducted Spring 2020, I examined the relationships among anxiety sensitivity, anxiety symptomology, BMI, and sleep dysfunction¹. As expected, there was a positive relationship between scores on the Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2017) and the Clinically Useful Anxiety Outcomes Scale (CUXOS; Zimmerman et al., 2010), such that participants with higher anxiety sensitivity also reported increased anxiety symptomology, $r(101) = 0.68, p < 0.001$. Participants’ scores on the ASI-3 and the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) were moderately correlated, with higher anxiety sensitivity scores associated with higher PSQI scores (indicating lower sleep quality), $r(90) = .44, p < 0.001$. Moreover, anxiety symptomology as measured by the CUXOS was also associated with lower sleep quality, $r(90) = 0.50, p < 0.001$.

It was hypothesized that ASI would moderate the relationship between CUXOS and PSQI scores. A hierarchical multiple regression was conducted. In the first step, CUXOS and ASI accounted for a significant amount of variance in PSQI scores, $R^2 = .268, F(2, 87) = 15.97$,

$p < .001$. In the second step, CUXOS, ASI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = .292$, $F(2, 86) = 11.82$, $p < .001$. However, the model including the interaction between ASI and CUXOS did not account for significantly more variance than the model with just ASI and CUXOS scores, $\Delta R^2 = .023$, $p = .096$, indicating that there was not a significant moderation occurring. While there was no significant moderation, the expected pattern was observed in this analysis: the relationship between anxiety symptomology and global sleep quality was higher for those with higher anxiety sensitivity (See Figure 1).

Figure 1

Plot of Linear Regression of Anxiety Symptomology and Anxiety Sensitivity as Predictors of PSQI Global Sleep Quality



Note. GlobalPSQI = Pittsburgh Sleep Quality Index global scores; cent_CUXOS = Clinically Useful Anxiety Outcome Scale scores; CentASI = Anxiety Sensitivity Index-3 scores.

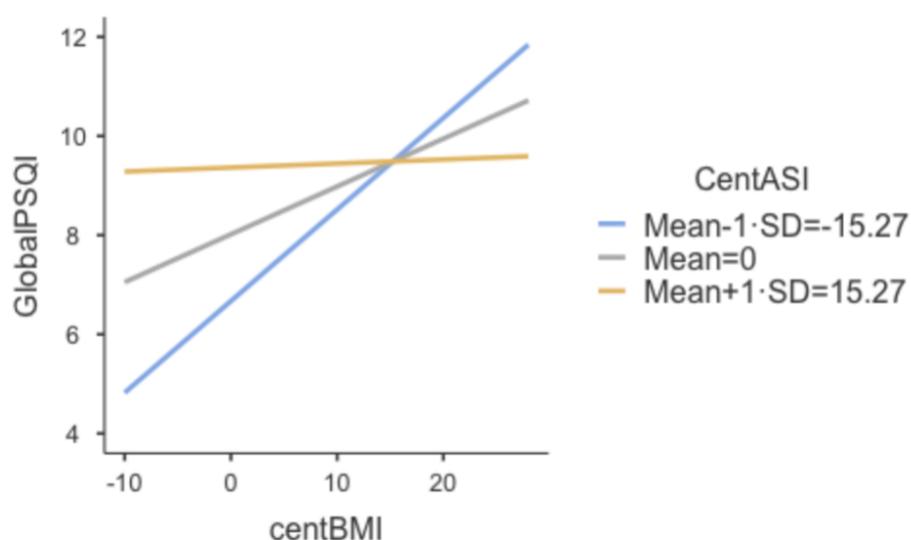
ASI was also hypothesized to moderate the relationship between BMI and scores on the PSQI. A linear regression was conducted to examine the relationship between BMI, ASI, and PSQI scores. In the first step, ASI and BMI accounted for a significant amount of variance in PSQI scores, $R^2 = .214$, $F(2, 84) = 11.40$, $p < .001$. In the second step, BMI, ASI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = .237$, $F(3, 83) = 8.57$, $p < .001$. However, the model containing the interaction between BMI and ASI scores did not account for significantly more variance than the first step,

$\Delta R^2 = .023, p = .118$, indicating that there was not a significant moderation occurring. A pattern different than the one expected was observed in this analysis, with the relationship between sleep quality and BMI seemingly stronger for those lowest in anxiety sensitivity (See Figure 2).

Figure 2

Plot of Linear Regression of Anxiety Sensitivity and Body-Mass Index as Predictors of PSQI

Global Sleep Quality



Note. GlobalPSQI = Pittsburgh Sleep Quality Index global scores; centBMI = Body Mass Index scores; CentASI = Anxiety Sensitivity Index-3 scores.

The subscales of the Anxiety Sensitivity Index-3 and the Pittsburgh Sleep Quality Index were examined for associations of interest (See Table 1, Table 2, and Table 3). The cognitive concerns subscale of the ASI-3 had the strongest relationship with global PSQI scores, indicating that cognitive anxiety sensitivity concerns were associated with global sleep dysfunction. More specifically, the cognitive concerns subscale was positively associated with daytime dysfunction,

sleep disturbance, and sleep duration, with higher anxiety sensitivity scores associated with less sleep. These results are consistent with those observed by Baker et al. (2017), in which the cognitive concerns subscale was the strongest predictor of global PSQI scales in people with panic disorder, generalized anxiety disorder, and social anxiety disorder. As described by Harvey's (2002) cognitive model of insomnia, people with insomnia may be concerned and worry about their lack of sleep, which consequently can interfere with their ability to fall asleep. Those with higher anxiety sensitivity, particularly focused on cognitive concerns, may more readily notice cognitive effects of sleep loss and may in turn worry more about their lack of sleep, maintaining insomnia and other sleep problems. The physical concerns subscale and social concerns subscale were also significantly correlated with global PSQI scores. More specifically, the physical and social ASI-3 subscales were significantly correlated with daytime dysfunction and sleep disturbance; the physical concerns subscale was also associated with use of sleep medication. Overall ASI-3 scores were positively and significantly correlated with the PSQI components of sleep disturbance, daytime dysfunction, and sleep duration.

Table 1*Correlational Relationships Between PSQI and ASI-3 Subscales*

Variable	<i>n</i>	<i>M</i>	<i>SD</i>	1	2	3	4
1. PSQI	90	7.94	3.27	–			
2. ASI-3 – Cognitive	101	13.72	6.57	.46**	–		
3. ASI-3 – Physical	101	13.64	5.77	.39**	.64**	–	
4. ASI-3 – Social	101	13.80	5.11	.28**	.65**	.59**	–

Note. PSQI = Pittsburgh Sleep Quality Index global scores, ASI-3 – Cognitive = Anxiety

Sensitivity Index-3 cognitive concerns subscale, ASI-3 – Physical = Anxiety Sensitivity Index-3

physical concerns subscale, ASI-3 – Social = Anxiety Sensitivity Index-3 social concerns

subscale.

** $p < 0.01$.

Table 2*Correlational Relationships Between ASI-3 and PSQI Components*

Variable	<i>n</i>	<i>M</i>	<i>SD</i>	1.	2.	3.	4.	5.	6.	7.	8.
1. ASI-3	101	24.17	15.15	–							
2. Comp1	99	1.30	.72	.13	–						
3. Comp2	99	1.62	.93	.16	.48**	–					
4. Comp3	100	.98	.90	.21*	.25*	.16	–				
5. Comp4	99	.68	.84	.14	.17	.20*	.49**	–			
6. Comp5	93	1.42	.58	.42**	.37**	.36**	.26*	.17	–		
7. Comp6	100	.54	.98	.18	.12	.14	.07	.13	.19	–	
8. Comp7	100	1.33	.87	.45**	.20	.13	.15	-.07	.42**	.00	–

Note. ASI-3 = Anxiety Sensitivity Index-3, Comp1 = Subjective sleep quality, Comp2 = Sleep latency, Comp3 = Sleep duration, Comp4 = Sleep efficiency, Comp5 = Sleep disturbance, Comp6 = Use of sleep medication, Comp7 = Daytime dysfunction.

* $p < 0.05$. ** $p < 0.01$.

Table 3*Correlational Relationships Between ASI-3 Subscales and PSQI Components*

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. ASI-C	–									
2. ASI-P	.64**	–								
3. ASI-S	.65**	.59**	–							
4. Comp1	.15	.14	.02	–						
5. Comp2	.20	.13	.09	.48**	–					
6. Comp3	.26**	.14	.12	.25*	.16	–				
7. Comp4	.14	.18	.03	.17	.20*	.49**	–			
8. Comp5	.39**	.37**	.31**	.37**	.36**	.26*	.17	–		
9. Comp6	.18	.22*	.06	.12	.14	.07	.13	.19	–	
10. Comp7	.45**	.32**	.38**	.20	.13	.15	-.07	.42**	.00	–

Note. ASI-C = Anxiety Sensitivity Index-3 cognitive concerns subscale, ASI-P = Anxiety Sensitivity Index-3 physical concerns subscale, ASI-S = Anxiety Sensitivity Index-3 social concerns subscale, Comp1 = Subjective sleep quality, Comp2 = Sleep latency, Comp3 = Sleep duration, Comp4 = Sleep efficiency, Comp5 = Sleep disturbance, Comp6 = Use of sleep medication, Comp7 = Daytime dysfunction.

