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Health Anxiety and Cognitive Processes as Risks for Insomnia in Women Undergoing Chemotherapy for Breast Cancer

A dissertation submitted in partial satisfaction of the requirements for the degree

Doctor of Philosophy

in

Clinical Psychology

by

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The dissertation of Michelle B. Rissling is approved, and

it is acceptable in quality and form for publication on microfilm and electronically:

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Chair

University of California, San Diego

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2012

Dedication

To my husband,

Anthony Joseph Rissling,

and my daughter,

Elizabeth Kathyrn Rissling,

with Love.

To my participants: the women diagnosed with

but not defined by breast cancer, and

the women willing to help friend and stranger alike

by volunteering for science.

Thank you.

Epigraph

"The Costs of Growth"

Every major life change destroys the equilibrium of our lives and our self-image and leaves behind a portion of an old self.

Joan Bolker, Ed.D.

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List of Abbreviations

BL = baseline

BSI = Brief Symptom Inventory

C4 = end of treatment

CES-D = Center for Epidemiological Studies Depression Scale

GCTI = Glasgow Content of Thoughts Inventory

GSES = Glasgow Sleep Effort Scale

GCS = Greene Climacteric Scale

ISI = Insomnia Severity Index

IV = independent variable

Sleep % = Sleep Percentage

TST = Total Sleep Time

WASO = Wake After Sleep Onset

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ABSTRACT OF THE DISSERTATION

Health Anxiety and Cognitive Processes as Risks for Insomnia in Women Undergoing Chemotherapy for Breast Cancer

by

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Breast cancer patients have a high incidence of co-morbid chronic insomnia which frequently persists into survivorship. The mechanism behind this insomnia is poorly understood, yet maladaptive responses to the sleep disturbance resulting from an acute stressor are implicated in cognitive models of insomnia. Evidence suggests that health anxiety, pre-sleep cognitive arousal and compensatory sleep effort may predispose and/or perpetuate psychophysiological insomnia. These mechanisms have not been examined in patients with breast cancer, but if present, may be used to identify individuals at risk for developing chronic insomnia as well as inform intervention. Twenty women recently diagnosed with breast cancer and scheduled for adjuvant chemotherapy (age M = 54.6, SD = 7.9, range = 36-64) and 20 healthy age-matched women without history of breast cancer (age M = 53.6, SD = 7.5, range = 38-69) completed self-assessments and 72-hour wrist actigraphy on two occasions:(a) baseline, which for breast cancer patients was prior to start of chemotherapy (BL); and

(b) at a subsequent occasion during or yoked to the last week of cycle 4 of chemotherapy (C4). Two-factor ANOVA revealed that at BL and C4 both groups reported similar levels of insomnia in addition to health anxiety, pre-sleep cognitive arousal and compensatory sleep effort. Actigraphic sleep and menopausal symptoms were also similar. Linear regression-based mediation analyses revealed that at BL, both groups demonstrated an association between health anxiety, compensatory sleep effort and insomnia. At C4, both groups demonstrated an association between compensatory sleep effort, pre-sleep cognitive arousal and insomnia. Additionally, compensatory sleep effort mediated links between health anxiety and insomnia, and pre-sleep cognitive arousal and insomnia. The results validate cognitive models of insomnia and provide support for targeting health anxiety, pre-sleep cognitive arousal and compensatory sleep effort as risk factors for insomnia in women with and without breast cancer.

Introduction

Insomnia

Insomnia describes a sleep disorder in which there is difficulty initiating or maintaining sleep, or non-restorative sleep, which causes clinically significant distress or impairment in daytime functioning (American Psychiatric Association, 2000). Insomnia is a very common sleep disorder, with prevalence rates ranging from 6%-23% in adults and 30-50% in elderly. Women, disabled persons and irregular shift workers have consistently higher rates of insomnia (Ancoli-Isreal & Roth, 1999; Ford & Kamerow, 1989; Hublin & Parninen, 2002; Ishigooka et al., 1999; Katz & McHorney, 2002; LeBlanc et al., 2009; M. Ohayon & Rorth, 2001; M. M. Ohayon, 2002; Roth et al., 2010; Simon & VonKorff, 1997).

For most individuals, insomnia is a transient phenomenon, resolving within days or weeks; however, a substantial fraction suffers from chronic insomnia. Intransient or chronic insomnia is defined by an increase in frequency (usually >=3 times per week) and duration (varies from 1-6 months). The severity of insomnia as a complaint appears to have a direct relationship with its persistence; therefore, chronic insomnia is the most severe manifestation of this disorder (Ancoli-Israel, 2006; Katz & McHorney, 1998).