* $p < 0.05$. ** $p < 0.01$.

While the expected significant moderations were not observed in this pilot study, there were limitations to the analysis. Specifically, there was a lack of power based on the number of participants. Additionally, this data was collected during the COVID-19 pandemic, which could

have affected participants' normal or typical sleep behaviors. Further study was needed to explore how anxiety sensitivity, anxiety symptoms, and BMI could interact to impact sleep dysfunction.

Current Research

The purpose of this study was to continue researching the relationships between anxiety sensitivity, trait anxiety, BMI, and sleep quality. Based on the methodology and results of the pilot study, I selected a more apt measure of anxiety – the State-Trait Anxiety Inventory (Spielberger et al., 1983), which allowed me to specifically examine trait anxiety.

In this study, it was hypothesized that 1) anxiety sensitivity would be positively associated with trait anxiety, as evidenced in multiple studies and in pilot data (Reiss et al., 1986; Olatunji & Wolitzky-Taylor, 2009; Naragon-Gainey, 2010); 2) that trait anxiety would be associated with sleep quality, such that those with higher trait anxiety would report greater global sleep dysfunction. Anxiety disorders have been found to be associated with sleep problems, possibly through a bidirectional causal relationship (Krystal, 2012; Neckelmann et al., 2007; Ramsawh et al., 2009); 3) that anxiety sensitivity would be associated with sleep quality, such that those with higher anxiety sensitivity would report greater sleep dysfunction. This relationship was found in my pilot data and has been shown in previous research (Baker et al., 2017; Vincent & Walker, 2001; Hoge et al., 2011); 4) that BMI would be associated with sleep quality, such that those with higher BMIs would report greater global sleep dysfunction. Higher BMIs are considered risk factors for developing sleep disorders such as obstructive sleep apnea syndrome (Jehan et al., 2017); 5) that anxiety sensitivity would moderate the relationship between trait anxiety and sleep quality. More specifically, that a sensitivity to one's physical and cognitive symptoms, and a fear of these feelings, is what makes those with higher trait anxiety

more susceptible to sleep dysfunction; 6) that anxiety sensitivity would moderate the relationship between BMI and overall sleep quality. People who are overweight or obese may experience higher anxiety sensitivity, which could impact their health. More specifically, those with higher BMIs may be more sensitive to and fearful of symptoms of anxiety; in turn, this sensitivity to anxiety could interfere with their ability to fall and stay asleep.

Method

Participants

Participants were recruited through Ball State University's Psychological Science Participant Pool, Reddit, Survey Circle, and social media. The participants recruited from Ball State University received 0.5 SONA credits for taking the survey; participants recruited from Survey Circle received points to increase their own surveys' rankings on the website. The other participants were not compensated. A G*Power analysis for a hierarchical multiple regression indicated that to detect a significant interaction, with $F^2 = 0.027$ (based on the results from the pilot study) with power of 0.80, a minimum of 289 participants were needed (Faul et al., 2007, 2009). A total of 368 responses were recorded. Thirty-one participants who completed less than 90% of the survey were excluded, along with an additional two participants who answered fewer than 90% of the questions on the ASI. The remaining sample included 335 participants, 115 of whom were college students enrolled at Ball State University and 220 of whom were adults recruited via social media. The mean age was 26.74 years ($SD = 11.45$ years), with 257 female participants (76.7%), 77 male participants (23%), and one participant who preferred not to answer (0.3%). The majority of participants were White (65.7%); other reported races and ethnicities included Hispanic or Latinx (6.6%), Asian or Pacific Islander (6.3%), Mixed race (5.4%), Black or African American (5.1%), and Native American (0.6%). Eighteen participants

(8.1%) reported their race as “other,” while eight (2.4%) preferred not to answer. The mean duration was 12.12 minutes ($SD = 28.80$ minutes).

Measures

Participants were asked to report their height and weight, used to calculate a Body Mass Index Score (BMI). To calculate the BMI, participants’ weight in kilograms was divided by their height in meters squared (NHLBI, n.d.). While BMI was used as a dimensional variable in this study, it is frequently used to categorize according to these guidelines: underweight = < 18.5 ; normal weight = $18.5-24.9$; overweight = $25-29.9$; and obese = 30 or greater. (Complete measures can be found in the Appendix).

The Anxiety Sensitivity Index-3

This measure was used to assess participants’ levels of anxiety sensitivity (Taylor et al., 2007). The 18-item measure assessed physical, cognitive, and social concerns related to anxiety sensitivity. Osman et al. (2010) determined the ASI-3 was suitable for use in nonclinical samples, with score reliability estimates all $\geq .80$. Participants ranked how often they experience a symptom on a 5-point Likert scale, with $0 = \textit{very little}$ and $4 = \textit{very much}$ and possible scores ranging from 0 to 72. An example item is, “When I notice my heart skipping a beat, I worry that there is something seriously wrong with me.” Allan et al. (2014; 2014) found support for a cut-score of 23 to identify people with high anxiety sensitivity and 17 to identify those with moderate-to-high anxiety sensitivity. In the current study, the ASI displayed high reliability, $\alpha = 0.92$.

The Pittsburgh Sleep Quality Index (PSQI)

To assess their sleep habits over the past month, participants responded to the PSQI (Buysse et al., 1989), a 19-item self-report questionnaire. A cumulative score ranging from 0 to

21 was possible, with lower scores indicating better sleep quality. When assessing the measurement's use in college students, Dietch et al. (2016) found moderate convergent validity with a sleep diary ($r = 0.53$), the Insomnia Severity Index ($r = 0.63$), and fatigue ($r = 0.44$). Based on these results, the authors recommended a cutoff score greater than or equal to 6 for use in a college population. Scores of 6 or above would differentiate those with poor sleep quality from those with good sleep quality. In a normal population, a score of 5 on the PSQI has high sensitivity and specificity in distinguishing between those with good sleep quality and poor sleep quality (Buysse et al., 1989). The seven components PSQI components displayed moderate reliability in the current study, $\alpha = 0.67$.

The State-Trait Anxiety Inventory (STAI)

Participants responded to the trait anxiety subscale of the STAI, a widely used measure of both state and trait anxiety (Spielberger et al., 1983). The trait anxiety subscale consists of 20 items (example: "I worry too much over something that really doesn't matter"). Participants indicated how much each item related to them on a 4-point scale (1 = *Almost never*, 4 = *Almost always*), with higher scores indicating greater anxiety. The STAI has been found to have good internal consistency, ranging from 0.86 to 0.95 (Spielberger et al., 1983). The trait anxiety subscale of the STAI displayed high reliability in the current study, $\alpha = 0.94$.

Procedure

Participants took this study on Qualtrics using their personal internet-connected devices. They read over an informed consent document, which detailed the purpose of the study, the name and contact information of the researcher, the anonymity of their responses, the potential benefits and risks of taking the study, and the contact information for the university's Institutional Review Board. If they consented to participate in this study, they were allowed to

access the rest of the survey. The ASI-3, STAI and PSQI were presented in randomized order, ending with demographic questions. When they finished, participants were thanked for their participation. If participants did not agree to the informed consent, the survey did not continue, and participants were instead taken to a screen thanking them for their time.

Results

Preliminary Analyses

Anxiety sensitivity was hypothesized to be positively associated with the trait anxiety subscale of the STAI. This hypothesis was supported, as scores on the ASI and the STAI were significantly and strongly correlated: $r = 0.64, p < 0.001$. ASI was also moderately associated with sleep quality, $r = 0.33, p < 0.001$. STAI and PSQI sleep quality were also moderately correlated, $r = 0.47, p < 0.001$. The relationship between anxiety sensitivity and BMI was expected to be significant, but scores on the ASI were not significantly associated with BMI, $r = 0.02, p = 0.788$, nor were there significant associations between STAI – BMI and PSQI – BMI (See Table 4 for correlations and descriptive statistics of all scales).

Table 4*Descriptive Statistics and Correlational Results*

Variable	<i>n</i>	<i>M</i>	<i>SD</i>	<i>Skewness</i>	<i>Kurtosis</i>	1	2	3	4
1. ASI	335	22.96	14.52	.52	-.48	–			
2. PSQI	335	7.55	3.44	.47	-.44	.33**	–		
3. STAI	335	47.94	12.94	-.08	-.64	.64**	.47**	–	
4. BMI	321	26.40	6.99	1.05	1.11	.08	.02	-.03	–

Note. ASI = Anxiety Sensitivity Index-3, PSQI = Pittsburgh Sleep Quality Index global scores, STAI = State-Trait Anxiety Inventory trait scale scores, BMI = Body-mass index.

** $p < 0.01$.

Independent samples t-tests did not reveal significant differences between college students and non-college participants on the measures of interest. College students ($M = 23.77$, $SD = 13.45$) did not significantly differ from non-college student participants ($M = 22.54$, $SD = 15.06$) on ASI anxiety sensitivity scores, $t(333) = 0.74$, $p = 0.461$, $d = -0.08$, 95% CI [-0.31, 0.14]. Likewise, no significant difference was found when comparing the STAI trait anxiety scores of college students ($M = 48.25$, $SD = 10.97$) to non-college student participants ($M = 47.78$, $SD = 13.88$), $t(281.95) = .337$, $p = 0.737$, $d = -0.04$, 95% CI [-0.26, 0.19]. Equal variances were not assumed for this comparison as Levene's Test for Equality of Variances was significant ($p = 0.002$). There was also no significant difference in PSQI sleep quality between college students ($M = 7.52$, $SD = 3.44$) and non-college students ($M = 7.57$, $SD = 3.45$), $t(333) = -.117$, $p = .907$, $d = 0.01$, 95% CI [-0.21, 0.24]. Finally, there was no significant difference between

college students' BMI ($M = 26.37$, $SD = 7.48$) and non-college students' BMI ($M = 26.42$, $SD = 6.73$), $t(319) = -.062$, $p = .951$, $d = 0.01$, 95% CI [-0.22, 0.24].

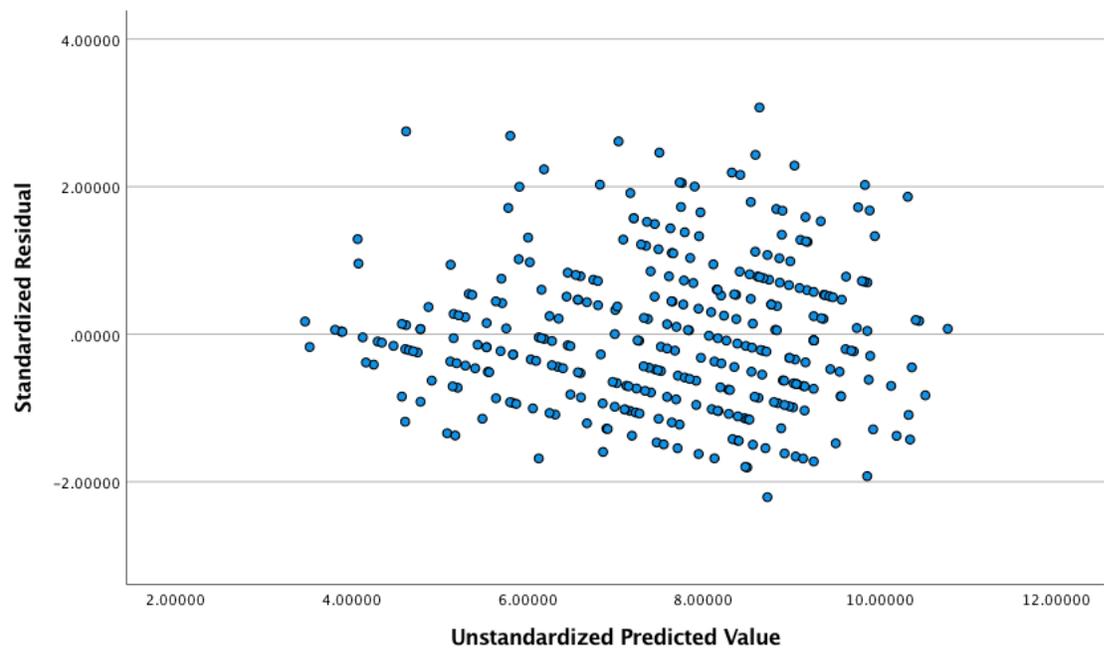
While there were no significant differences between college student participants and non-college participants in terms of ASI, STAI, PSQI, and BMI scores, there was a significant difference in age. College students ($M = 19.21$ years, $SD = 1.27$) were significantly younger than non-college participants ($M = 30.68$, $SD = 12.40$), $t(227.76) = -13.59$, $p < 0.001$, $d = 1.14$, 95% CI [0.90, 1.39]. Also of note, age is positively and significantly associated with BMI ($r = 0.23$, $p < 0.001$) and negatively and significantly associated with trait anxiety ($r = -0.31$, $p < 0.001$) and anxiety sensitivity ($r = -0.27$, $p < 0.001$).

Assumption Checks

Prior to running regression analyses, I conducted assumption checks. The scale of measurement assumption was met, as ASI, trait anxiety, PSQI sleep quality, and BMI were measured on an interval scale and were continuous variables. Normality also appeared to be met, as a scatterplot of differences between the predicted values of PSQI sleep quality and the actual values of PSQI sleep quality as predicted by anxiety sensitivity and trait anxiety appeared to be normally distributed. Most of the errors are clustered towards the mean (See Figure 3), indicating fewer larger errors and few outliers. Homoscedasticity, which requires equal variance in error at all points along the scatterplot, also appeared to be met, as all error scores appear to be contained within the same rectangular shape of the plot. The independence assumption, requiring that scores on the PSQI not be dependent on other scores, also appeared to be met, as no obvious patterns emerge when examining the scatterplot. Finally, a matrix scatter plot of the four study variables did not indicate any linear violations, as no curvilinear relationships appeared between variables (See Figure 4).

Figure 3

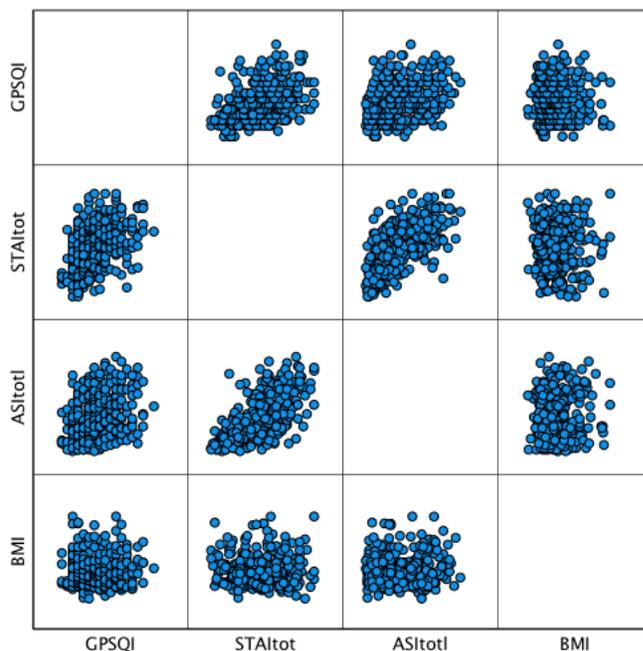
Scatterplot of Errors of Predicted and Actual PSQI Scores



Note. Standardized Residual = Standardized Residual scores of Pittsburgh Sleep Quality Index global scores; Unstandardized Predicted Value = predicted values of PSQI global scores.

Figure 4

Matrix Scatterplot of Linear Relationships Between Study Variables



Note. GPSQI = Pittsburgh Sleep Quality Index global scores; STAItot = State-Trait Anxiety Inventory trait anxiety subscale scores; ASItotl = Anxiety Sensitivity Index-3 scores; BMI = Body Mass Index scores.

Primary Analyses

It was hypothesized that ASI would moderate the relationship between scores on the trait anxiety subscale of the STAI and PSQI global sleep quality scores. A hierarchical multiple regression was conducted. In the first step, STAI and ASI accounted for a significant amount of variance in PSQI scores, $R^2 = 0.218$, $F(2, 332) = 46.20$, $p < .001$. In the second step, STAI, ASI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = 0.222$, $F(3, 331) = 31.5$, $p < .001$ (See Table 5). However, the model including the interaction between ASI and STAI did not account for significantly more variance than the

model with just ASI and STAI scores, $\Delta R^2 = 0.004$, $p = 0.176$, indicating that there was not a significant moderation occurring (see Figure 5 depicting very similar STAI – PSQI relationships at high/low levels of ASI).