Insomnia has a host of debilitating consequences, including tiredness, negative mood, inability to enjoy family and social relationships, difficulty concentrating, memory problems, decreased quality of life, increased absenteeism, decreased job performance, increased severity of pain and poor health, and increased risk of falls (Ancoli-Isreal & Roth, 1999; Stone, Ensrud, & Ancoli-Israel, 2008). Chronic insomnia

is especially associated with greater functional impairment, loss of productivity (Ancoli-Isreal & Roth, 1999), excess health care utilization (Simon & VonKorff, 1997), and a high risk of developing affective disorders, particularly depression and anxiety (Neckelmann, Mykletun, & Dahl, 2007; D. J. Taylor, Lichstein, Durrence, Reidel, & Bush, 2005).

Insomnia is often associated with a chronic medical or psychiatric conditions such as arthritis, fibromyalgia, cancer, cardiovascular disease, diabetes and depression (Ancoli-Israel, 2006; Foley, Ancoli-Israel, Britz, & Walsh, 2004; A. G. Harvey, 2001b; Mellinger, Balter, & Uhlenhuth, 1985). Insomnia in cancer is a relatively new area of research, but evidence suggests that in this population insomnia is independently associated with worsened quality of life to almost the same extent as clinical depression (Katz & McHorney, 2002). In 2005, the National Institutes of Health State-of-the-Science Conference Statement on Manifestations and Management of Chronic Insomnia in Adults recognized a lack of longitudinal research of risk factors associated with insomnia, especially with regard to insomnia in cancer (National Institutes of Health, 2005).

Insomnia in breast cancer. As described by Vena et al. (Vena, Parker, Cunningham, Clark, & McMillan, 2004) and Clark et al. (J. Clark, Cunningham, McMillan, Vena, & Parker, 2004), poor sleep is common in all types of cancer and can often have serious consequences. However, insomnia in cancer is considered a neglected medical problem; Savard and Morin (2001) postulated that insomnia is often considered a natural and transient reaction to the stressors of cancer diagnosis and treatment and is thus more likely to be attributed to co-morbid depression or anxiety.

In the context of medical care for cancer, patients may fail to report insomnia to health care providers and, in turn, health care providers may fail to assess or address it adequately.

In the last decade, a large portion of the literature on sleep in cancer has consisted of observational studies of women with breast cancer. The consensus is that in breast cancer especially, poor sleep is a common yet often neglected complaint (Berger et al., 2005; J. Savard & Morin, 2001; Vena et al., 2004). In addition to having the risk factors of female gender and increasing age, breast cancer affects women more than men (World Health Report, 1997) and women with breast cancer report more physical symptoms and poorer perceptions of their physical health than their male counterparts (O'Neill & Morrow, 2001). Studies of subjective sleep reports in breast cancer patients have found significant complaints of difficulty sleeping (Ancoli-Israel, Kryger, Roth, & Dement, 2005) with the severity of the complaints being comparable to the insomnia complaints in other medical conditions (Fortner, Stepanski, Wang, Kasprowicz, & Durrence, 2002).

Estimates of insomnia in newly-diagnosed breast cancer patients range from 30% to 75% (J. Savard & Morin, 2001). While the course of insomnia in the context of breast cancer is not well understood, women with breast cancer consistently report difficulty sleeping during the first few months after diagnosis while undergoing treatment (Beck et al., 2010; Knobf, 1990; McCorkle & Quint-Benoliel, 1983). Fatigue, or tiredness that persists despite adequate sleep, is also a primary complaint in patients with breast cancer and may be related to sleep disturbances (Ancoli-Israel, Moore, & Jones, 2001). Despite the prevalence and debilitating effect of these

symptoms, only recently has research focused on factors that contribute to the increased risk of insomnia in breast cancer. One survey of breast cancer patients found that 58% reported that cancer caused or exacerbated their sleep problems (J. Savard, Simard, Blanchet, Ivers, & Morin, 2001) and a large cross-sectional study of 982 cancer patients (predominantly breast cancer type) found that a significant portion of patients that met diagnostic criteria for insomnia also began having difficulties sleeping around the time of diagnosis (Davidson, MacLean, Brundage, & Schulze, 2002).

Risk factors for insomnia in breast cancer.

*3-P behavioral model***.** The factors that increase risk of insomnia in breast cancer patients are poorly understood. However, in considering such factors, the 3-P behavioral model proposed by Spielman and Glovinksy (1991) provides a useful heuristic: predisposing, precipitating and perpetuating factors. First, predisposing factors are those psychological or biological characteristics that increase vulnerability, or predisposition, to sleep difficulties (e.g., family history, female gender, hyperarousal). Predisposing factors are not a direct cause of insomnia per se but increase the risk that an individual will develop sleep difficulties. Second, precipitating factors are life events and the medical, environmental or psychological factors that trigger insomnia (e.g., divorce, death of a significant other, major illness, medication, familial or occupational stress). Finally, perpetuating factors are elements that maintain or exacerbate sleep difficulties. As described in more detail below, perpetuating factors are behaviors (e.g., extending time spend in bed to try to sleep more, napping, maladaptive beliefs or thoughts) that individuals employ in order to

cope with transient sleep loss, but over time are theorized to have the opposite effect and prolong insomnia (Bastien, Vallieres, & Morin, 2004).

In comparison to predisposing factors, precipitating and perpetuating factors have a much larger implication in the etiology of insomnia; in particular, processes which transform acute or transient insomnia into persistent or chronic insomnia. Most cases of insomnia in non-chronically ill populations are precipitated by transient but disruptive events, e.g., stressful and/or arousing events involving family, health, and work/school; however, most of these cases spontaneously remit and good sleep is restored (Bastien, Vallieres, & Morin, 2004). The extension of poor sleep into chronic insomnia is a large target in this area of research but one that is also difficult to hit; as observed by Bastien et al., even the heuristic provided by the 3-P model loses effectiveness when precipitating factors become themselves chronic by nature.

*Predisposing factors in insomnia***.** The consensus of the 2005 National Institute of Health's conference on chronic insomnia in adults states that two issues limit the ability to draw conclusions from extant studies of predisposing factors of insomnia: (a) validated diagnostic instruments have not been applied in large, population-based studies; and (b) the many co-morbid physical and psychiatric conditions associated with a diagnosis of insomnia may be its cause, its consequence, or share its risk factors ("NIH State-of-the-Science Conference Statement on manifestations and management of chronic insomnia in adults," 2005). The paucity of evidence to describe the course or duration of insomnia is due to a preponderance of cross-sectional rather than prospective studies. Therefore, the current state of the science of insomnia is that

causal statements about specific risk factors are limited. Nonetheless, several consistent associations have emerged and are conceptualized as predisposing factors.

As mentioned previously, aging and female gender are two consistent predisposing factors in insomnia. Additional demographic characteristics linked to insomnia in general populations include: being unemployed, single, separated or widowed (Ford & Kamerow, 1989; Mellinger et al., 1985). Less consistent is education level; studies have demonstrated that both low or high education is associated with insomnia (Morin, 1993), or low education only in men (Li, Wing, Ho, & Fong, 2002), or no association at all (Morin, LeBlanc, Daley, Gregoire, & Merette, 2006). The NIH insomnia conference also concluded that the evidence on racial or ethnic risk factors is “limited and inconclusive” ("NIH State-of-the-Science Conference Statement on manifestations and management of chronic insomnia in adults," 2005, p. 1050). A 2010 review on race and ethnicity (i.e., Hispanic ethnicity) upholds this conclusion but suggests that the report of sleep disturbances by minority groups may be biased by a variety of factors including: acculturation, age, gender, environment, and socioeconomic status (MacKinnon, Fairchild, & Fritz, 2007).

Predisposing and precipitating factors in insomnia in cancer. In cancer populations, insomnia has been linked to cancer-specific risk factors, including higher stage (i.e., metastatic), treatment effects (radiotherapy and chemotherapy), physical symptoms (i.e., pain and vasomotor) and decreased light exposure (Ancoli-Israel et al., 2006; Koopman et al., 2002; Liu et al., 2005; O. Palesh et al., 2007; J. Savard et al., 2001). In a recent sample of 288 cancer patients (32% breast cancer) scheduled to receive chemotherapy, 26% reported very or fairly poor sleep, and poor sleep was

predicted by less education, less physical activity, more medical comorbidities and tobacco use (Phillips, Jim, Donovan, Pinder-Schenck, & Jacobsen, 2011).