Table 5

Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality From ASI and STAI

Variable	<i>b</i>	<i>SE</i>	β	<i>t</i>	R^2	ΔR^2
Model 1					0.22**	
ASI	0.01	0.02	0.06	0.91		
STAI – Trait Anxiety	0.11	0.02	0.43	6.77**		
Model 2					0.22**	0.004
ASI	0.02	0.02	0.07	1.15		
STAI – Trait Anxiety	0.11	0.02	0.42	6.49**		
ASI x STAI – Trait Anxiety	<.01	<.01	-0.07	-1.36		

Note. Model 1 $F(2, 332) = 46.20$, $p < 0.001$. Model 2 $F(3, 331) = 31.50$, $p < 0.001$; $b =$

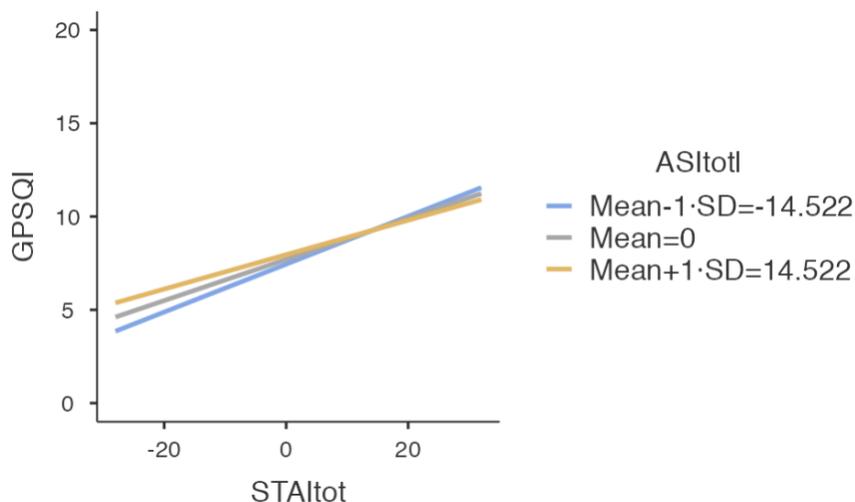
unstandardized coefficient; $SE =$ standard error of the unstandardized coefficient; $\beta =$

standardized coefficient; ASI = Anxiety Sensitivity Index – 3; STAI – Trait Anxiety = Trait

Anxiety subscale of State-Trait Anxiety Inventory. ** $p < 0.001$.

Figure 5

Plot of Linear Regression of Anxiety Sensitivity and Trait Anxiety as Predictors of PSQI Global Sleep Quality



Note. GPSQI = Pittsburgh Sleep Quality Index global scores; STAI_{tot} = State-Trait Anxiety Inventory trait anxiety subscale scores; ASI_{tot} = Anxiety Sensitivity Index-3 scores.

Somewhat different results were observed when college students were analyzed separately from the non-college participants. In the college sample ($N = 114$), ASI and STAI scores accounted for a significant amount of variance in PSQI scores in the first step of the hierarchical multiple regression, $R^2 = .201$, $F(2, 112) = 14.10$, $p < 0.001$. In the second step, ASI, STAI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = .229$, $F(3, 111) = 11.00$, $p < 0.001$. The model containing ASI, STAI, and the interaction between the two variables accounted for significantly more variance in PSQI scores than the first model containing only the ASI and STAI, $\Delta R^2 = 0.028$, $\Delta F(1, 111) = 3.96$, $p = 0.049$ (See Table 6). Examining the interaction plot revealed that a significant moderation was occurring, consistent with the hypothesized pattern: The relationship between

PSQI sleep quality and trait anxiety was strongest for those higher in anxiety sensitivity (See Figure 6).

Table 6

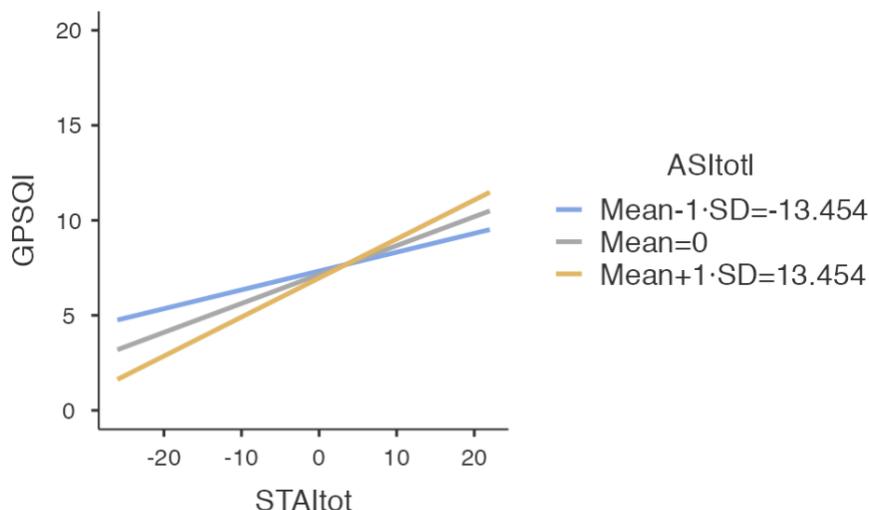
Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality From ASI and STAI – College Student Sample

Variable	<i>b</i>	<i>SE</i>	β	<i>t</i>	R^2	ΔR^2
Model 1					0.20**	
ASI	<.01	0.03	-0.01	-0.11		
STAI – Trait Anxiety	0.14	0.04	0.46	4.11**		
Model 2					0.21**	0.03*
ASI	-0.02	0.03	-0.05	-0.52		
STAI – Trait Anxiety	0.15	0.04	0.49	4.32**		
ASI x STAI – Trait Anxiety	<.01	<.01	0.17	1.99*		

Note. Model 1 $F(2, 112) = 14.10, p < 0.001$. Model 2 $F(3, 111) = 11.00, p < 0.001$; *b* = unstandardized coefficient; *SE* = standard error of the unstandardized coefficient; β = standardized coefficient; ASI = Anxiety Sensitivity Index – 3; STAI – Trait Anxiety = Trait Anxiety subscale of State-Trait Anxiety Inventory. * $p < 0.05$, ** $p < 0.001$.

Figure 6

Plot of Linear Regression of Anxiety Sensitivity and Trait Anxiety as Predictors of Global Sleep Quality – College Student Sample



Note. GPSQI = Pittsburgh Sleep Quality Index global scores; STAI_{tot} = State-Trait Anxiety Inventory trait anxiety subscale scores; ASI_{tot} = Anxiety Sensitivity Index-3 scores.

In the non-college participants ($N = 219$), STAI and ASI accounted for a significant amount of variance in the first step of the hierarchical multiple regression, $R^2 = .230$, $F(2, 217) = 32.46$, $p < 0.001$. In the second step, ASI, STAI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = .256$, $F(3, 216) = 24.8$, $p < 0.001$. The second model accounted for a significant amount of additional variance in PSQI scores than the first model, $\Delta R^2 = 0.026$, $\Delta F(1, 216) = 7.47$, $p = 0.007$ (See Table 7). Examining the interaction plot revealed a moderation was occurring, but the pattern was opposite of the hypothesis: The relationship between PSQI sleep quality and trait anxiety was strongest for those lower in anxiety sensitivity (See Figure 7).

Table 7

Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality From ASI and STAI –

Non-College Student Sample

Variable	<i>b</i>	<i>SE</i>	β	<i>t</i>	R^2	ΔR^2
Model 1					0.22**	
ASI	0.02	0.02	0.09	1.12		
STAI – Trait Anxiety	0.10	0.02	0.42	5.43**		
Model 2					0.25**	0.03*
ASI	0.03	0.02	0.13	1.64		
STAI – Trait Anxiety	0.10	0.02	0.39	4.94**		
ASI x STAI – Trait Anxiety	<.01	<.01	-0.17	-2.73*		

Note. Model 1 $F(2, 217) = 32.50, p < 0.001$. Model 2 $F(3, 216) = 24.80, p < 0.001$; *b* =

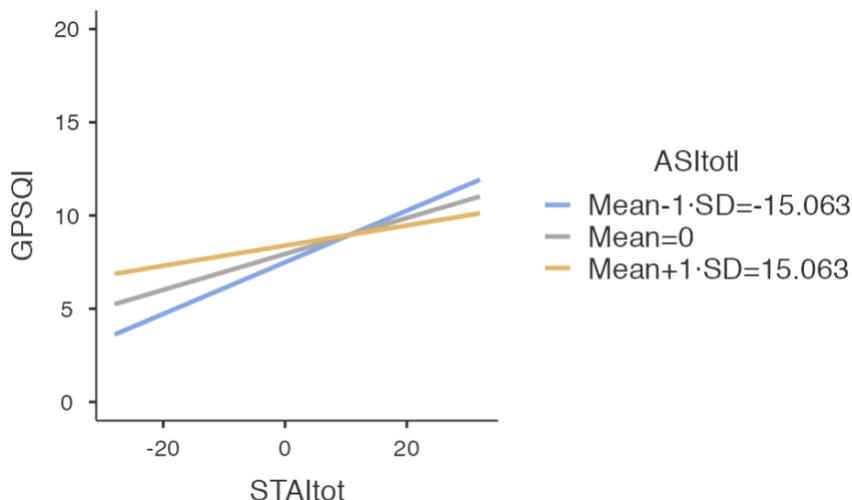
unstandardized coefficient; *SE* = standard error of the unstandardized coefficient; β =

standardized coefficient; ASI = Anxiety Sensitivity Index – 3; STAI – Trait Anxiety = Trait

Anxiety subscale of State-Trait Anxiety Inventory. * $p < 0.01$, ** $p < 0.001$.

Figure 7

Plot of Linear Regression of Anxiety Sensitivity and Trait Anxiety as Predictors of Global Sleep Quality – Non-College Student Sample



Note. GPSQI = Pittsburgh Sleep Quality Index global scores; STAI_{tot} = State-Trait Anxiety Inventory trait anxiety subscale scores; ASI_{tot} = Anxiety Sensitivity Index-3 scores.