In the largest epidemiological study to date of insomnia in breast cancer (N = 2,645), cancer-specific and patient factors were not found to be significant risk factors. When all factors were considered separately, lower education, less physical activity, worse physical health (i.e., pain and vasomotor symptoms) and worse psychosocial functioning were linked with insomnia symptoms. When these factors were considered together and used to predict high vs. low insomnia group membership, only physical health and psychosocial functioning were predictive. Of these, vasomotor and depression symptoms were the strongest predictors (Bardwell et al., 2008).

Although age was not a significant risk factor in the Bardwell et al. study, other studies have found interesting relationships between age and insomnia in breast cancer. Palesh and colleagues found that younger patients reported more symptoms of insomnia than older patients (O. G. Palesh et al., 2010). These results echo those of an earlier study which also found that younger patients (age < 50 yrs) had a larger symptom burden, including insomnia, than older patients (age > 64 yrs; Mao et al., 2007). These results contradict those found in non-cancer populations. The authors of both studies speculated that younger patients may expect better health outcomes despite possibly having more aggressive tumors that require more aggressive treatments than older patients. The collusion of high prognostic expectations and more severe treatment side effects may contribute to increased complaints of insomnia. These factors may also serve to induce or increase cancer-related health anxiety,

which, as postulated in the current study, may also lead to increased insomnia symptoms in a younger patient population.

Few longitudinal studies of insomnia in breast cancer have prospectively investigated predisposing, precipitating and perpetuating factors. In one such recent study, 991 non-metastatic cancer patients were followed from pre-surgery to 18 months post; however, only the first two study points have been published to date (J. Savard, Villa, Ivers, Simard, & Morin, 2009). At pre-surgery, 28.5% met criteria for insomnia and 31% had insomnia symptoms; of these, breast cancer patients were the majority. The most significant predisposing factors were female gender and the presence of a self-reported arousability trait. Two months after surgery, the surgical procedure itself and an increase in anxiety symptoms from pre-surgery levels were both found to predict the onset of insomnia symptoms.

Of those patients already experiencing insomnia, both higher baseline levels of and increases in dysfunctional beliefs about sleep, sleep monitoring, and maladaptive sleep behaviors were all associated with an increased risk for insomnia incidence. A surprising finding in a relatively large sub-sample of patients with upper gastrointestinal cancer was that female gender was not a predisposing factor; in this group, both male and female gender were equally represented and neither gender had a higher incidence in insomnia than the other. Of more relevance to the current study is the finding that trait hyperarousability and an increased state of anxiety were both highly associated with the onset or exacerbation of insomnia.

Pain symptoms and insomnia in breast cancer. Pain is a common symptom in cancer patients and also a potent disruptor of sleep. The prevalence of pain in cancer is similar to insomnia in cancer and ranges from 33%-65% of patients; rates are highest in metastatic or palliative cancer (McGuire, 2004). Cancer pain may be constant or breakthrough (pain flares interrupting well-controlled baseline pain); however, evidence suggests that both presentations are experienced similarly by young and aged cancer patients alike (Green & Hart Johnson, 2010).

The relationship between pain and disturbed sleep in general is complex; it has been described as encompassing physiological, psychological, behavioral and socio-cultural domains (Parker, Kimble, Dunbar, & Clark, 2005). Despite this complexity, few studies have investigated the direct effect of pain on sleep; moreover, sleep loss has been shown to be hyperalgesic and thus may increase the perception of pain (Roehrs, Hyde, Blaisdell, Greenwald, & Roth, 2006). In cancer, pain frequently accompanies sleep disturbances (Fortner et al., 2002; Mercadante, Girelli, & Casuccio, 2004; Yue & Dimsdale, 2010).

Pain also frequently accompanies depression and fatigue, both of which are associated with sleep disturbance; these co-occurring symptoms have been recently conceptualized as comprising a cluster of symptoms (pain, sleep, fatigue; Beck, Dudley, & Barsevick, 2005; sleep, depression, fatigue; Liu et al., 2009; pain, depression, fatigue; Miaskowski, Dodd, & Lee, 2004). Symptom clusters are defined as three or more concurrent and related symptoms (Dodd, Miaskowski, & Paul, 2001). Studies have consistently demonstrated that an increase in one cluster symptom is associated with an increase in the other symptoms (Dodd, Cho, Cooper, &

Miaskowski, 2010; Liu et al., 2009; Longman, Braden, & Mishel, 1999). In one meditational study, pain directly influenced fatigue and indirectly influenced fatigue by its effect on sleep (Beck et al., 2005).