It was also hypothesized that ASI would moderate the relationship between BMI and PSQI scores. A hierarchical multiple regression was conducted. In the first step, BMI and ASI accounted for a significant amount of variance in PSQI scores, $R^2 = 0.115$, $F(2, 318) = 20.6$, $p < 0.001$. In the second step, BMI, ASI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = 0.120$, $F(3, 317) = 14.4$, $p < 0.001$ (See Table 8). However, the model including the interaction between ASI and BMI did not account for significantly more variance than the model with just ASI and BMI scores, $\Delta R^2 = 0.005$, $\Delta F(1, 317) = 1.78$, $p = 0.183$, indicating that there was not a significant moderation occurring (See Figure 8).

Table 8*Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality From ASI and BMI*

Variable	<i>b</i>	<i>SE</i>	β	<i>t</i>	R^2	ΔR^2
Model 1					0.12**	
ASI	0.08	0.01	0.34	6.41**		
BMI	<.01	0.03	-0.01	-0.18		
Model 2					0.12**	<.01
ASI	0.08	0.01	0.33	6.08**		
BMI	<.01	0.03	-0.02	-0.26		
ASI x BMI	<.01	<.01	0.07	1.34		

Note. Model 1 $F(2, 318) = 20.60, p < 0.001$. Model 2 $F(3, 317) = 14.40, p < 0.001$; *b* =

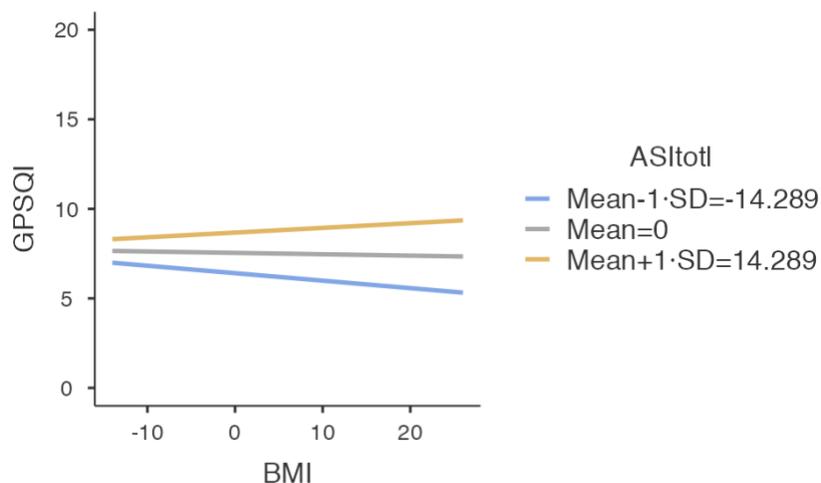
unstandardized coefficient; *SE* = standard error of the unstandardized coefficient; β =

standardized coefficient; ASI = Anxiety Sensitivity Index – 3; STAI – Trait Anxiety = Trait

Anxiety subscale of State-Trait Anxiety Inventory. ** $p < 0.001$.

Figure 8

Plot of Linear Regression of Anxiety Sensitivity and BMI as Predictors of PSQI Global Sleep Quality



Note. GPSQI = Pittsburgh Sleep Quality Index global scores; BMI= Body-Mass Index; ASItotl = Anxiety Sensitivity Index-3 scores.

The same pattern of results was observed when the hypothesized BMI-ASI-PSQI moderation was analyzed for college students and non-college students separately. In the college student sample, BMI and ASI accounted for a significant amount of variance in PSQI scores in the first step of a hierarchical linear regression, $R^2 = 0.08$, $F(2, 111) = 4.85$, $p = 0.01$. In the second step, BMI, ASI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = 0.09$, $F(3, 110) = 3.64$, $p = 0.015$. The model containing the interaction between BMI and ASI did not account for significantly more variance than the model including just ASI and BMI scores, $\Delta R^2 = .01$, $\Delta F(1, 110) = 1.21$, $p = 0.274$. In the non-college student sample, BMI and ASI accounted for a significant amount of variance in PSQI scores in the first step of a hierarchical linear regression, $R^2 = 0.143$, $F(2, 204) = 17.01$, $p <$

0.001. In the second step, BMI, ASI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = 0.148$, $F(3, 203) = 11.77$, $p < 0.001$.

However, the model containing the interaction between BMI and ASI did not account for significantly more variance than the first step of the model, $\Delta R^2 = 0.005$, $\Delta F(1, 203) = 1.25$, $p = 0.266$.

Exploratory Analyses

Subscales of the PSQI were also examined for associations of interest with other variables in this study (See Table 9). The ASI was moderately associated with daytime dysfunction and sleep latency, as those with higher anxiety sensitivity reported greater levels of daytime dysfunction and more difficulty falling asleep. The ASI was also weakly associated with sleep disturbance, subjective sleep quality, and sleep duration, such that those with higher anxiety sensitivity reported more sleep disturbance, less subjective sleep quality, and shorter sleep duration. The cognitive concerns subscale of the ASI was specifically examined for its associations with the PSQI, displaying a similar pattern of results (See Table 10). The cognitive concerns subscale was strongly and significantly associated with daytime dysfunction, indicating that those who scored higher on the cognitive concerns subscale reported greater daytime dysfunction. The subscale was significantly but weakly associated with subjective sleep quality, sleep latency, sleep duration, and sleep disturbance, indicating that those with higher cognitive concerns reported worse subjective sleep quality, longer sleep latency, shorter sleep duration, and greater sleep disturbances.

Table 9*Correlational Relationships Between ASI and PSQI Components*

	<i>n</i>	<i>M</i>	<i>SD</i>	Correlation with ASI
Comp1	335	1.27	0.72	0.22**
Comp2	335	1.71	1.00	0.25**
Comp3	334	0.52	0.79	0.11*
Comp4	333	0.79	1.01	0.07
Comp5	335	1.36	0.57	0.23**
Comp6	335	0.51	0.98	0.10
Comp7	335	1.36	0.79	0.43**

Note. ASI = Anxiety Sensitivity Index-3, Comp1 = Subjective sleep quality, Comp2 = Sleep latency, Comp3 = Sleep duration, Comp4 = Sleep efficiency, Comp5 = Sleep disturbance, Comp6 = Use of sleep medication, Comp7 = Daytime dysfunction.

* $p < 0.05$. ** $p < 0.01$.

Table 10*Correlational Relationships Between ASI Cognitive Concerns Subscale and PSQI Components*

Variable	<i>n</i>	<i>M</i>	<i>SD</i>	1.	2.	3.	4.	5.	6.	7.	8.
1. ASI-Cog	335	6.50	5.74	–							
2. Comp1	335	1.27	.72	.24**	–						
3. Comp2	335	1.71	1.00	.23**	.39**	–					
4. Comp3	334	.52	.79	.13*	.38**	.18**	–				
5. Comp4	333	.79	1.01	.10	.35**	.30**	.45**	–			
6. Comp5	335	1.36	.57	.23**	.33**	.25**	.17**	.10	–		
7. Comp6	335	.51	.98	.12	.19**	.21**	.12	.10	.18**	–	
8. Comp7	335	1.36	.79	.45**	.37**	.21**	.21**	.14**	.25**	.15**	–

Note. ASI-Cog = Anxiety Sensitivity Index-3 Cognitive Concerns subscale, Comp1 = Subjective sleep quality, Comp2 = Sleep latency, Comp3 = Sleep duration, Comp4 = Sleep efficiency, Comp5 = Sleep disturbance, Comp6 = Use of sleep medication, Comp7 = Daytime dysfunction.

* $p < 0.05$. ** $p < 0.01$.

An exploratory hierarchical linear regression was conducted to examine the relationships between the cognitive subscale of the ASI (See Appendix), STAI, and PSQI scores. In the full sample of participants, the ASI cognitive subscale and the STAI accounted for a significant amount of variance in PSQI scores, $R^2 = 0.22$, $F(2, 332) = 46.6$, $p < 0.001$. In the second step, the ASI cognitive subscale, STAI, and the interaction between the two variables accounted for a significant amount of variance in PSQI scores, $R^2 = 0.23$, $F(3, 331) = 32.8$, $p < 0.001$. The second model accounted for a significant amount of additional variance in PSQI scores when

compared to the first model, $\Delta R^2 = 0.01$, $\Delta F(1, 331) = 7.47$, $p = 0.042$ (See Table 11). The interaction plot showed a moderation was occurring, as the relationship between PSQI sleep quality and trait anxiety was strongest for those with lower scores on the cognitive subscale of the ASI (See Figure 9).

Table 11

Hierarchical Multiple Regression Predicting PSQI Global Sleep Quality From Cognitive Subscale of ASI and STAI Scores

Variable	<i>b</i>	<i>SE</i>	β	<i>t</i>	R^2	ΔR^2
Model 1					0.22**	
Cognitive ASI	0.05	0.04	0.08	1.20		
STAI – Trait Anxiety	0.11	0.02	0.42	6.48**		
Model 2					0.23**	0.01*
Cognitive ASI	0.08	0.04	0.13	1.86		
STAI – Trait Anxiety	0.10	0.02	0.38	5.84**		
Cognitive ASI x STAI – Trait Anxiety	-0.01	<.01	-0.11	-2.04*		

Note. Model 1 $F(2, 332) = 46.60$, $p < 0.001$. Model 2 $F(3, 331) = 32.80$, $p < 0.001$; $b =$

unstandardized coefficient; $SE =$ standard error of the unstandardized coefficient; $\beta =$

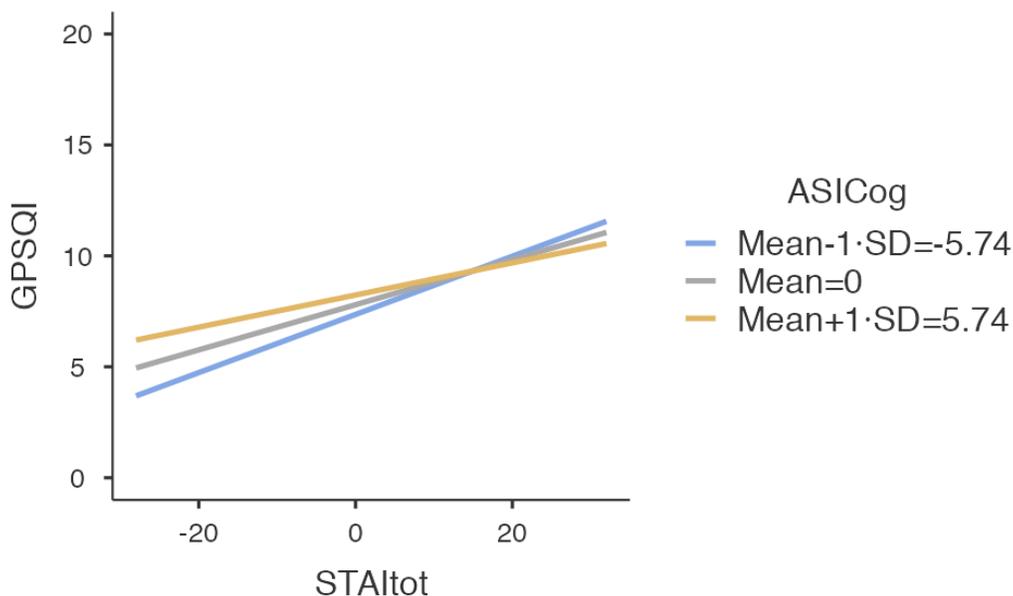
standardized coefficient; Cognitive ASI = Cognitive Concerns subscale of Anxiety Sensitivity

Index – 3; STAI – Trait Anxiety = Trait Anxiety subscale of State-Trait Anxiety Inventory. * $p <$

0.05, ** $p < 0.001$.

Figure 9

Plot of Linear Regression of ASI Cognitive Concerns Subscale and Trait Anxiety as Predictors of PSQI Global Sleep Quality



Note. GPSQI = Pittsburgh Sleep Quality Index global scores; STAI_{tot} = State-Trait Anxiety Inventory trait anxiety subscale scores; ASI_{Cog} = Anxiety Sensitivity Index-3 cognitive concerns subscale scores.

Discussion

Purpose and Rationale

The purpose of this research was to examine how anxiety sensitivity, trait anxiety, BMI, and sleep quality were related in an adult sample. Sufficient and quality sleep are important for optimal health and well-being; however, about a third of U.S. adults sleep fewer than 7 hours per night (Centers for Disease Control and Prevention, n.d.; Hirshkowitz et al., 2015). People who do not get enough sleep are at an increased risk for mental and physical distress, including anxiety

and depressive symptoms (Strine & Chapman, 2005). Sleep dysfunction can be both a cause and consequence of psychological disorders (Krystal, 2012), with insomnia posing as both a risk factor for the development of anxiety disorders (Neckelmann et al., 2007) and a possible side effect of experiencing anxiety (Johnson et al., 2006). Body weight may also have a reciprocal relationship with sleep dysfunction. Sleep deprivation can increase food intake (Brondel et al., 2010), possibly leading to increases in body weight; higher weight is a risk factor for obstructive sleep apnea, which in turn increases one's risk of chronic sleep deprivation and higher anxiety symptomology (Rezaeitalab et al., 2014). Anxiety and body weight also have an interesting relationship, such that those who are underweight or overweight/obese are more likely to report anxiety and other psychological disorders (Zhao et al., 2009; DeJesus et al., 2016).

Given anxiety's relationship with both BMI and sleep quality, it may be useful to examine specific facets of anxiety to further explore these connections. Anxiety sensitivity, a transdiagnostic mechanism conceptualized as a fear of or an increased sensitivity toward anxiety symptoms (Reiss, 1991), may be a topic of interest. People with higher anxiety sensitivity are more distressed by symptoms of anxiety (such as a racing heart), may be alert to any stimuli that could cause anxiety, may worry about becoming anxious, and may avoid anxiety-provoking situations (Reiss et al., 1986). Anxiety sensitivity has been found to be elevated in people diagnosed with anxiety disorders, specifically generalized anxiety disorder, panic disorder, and posttraumatic stress disorder (Naragon-Gainey, 2010; Olatunji & Wolitzky-Taylor, 2009). Anxiety sensitivity is a significant predictor of PSQI scores (Baker et al., 2017). Harvey's (2002) cognitive model of insomnia can help explain this connection; those with higher anxiety sensitivity may be more fearful of the effects of sleep deprivation on their physical and mental capabilities, and may be more attentive to cues of these possible side effects during the day. This

worry, especially if it takes place immediately preceding sleep, could interfere with one's ability to fall asleep, possibly leading to increased sleep latency and insomnia.

Findings

As hypothesized, trait anxiety was strongly associated with anxiety sensitivity, such that those with higher trait anxiety reported higher anxiety sensitivity. This aligns with previous research into the anxiety symptomology – anxiety sensitivity relationship, in which anxiety sensitivity has been found to be elevated in those with anxiety disorders (Naragon-Gainey, 2010; Olatunji & Wolitzky-Taylor, 2009). Also in line with this study's hypotheses, trait anxiety and anxiety sensitivity were both moderately associated with sleep quality; those higher in trait anxiety reported greater sleep dysfunction, as did those higher in anxiety sensitivity. Anxiety disorders such as generalized anxiety disorder have been found to be significantly associated with the PSQI (Ramsawh et al., 2009); insomnia, a common sleep disorder, is a risk factor for developing an anxiety disorder (Neckelmann et al., 2007), while anxiety disorders are associated with an increased risk of insomnia (Johnson et al., 2006). Contrary to what was hypothesized, BMI was not significantly associated with trait anxiety, anxiety sensitivity, or sleep quality. This may be because the distribution of BMI differed from trait anxiety, anxiety sensitivity, and sleep quality. Namely, BMI was positively skewed and kurtotic, while the other variables were more normally distributed. The more dissimilar the shapes of the variable distributions, the lower the maximum correlation between the variables (Goodwin & Leech, 2006). However, this distribution was expected for a normal adult population, as the National Health and Nutrition Examination Survey (Kumanyika et al., 2010) shows a kurtotic and positively skewed distribution of BMIs in U.S. adults.

Anxiety sensitivity and trait anxiety did account for a significant amount of variance in sleep quality. This is in line with previous research on the relationships between psychological disorders and sleep quality; anxiety disorders and insomnia, a common sleep disorder, frequently co-occur (Uhde et al., 2009). Insomnia may be a risk factor for developing an anxiety disorder, but is also a consequence of anxiety disorders (Neckelmann et al., 2007; Johnson et al., 2006); anxiety disorders are also frequently associated with the PSQI, the measure used in this study (Ramsawh et al., 2009). However, contrary to the hypothesis of this study, anxiety sensitivity did not emerge as a moderator of the relationship between trait anxiety and sleep quality. This analysis may have been affected by the strong degree to which anxiety sensitivity and trait anxiety were related to one another. It was hypothesized that anxiety sensitivity would be a significant predictor of PSQI sleep quality in the regression model, but it did not emerge as a significant predictor and anxiety sensitivity did not moderate the relationship between trait anxiety and sleep quality. While the multicollinearity diagnostics were within the normal range, the strong relationship between trait anxiety and anxiety sensitivity may have interfered with anxiety sensitivity's ability to emerge as a unique predictor of sleep quality. The STAI and ASI measures assess distinct, but still similar, constructs, which could result in trait anxiety explaining a significant amount of variance in sleep quality while anxiety sensitivity did not.