The significance of symptoms clusters in cancer may be more than strong positive association; these symptoms are posited to share the same underlying mechanisms and as such, treatment approaches which address all three symptoms may be more efficacious than addressing any single symptom (Barsevick et al., 2010; Lengacher et al.; A. H. Miller, Ancoli-Israel, Bower, Capuron, & Irwin, 2008; J. Savard, Simard, Ivers, & Morin, 2005; Sherwood et al., 2005).

Menopausal symptoms and insomnia in breast cancer. In pre- and peri-menopausal women undergoing chemotherapy for breast cancer, there is a significant risk of acute ovarian failure which may result in either permanent or temporary amenorrea and a sudden onset or exacerbation of the symptoms of menopause (Knobf, 2006). Natural or aging-related menopause is associated with a host of sequelae, including mood changes, sleep disturbance and vasomotor symptoms (Baker, Simpson, & Dawson, 1997; Shaver, 2009). In chemotherapy-related menopause, these sequalae often manifest in a much shorter time frame and acutely disrupt sexual functioning; thus, these menopausal symptoms may be more distressing and more likely to contribute to insomnia (Ganz et al 2003; Knobf 2006).

Of all menopausal symptoms experienced by breast cancer patients, vasomotor symptoms, i.e., hot flashes and night sweats, are most associated with subjective sleep disturbances (Polo-Kantola, Erkkola, Irjala, Helenius, Pullinen, & Polo, 1999; Bardwell, Profant, Casden, Dimsdale, Ancoli-Israel, et al., 2008); vasomotor

symptoms are hypothesized to contribute to poorer, less consolidated sleep by increasing awakenings and sleep stage changes (Savard et al., 2004). Carpenter et al. (2004) found that 67% of survivors of breast cancer experienced nighttime hot flashes compared to only 37% of healthy women matched, among other variables, on age and menopausal status. Savard et al. (2004) reported that nights with hot flashes were associated with more sleep disturbance compared to nights with no hot flashes. Therefore, hot flashes may be a significant precipitating factor of poor sleep in women with breast cancer. However, no study to date has evaluated whether chemotherapy-induced vasomotor symptoms are as frequent and/or intense as aging-induced vasomotor symptoms.

In addition, there is a growing body of evidence from studies of natural menopause that suggest sleep disturbance may be independent of self-reported vasomotor symptoms; in one study, hot flashes were temporally measured as following, rather than preceding nighttime sleep disturbances (Freedman, 2005). Although similarly controlled studies have yet to be done in breast cancer patients, it is possible that as in natural menopause, increased vasomotor symptoms may be the consequence of sleep disturbances related to younger age, co-morbid sleep disorders and elevated anxiety (Carpenter et al., 2004; Knobf, 2006; Parry, 2007; Quesnel, Savard, Simard, Ivers, & Morin, 2003).

Psychiatric symptoms and insomnia in breast cancer. The psychological reaction to the cancer diagnosis and treatment can also play an important role in the development of insomnia. It is reasonable to assume that in many women the recognition of a life threatening condition represents an acute stressor. Therefore,

recent research has highlighted the contribution of bio-psycho-social vulnerabilities and related risk factors to the presentation of insomnia in cancer (Fiorentino & Ancoli-Israel, 2006).In a recent review of behavioral symptoms in both patients and survivors of breast cancer, psychosocial factors such as psychiatric history and negative coping have been found to contribute to the development and persistence of sleep disturbances and fatigue (Bower, 2008). Furthermore, the diagnosis of breast cancer and the decision to initiate treatment may induce or worsen extent symptoms of anxiety and/or depression that in turn may also disrupt sleep. However, as noted in the National Institute of Health's consensus on insomnia, the temporal relationship between insomnia and psychiatric disorders is still unknown ("NIH State-of-the-Science Conference Statement on manifestations and management of chronic insomnia in adults," 2005); current evidence suggests that chronic insomnia may also be a precursor to, rather than just a consequence of, psychiatric comorbidities, i.e., major depression and generalized anxiety (Breslau, Roth, Rosenthal, & Andreski, 1996; Ford & Kamerow, 1989; Kennedy, Kelman, & Thomas, 1991). The life-threatening diagnosis and difficult, protracted course of treatment in breast cancer may represent a unique opportunity to study the processes contributing to insomnia in this population.