Exploratory analyses examining college students and non-college student participants separately did reveal statistically significant moderation patterns. Namely, anxiety sensitivity emerged as a moderator between trait anxiety and PSQI sleep quality when these two groups were analyzed separately. However, a different pattern of moderation was observed in the two groups. For college students, the relationship between trait anxiety and PSQI sleep quality was stronger for those with higher anxiety sensitivity, in line with this study's hypotheses. It was

hypothesized that anxiety sensitivity would enhance the relationship between sleep quality and trait anxiety by increasing worry about the effects of a lack of sleep and vigilance of somatic symptoms of sleep dysfunction, in accordance with Harvey's (2002) cognitive model of insomnia. However, for non-college participants, the relationship between trait anxiety and PSQI sleep quality was stronger for those lower in anxiety sensitivity, opposite to this study's hypotheses. Hearon et al.'s (2014) study could help explain the results of this analyses; the researchers found that people with higher anxiety sensitivity may be more likely to engage in moderate physical activity when compared to those with lower anxiety sensitivity. They hypothesized that higher anxiety sensitivity may motivate someone to engage in health behaviors in order to preserve their health, because they are more anxious about the effects of unhealthy behaviors on their wellbeing. Perhaps a similar effect occurs for those in the general population with higher anxiety sensitivity – they may be more motivated to engage in effective sleep hygiene behaviors out of a fear of a lack of sleep and the subsequent health consequences. Another possibility is that age affects the relationship between sleep quality and trait anxiety, as the non-college student sample was significantly older than the college student sample. Additionally, older age was associated with lower levels of anxiety sensitivity and trait anxiety. This is in line with previous research on the relationships between age and anxiety; namely, anxiety levels appear to decline with age (Mirowsky & Schieman, 2008). Teachman (2006) found that the STAI trait anxiety subscale and age had a curvilinear relationship, with anxiety levels rising into early adulthood, then decreasing until older adulthood, at which point anxiety levels increase again with age. Lenze & Loebach Wetherell (2011) in a review of anxiety over the lifespan note that anxiety disorders associated with panic and panic-like symptoms are more prevalent earlier in life, as opposed to in older adulthood, likely because age changes one's

autonomic responses to stressors. Anxiety sensitivity has frequently been found to be elevated in people with panic disorder and PTSD (Maller & Reiss, 1992; Marshall et al., 2010). While there was not a significant difference in anxiety sensitivity scores between the two samples, it may be that the two groups differed in *how* they experienced anxiety sensitivity – perhaps as more cognitive than somatic, or vice-versa, for instance. Given that age can affect the severity and presentation of anxiety symptomology, it is possible that participants in the non-college sample experience a different relationship between trait anxiety and sleep quality than participants in the college student sample.

While the results of these exploratory analyses provide interesting results, it is important not to overemphasize their directions. Anxiety sensitivity did emerge as a significant moderator when the populations were analyzed separately; however, the interaction between trait anxiety and anxiety sensitivity only explained a small additional amount of variance in both analyses. It is thus possible that these statistically significant moderation results represent Type I errors and “HARKing” (Kerr, 1998). More theory and research/replication is needed investigate the possibility of an age difference and better understand these relationships.

It was hypothesized that anxiety sensitivity would moderate the relationship between BMI and PSQI scores, but this pattern was not observed. Although the model containing BMI and anxiety sensitivity explained a significant amount of variance in sleep quality scores, only anxiety sensitivity was a significant predictor of sleep quality. This pattern of results makes sense, given that BMI and sleep quality were not significantly correlated. While previous research has found that BMI and anxiety sensitivity could be related, with BMI possibly increasing the distress caused by higher anxiety sensitivity (Hearon et al., 2014; Smits et al., 2010), this relationship was not observed in the current study. Hearon et al. (2014) found that

overweight/obese individuals scored significantly higher than normal weight individuals on the ASI, and Kauffman et al. (2020) found a significant relationship between BMI and a short version of the ASI. However, Smits et al. (2010) and DeBoer et al. (2012) did not observe a significant relationship between BMI and ASI. Additionally, Farris (2016) did not find a significant relationship between ASI scores and BMI ($r = -0.02$) in a sample of cigarette smokers. In that study, the relationship between ASI and BMI was only significant when cigarette smokers had lower levels of exercise self-efficacy scores, indicating a lack of confidence to begin exercising. Perhaps other variables can better explain how anxiety sensitivity may be related to BMI and other measures of body fat or body weight. Additionally, BMI may not have been an accurate representation of excess body weight; for instance, people self-reporting BMIs may report higher heights and lower weights, leading to lower reported than actual BMI scores (Elgar & Stewart, 2008). Therefore, the use of self-report BMI may result in underestimation of obesity rates (Großschädl et al., 2012), which could have affected the statistical analyses conducted in this study.

Exploratory analyses were conducted to examine how specific facets of the ASI and the PSQI related to one another. Scores on the cognitive concerns subscale of the ASI were found to be significantly and strongly related to the daytime dysfunction component of the PSQI, indicating that people with greater cognitive concerns reported greater daytime dysfunction. This component consists of two questions about staying awake during daily activities and having enough enthusiasm to get things done. This result aligns with past research on the connection between ASI-cognitive concerns and sleep dysfunction. More generally, the cognitive concern's moderate relationships with subjective sleep quality, sleep duration, and sleep disturbance also line up with previous research on the correlation between anxiety sensitivity and sleep

dysfunction. Those with higher concerns about their mental functioning reported worse subjective sleep quality, shorter sleep duration, and greater sleep disturbance. The cognitive concerns subscale of the ASI was also found to moderate the relationship between trait anxiety and PSQI sleep quality.

The results of these exploratory analyses align with previous research on the relationships between the cognitive concerns subscale and sleep dysfunction. Baker et al. (2007) found that the cognitive concerns subscale was the strongest predictor of global PSQI scores in people diagnosed with anxiety disorders. Additionally, Vincent and Walker (2001) found that those with a greater fear of anxiety's effects on their mental functioning reported greater levels of sleep dysfunction, positing that those with higher anxiety sensitivity would be more sensitive to any effects of sleep dysfunction, resulting in greater daytime impairment. These results align with Harvey's (2002) cognitive model of insomnia, which states that people who are more worried about the negative consequences of a lack of sleep may find it more difficult to fall asleep because of that worry, especially if it takes place immediately preceding sleep. People with higher anxiety sensitivity in particular may be worried about and pay closer attention to their somatic symptoms, and may be more likely to notice or catastrophize any symptom that indicates that they are not getting enough sleep. They may be more preoccupied with these symptoms and subsequently worry about them, which could interfere with their ability to fall asleep at night and result in a "vicious circle" of sleep dysfunction and worry about sleep dysfunction.

Problems and Limitations

A limitation of this study is the strong correlation between trait anxiety and anxiety sensitivity. Past research has shown that trait anxiety and anxiety sensitivity are related to one

another; Taylor et al. (1991) found that items from the ASI and the trait anxiety subscale of the STAI generally loaded onto separate factors, and those factors had a moderate correlation ($r = 0.39$). The researchers posited that the relationship could be attributed to shared method variance and because both the STAI and the ASI are measures of anxiety. Other studies reviewed by Taylor et al. yielded an average of moderately high correlations between anxiety sensitivity and trait anxiety (median $r = 0.46$). Past research has found moderate to strong relationships between the ASI and trait anxiety, as measured by the STAI; Schmidt and Mallott (2006) found a moderate relationship between the STAI trait anxiety subscale and the ASI ($r = 0.36$), while Kemper et al. (2012) found a strong relationship between the STAI trait anxiety subscale and the ASI-3 ($r = 0.61$). The strong relationship between trait anxiety and anxiety sensitivity in this study, similar to that found by Kemper et al., may have affected the moderator analysis, causing multicollinearity that resulted in anxiety sensitivity not emerging as a moderator in the relationship between trait anxiety and PSQI sleep quality. Indeed, anxiety sensitivity was not a significant predictor in the regression model predicting PSQI sleep quality from anxiety sensitivity and trait anxiety, despite the strong correlation between PSQI sleep quality and anxiety sensitivity. Additionally, anxiety sensitivity was a significant predictor of PSQI sleep quality in the regression model predicting PSQI sleep quality from anxiety sensitivity and BMI.

Participants were adults recruited via social media and from a pool of students enrolled in an undergraduate introduction to psychology course at a Midwestern public university. Perhaps college students and a general adult population experience the relationships between anxiety sensitivity, trait anxiety, and sleep quality in different manners. While there were no significant differences between college students and non-college student participants in anxiety sensitivity, trait anxiety, and PSQI sleep quality, there was a difference in age: Namely, the non-college

sample was significantly older than the college student sample. The significant difference in age may indicate important differences between these two samples that were not assessed by any of the three measures of interest. Anxiety has a curvilinear relationship with age (Teachman, 2006). There may have been other important but unmeasured differences between the samples that could have affected the relationships between anxiety sensitivity, trait anxiety, and PSQI sleep quality.