Significant psychiatric comorbidities to breast cancer include: major depressive disorder, dysthymic disorder, adjustment disorder with depressive mood or mixed depressive and anxious mood, and anxiety disorders, including generalized anxiety disorder, and adjustment disorder with anxious mood (Kissane et al., 2004; S. L. B. Miller, Jones, & Carney, 2005). In a prospective study of 269 women with early

stage breast cancer, 49% met clinical criteria for an anxiety disorder and 37% for depression within 3 months of the onset of chemotherapy (Hall, A'hern, & Fallowfield, 1999). In a longitudinal study of 222 women diagnosed with early stage breast cancer, nearly 50% reported depression, anxiety, or both in the year after diagnosis and 25% persisting through the four year following diagnosis (Burgess et al., 2005). While rates of each disorder vary by study and condition, most studies recognize depression and anxiety disorders as the most common. Moreover, these estimates are significantly higher than the point prevalence of either depressive disorders (3-9%) or anxiety disorders (0.5-11.3%) found in large community samples (American Psychiatric Association, 2000).

As previously described, there is a strong need for longitudinal and prospective research on the bio-psycho-social characteristics of individuals vulnerable to insomnia. However, one of the methodological quandaries of such research is in measuring vulnerability to insomnia when it is incipient but not yet evident. As suggested by evidence of both predisposing and precipitating factors, insomnia frequently accompanies both depression and elevated anxiety. Evidence suggests that insomnia may be a prodromal feature of depressive episodes (D. J. Taylor, 2008). However, the course of anxiety, depression and insomnia is difficult to examine without experimental manipulation. One arguable alternative may be a quasi-experimental design that examines processes likely to both precede as well as increase the likelihood of insomnia.

Health Anxiety

Health anxiety refers to excessive worry about and preoccupation with illness. Traditionally considered a feature of hypochondriasis, a somatoform disorder that was first recognized by the third edition of the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2000), health anxiety has since garnered recognition as a separate and less severe illness-related anxiety disorder (Salkovskis, 1996; Salkovskis, Rimes, Warwick, & Clark, 2002). Proposed changes in the upcoming 5th edition of the DSM may canonize this re-conceptualization (American Psychiatric Association, 2011). In this sense, health anxiety is conceptualized as a continuum ranging from indifference or lack of attention to health, to strong illness-related fears and constant worry about bodily sensations; at the extreme end of this continuum, the term hypochondriasis is used to describe severe and persistent anxiety focused upon a perceived health threat (Salkovskis & Warwick, 2001). In health anxiety, the perceived health threat may involve "catastrophic overestimates of the probability and seriousness of medical conditions" which "give rise to preoccupation with the suspected illness [and] selective attention to illness-related stimuli" (Abramowitz, Olatunji, & Deacon, 2007, p. 86).

The majority of research in health anxiety has been framed using a cognitive behavioral model. According to this model, the development and persistence of health anxiety in an individual is mediated by knowledge and past experience with illness in oneself or others (Salkovskis & Warwick, 2001). Health anxiety may be triggered by selective attention to bodily sensations and symptoms (body vigilance) that are interpreted as indications of serious physical illness. In this sense, low levels of health

anxiety may be considered adaptive by motivating individuals to respond to critical signs and symptoms. Health anxiety may become maladaptive when relatively benign cues are misinterpreted as catastrophic (anxiety sensitivity). It is important to note that this theoretical framework includes features found in other anxiety disorders; for example, individuals with generalized anxiety disorder (GAD) often report excessive worry and rumination about health (in addition to other concerns) and individuals with panic disorder (PD) often report high levels of body vigilance and anxiety sensitivity. Also, some presentations of obsessive-compulsive disorder (OCD) feature severe contamination fear and avoidance (American Psychiatric Association, 2000).

The most recent systematic review of health anxiety and hypochrondriasis literature concluded that there is considerable support for the cognitive behavioral model of health anxiety; in particular, that health anxious individuals hold different beliefs about health and illness than non-health anxious individuals (Preacher & Hayes, 2004). The authors suggested that future studies of health anxiety should investigate the underlying cognitive processes that differentiate health anxiety from other anxiety or mood disorders. One such study found that, in a sample of medical and non-medical participants, specific health-related cognitions were uniquely associated with health anxiety even after controlling for depression and anxiety (Preacher, Zyphur, & Zhang, 2010). Evidence has demonstrated that while health anxiety and its more severe form, hypochondriasis, are both distinguishable from GAD, PD and OCD, these disorders may nonetheless share psychological mechanisms (Abramowitz et al., 2007; Deacon & Abramowitz, 2008) and be amenable to comparable psychological therapy (Nakao, Shinozaki, Ahern, & Barsky, 2011). Such

underlying processes have the potential to elucidate whether and by what mechanism(s) health anxiety may be triggered in individuals with latent, health-related beliefs (Preacher & Hayes, 2004). If such vulnerability were found, then as in depressive and anxiety disorders, research may discover bio-psycho-social antecedents that are amenable to intervention.