The data provided in this study was all self-report, requiring participants to recall their behavior and typical psychological functioning. This included average sleep behaviors over the past month, body weight and height information, and anxiety symptomology. Participants' recollections may have been inaccurate; they could also be intentionally or unintentionally employing a response style or response distortion, in which their answers do not accurately reflect their true functioning (Rogers, 2008). This could include overreporting of desirable behaviors, such as sleep hygiene, and underreporting of stigmatized behaviors or attributes, such as body weight or anxiety symptomology. Finally, the use of the PSQI itself could have interfered with the ability to find significant moderation results. While it is one of the most widely used measures of sleep quality, the PSQI is limited by its dependence on self-report and also has low to moderate reliability, as it combines many different components of sleep quality including sleep hygiene and sleep duration. Additionally, as observed in the exploratory analyses, there are two components (sleep efficiency and use of sleep medication) which were not correlated with anxiety sensitivity. Perhaps these components of sleep quality are not relevant for those with higher anxiety sensitivity. A more objective or in-depth measure of sleep quality, such as via actigraphy device and daily sleep diary, might yield more accurate

representations of participants' sleep patterns and sleep quality, possibly leading to more interesting and representative results.

Implications and Future Research

Anxiety sensitivity and trait anxiety were significantly correlated with sleep quality, and the two variables combined to significantly predict sleep quality. These results help support the relationship between anxiety and sleep dysfunction. Future research should further explicate these relationships, perhaps in a more realistic/real-world setting as opposed to a self-report questionnaire. Further studies on this topic could use sleep trackers in collaboration with self-reported sleep diaries to have a more accurate representation of participants' sleep schedules. Contrary to this study's hypotheses, BMI and ASI were not significantly correlated. Future research could measure body fat in a more objective manner to have a truer assessment of participants' body weight.

To avoid issues of multicollinearity, future research should examine the role of anxiety sensitivity in the relationships between other psychological disorders and sleep quality. Sleep dysfunction is a common symptom in many psychological disorders; higher rates of anxiety sensitivity, which is designated as a transdiagnostic mechanism, have also been observed in other types of anxiety and related disorders, such as posttraumatic stress disorder. While anxiety sensitivity is related to PTSD, it is likely not as strongly correlated with measures of PTSD as it is with measures of trait anxiety. Therefore, the measure assessing PTSD and the ASI may not be as strongly correlated, leading to less collinearity and a more interpretable hierarchical regression.

In exploratory analyses, the cognitive concerns subscale emerged as a moderator of the relationship between trait anxiety and PSQI sleep quality. The subscale, like the ASI as a whole,

was also correlated with five of the seven PSQI components, and specifically had a strong relationship with daytime dysfunction. Future research could examine the cognitive concerns subscale specifically to see if it is a more accurate predictor of sleep dysfunction than the ASI as a whole. Additionally, from these results it seems anxiety sensitivity generally and the cognitive concerns subscale of the ASI specifically are only correlated with some – not all – of the PSQI components; sleep efficiency and use of sleep medication, which are the components that were not significantly correlated with the ASI or the cognitive concerns subscale, may not be as relevant for those with higher anxiety sensitivity. Again, perhaps different measures of sleep duration and sleep quality could yield more pertinent results when examining the relationships between anxiety sensitivity and sleep.

Conclusion

This study examined the relationships between anxiety sensitivity, trait anxiety, sleep quality, and BMI. Trait anxiety and anxiety sensitivity were found to be significant predictors of sleep quality, in line with previous research; however, contrary to the study's hypotheses, anxiety sensitivity did not moderate the relationship between trait anxiety and sleep quality. Significant moderations were only observed in exploratory analyses when the participants were examined in separate groups of college participants and non-college participants, resulting in opposite patterns of moderation, perhaps because of a significant difference in age between the two groups and differences in how anxiety symptomology manifests as people age. It is possible that the strong relationship between trait anxiety and anxiety sensitivity interfered with the ability to detect a significant moderation in the sample at large; future research could avoid this issue by examining if anxiety sensitivity, which is a mechanism found in many psychological disorders, moderates the relationship between sleep quality and some other disorder, such as PTSD. Also

contrary to this study's hypotheses, BMI was not found to be related to any other variable of interest; anxiety sensitivity did not moderate the relationship between BMI and sleep quality. Past research examining BMI and anxiety sensitivity has had inconsistent results, with only some researchers finding a significant relationship. Given the conflicting results on the relationship between BMI and anxiety sensitivity, future research could examine body weight in a more objective or precise manner to examine how it relates to anxiety sensitivity. While anxiety sensitivity did not emerge as a moderator in either hypothesized relationship, the results of this study indicate that there are interesting relationships between anxiety sensitivity, trait anxiety, and sleep quality that should be further explicated in future research.

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Appendix

Anxiety Sensitivity Index III (Taylor et al., 2007)

(0 = Very little, 1 = A little, 2 = Some, 3 = Much, 4 = Very)

* = Cognitive Concerns subscale items

- 1) It is important for me not to appear nervous.
- 2) When I cannot keep my mind on a task, I worry that I might be going crazy.*
- 3) It scares me when my heart beats rapidly.
- 4) When my stomach is upset, I worry that I might be seriously ill.
- 5) It scares me when I am unable to keep my mind on a task.*
- 6) When I tremble in the presence of others, I fear what people might think of me.
- 7) When my chest feels tight, I get scared that I won't be able to breathe properly.
- 8) When I feel pain in my chest, I worry that I'm going to have a heart attack.
- 9) I worry that other people will notice my anxiety.
- 10) When I feel "spacey" or spaced out I worry that I may be mentally ill.*
- 11) It scares me when I blush in front of people.
- 12) When I notice my heart skipping a beat, I worry that there is something seriously wrong with me.
- 13) When I begin to sweat in a social situation, I fear people will think negatively of me.
- 14) When my thoughts seem to speed up, I worry that I might be going crazy.*
- 15) When my throat feels tight, I worry that I could choke to death.
- 16) When I have trouble thinking clearly, I worry that there is something wrong with me.*
- 17) I think it would be horrible for me to faint in public.
- 18) When my mind goes blank, I worry there is something terribly wrong with me.*

Demographic questions

What is your age?

(Open-ended)

What is your biological sex (as assigned at birth)?

("male," "female," "intersex," "prefer not to answer")

What is your race/ethnicity?

- Black or African American
- Asian or Pacific Islander
- Hispanic or Latinx
- Non-Hispanic White or Euro-American
- Native American
- Other
- Mixed race
- Prefer not to answer
-

What is your height?

(Open-ended)

What is your weight in pounds?
(Open-ended)

State Trait Anxiety Inventory

(1 = Not at all, 2 = A little, 3 = Somewhat, 4 = Very much so)

1. I feel calm
2. I feel secure
3. I feel tense
4. I feel strained
5. I feel at ease
6. I feel upset
7. I am presently worrying over possible misfortunes
8. I feel satisfied
9. I feel frightened
10. I feel uncomfortable
11. I feel self confident
12. I feel nervous
13. I feel jittery
14. I feel indecisive
15. I am relaxed
16. I feel content
17. I am worried
18. I feel confused
19. I feel steady
20. I feel pleasant

The Pittsburgh Sleep Quality Index

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions. During the past month,

- 1) When have you usually gone to bed? Usual bedtime _____
- 2) How long (in minutes) has it taken you to fall asleep each night? Number of minutes _____
- 3) When have you usually gotten up in the morning? Usual getting up time _____
- 4) How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed). Hours of sleep per night _____
- 5) During the past month, how often have you had trouble sleeping because you: (answer with 0 = *Not during the past month*, 1 = *Less than once a week*, 2 = *Once or twice a week*, and 3 = *Three or more times a week*)
 - a. Cannot get to sleep within 30 minutes
 - b. Wake up in the middle of the night or early morning
 - c. Have to get up to use the bathroom
 - d. Cannot breathe comfortably
 - e. Cough or snore loudly
 - f. Feel too cold

- g. Feel too hot
 - h. Have bad dreams
 - i. Have pain
 - j. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason.
- 6) During the past month, how would you rate your sleep quality overall? (*very good, fairly good, fairly bad, or very bad*)
- 7) During the past month, how often have you taken medicine (prescribed or “over the counter”) to help you sleep? (*Not during the past month, less than once a week, once or twice a week, or three or more times a week*)
- 8) During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? (*Not during the past month, less than once a week, once or twice a week, or three or more times a week*)
- 9) During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done? (*No problem at all, only a very slight problem, somewhat of a problem, or a very big problem*)
- 10) Do you have a bed partner or roommate? (*No bed partner or roommate, partner/roommate in other room, partner in same room but not same bed, or partner in same bed.*)
- 11) If you have a roommate or bed partner, ask him/her how often in the past month you have had: (*Not during the past month, less than once a week, once or twice a week, or three or more times a week*)
- a. Loud snoring
 - b. Long pauses between breaths while asleep
 - c. Legs twitching or jerking while you sleep
 - d. Episodes of disorientation or confusion during sleep
 - e. Other restlessness while you sleep, please describe:

Footnotes

¹In addition to sleep, the pilot study also explored the relationships between anxiety, anxiety sensitivity, and the health behaviors of physical activity and alcohol consumption. Alcohol consumption, as measured by the Alcohol Use Disorders Identification Test (Babor et al., 1992) was not significantly correlated with anxiety sensitivity, anxiety symptomology, or BMI. Physical activity, as measured by the Global Physical Activity Questionnaire (Armstrong & Bull, 2006), was not significantly correlated with anxiety sensitivity, anxiety symptomology, or BMI.