In the absence of an empirically-supported bio-psycho-social model of health anxiety, this construct has been primarily investigated in individuals with chronic illness. Over the last decade, health anxiety has been especially recognized as a key characteristic of chronic pain patients (Deacon & Abramowitz, 2008). Compared with chronic pain patients without health anxiety, patients with health anxiety are more likely to show selective attention to bodily sensations, report more intense pain, exhibit reduced pain tolerance and report more engagement in catastrophizing thinking (Nakao et al., 2011; Preacher & Hayes, 2008a; Wheaton, Berman, Franklin, & Abramowitz, 2010).

Although similar research is lacking in breast cancer, it is conceivable that the diagnosis of breast cancer may induce uncontrollable worry and intrusive health-related thoughts as have been found in chronic pain, and that these experiences may in turn disrupt sleep. A previously described study found that the majority of cancer patients attributed their sleeping difficulties to thoughts (52%), pain or discomfort (45%) and health concerns (38.7%; Davidson et al., 2002). A similar study of chronic pain patients found an association between pre-sleep cognitive arousal and sleep disturbance independent of either depression or pain severity (Smith, Perlis, Carmody, Smith, & Giles, 2001). Similarly to the cancer study by Davidson et al., this sample of

chronic pain patients reported predominantly pain- and negative sleep-related thoughts in association with sleep disturbances; however, these thoughts were prospectively reported at bedtime rather than retrospectively. Perhaps surprisingly, cognitive arousal resulting from thoughts occurring at bedtime was found to be a better predictor of sleep disturbances than pain severity.

One criticism of this cross-sectional and exploratory study is that it did not employ any diagnostic criteria for insomnia; thus, it is unknown whether these patients were experiencing insomnia during the study period. In a more recent study of chronic back pain patients with chronic insomnia, affective pain ratings and health anxiety were the best predictors of insomnia (Tang, Wright, & Salkovskis, 2007). This evidence suggest that if breast cancer patients have a propensity to dwell on health- and sleep-related thoughts, especially during the period immediately following diagnosis, the resulting health-related anxiety may contribute significantly to the risk of insomnia.

Cognitive Models of Insomnia

Psychophysiological insomnia. The International Classification of Sleep Disorders-Second Edition (ICSD2) uses the term "psychophysiological insomnia" to describe insomnia associated with mental arousal (American Academy of Sleep Medicine, 2005). Mental arousal may characterize the experience of individuals with insomnia that tend to be more maladjusted, anxious, depressed, neurotic and worried than people without insomnia (Brabbins et al., 1993; Dorsey & Bootzin, 1997; Fuller, Waters, Binks, & Anderson, 1997; Lundh, Broman, & Hetta, 1995; Morin & Gramling, 1989). Individuals with psychophysiological insomnia complain of

excessive verbal thinking (e.g., “racing mind”) while trying to fall asleep; having an “overactive mind" is the attribution rated most highly by individuals with insomnia (Harvey, 2000; Kuisk, Bertelson, & Walsh, 1989; Lichstein & Rosenthal, 1980; Nicassio, Mendlowitz, Fussell, & Petras, 1985; Robertson, Broomfield, & Espie, 2007).

Although most research in insomnia focuses on adults, recent evidence suggests that pre-sleep arousal is also associated with sleep disturbances in children and adolescents (Alfano, Pina, Zerr, & Villalta, 2010). Therefore, in addition to focusing on psychophysiological insomnia with or without the presence of a comorbid mental disorder, focusing on factors that contribute to psychophysiological insomnia may provide an effective approach to epidemiological research.

Clark (1997) described two potential benefits of specifying a theoretical model on the etiology of a chronic illness: (a) the identification of specific testable processes which contribute to the disorder; (b) provide support for the development of interventions which might reverse these processes. Harvey (2002) and Espie (2002) have both proposed theoretical models of insomnia, each with considerable empirical support. Harvey’s cognitive model of insomnia is an extension of the cognitive approach to mental disorders, i.e., anxiety disorder. Recent work in anxiety has identified processes that prevent automatic correction of distorted beliefs and perceptions that are believed to contribute to the chronicity of anxiety disorder (D. M. Clark & Fairburn, 1997; Salkovskis, 1996). The theoretical framework rests upon the fact that many people develop clinically significant anxiety throughout their lives but

most recover without intervention (D. M. Clark, 1999). Similarly, nearly everyone experiences a bout of acute insomnia, but most recover.

Harvey's model posits that similar to anxiety, insomnia may become chronic by processes of selective attention and monitoring that lead to coping behaviors that, instead of being effective, are maladaptive and perpetuate the sleep disturbance. Such attention to the stressor (along with negative beliefs) is hypothesized to induce excessive worries and ruminations that trigger autonomic arousal and emotional distress. In other words, the individual is plunged into a state of arousal incompatible with the state of sleep.

Espie's (2007) model posits that insomnia results when the de-arousal processes associated with normal sleep are disrupted. Similar to Harvey's model, Espie suggests that sleep onset may be compromised by increased selective attention to both the symptoms of insomnia and subsequent efforts to fall asleep. Psychophysiological insomnia is, in part, defined by the maladaptive coping behavior patients with insomnia employ to attempt to compensate for the day and nighttime consequences of their poor sleep. These maladaptive behaviors include "trying too hard to fall to sleep" to compensate during subsequent sleep opportunities for previous night's of poor sleep and have been termed collectively as sleep effort. This compensatory sleep effort has been shown to discriminate 100% of the individuals with psychophysiological insomnia or insomnia due to a mental disorder from good sleepers (Kohn & Espie, 2005). Interference of compensatory sleep effort through paradoxical intention (e.g., trying not to fall asleep) or with a low versus high mental

load (e.g., listening to relaxing versus marching music) has been shown to improve sleep and to be effective treatments for insomnia (Broomfield & Espie, 2005).

Additional evidence supporting these models have come from self-reports of unpleasant intrusive thoughts and excessive and uncontrollable worry both during the day as well as during the pre-sleep period in individuals with insomnia (Bélanger, Morin, Gendron, & Blais, 2005; A. G. Harvey, 2000, 2001a; Nelson & Harvey, 2003; Van Egeren, Haynes, Franzen, & Hamilton, 1983; Wicklow & Espie, 2000). Lichstein and Rosenthal (1980) found that individuals with insomnia were 10 times more likely to blame excessive cognitive activity for their sleep disturbance. Moreover, increased time to fall asleep may be induced in good sleepers by inducing cognitive arousal just prior to sleep onset (Gross & Borkovec, 1982; Haynes, Adams, & Franzen, 1981). By implication, pre-sleep cognitive arousal may differentiate between those that recover from acute insomnia versus those that develop chronic insomnia. However, in a cross-sectional study of good and poor sleepers, high cognitive arousal was not associated with insomnia but was associated with poor psychological adjustment (Alapin, Libman, Bailes, & Fichten, 2003).

Theoretical model. Figure 1 represents the theoretical model for the current study; the model was adapted from both the Harvey and Espie models discussed above in an attempt to better describe the processes that may contribute to insomnia in women with breast cancer. As shown in Fig. 1, the diagnosis of breast cancer represents an acute stressor that induces psychological stress. Attention is directed toward the stressor(s) which in turns leads to cognitive arousal. Cognitive arousal present at sleep onset leads to symptoms of insomnia (e.g., difficulty falling asleep).

Furthermore, worry and rumination about insomnia may also increase pre-sleep cognitive arousal. Effort to control the onset of sleep is employed to compensate for both the symptoms of insomnia and the associated cognitive arousal. However, compensatory sleep effort represents a maladaptive attempt to control sleep and serves to extend the symptoms of insomnia. Escalating cognitive arousal and compensatory sleep effort prevents a return to normal sleep. The resulting insomnia may also increase vulnerability for psychiatric illness. Health anxiety also results from selective attention towards the health-related stressors and may induce/increase cognitive arousal at sleep onset. Moreover, medical treatment may represent a subsequent stressor that worsens the symptoms of insomnia. It is important to note that if insomnia exists as a pre-morbid condition the course of breast cancer would most likely aggravate the severity of the insomnia via a similar process.

Summary, Aim, and Hypotheses of the Present Study

The principal focus of this dissertation is to examine the effect of health anxiety, cognitive arousal and compensatory sleep effort on sleep in women undergoing chemotherapy following a diagnosis of breast cancer and age-matched healthy women. The contribution of anxiety and cognitive processes to insomnia is suggested both by previous research and specified by cognitive models of insomnia. In particular, cognitive models of insomnia recognize that sleep disturbances following acute stressors may become chronic if cognitive arousal and compensatory sleep effort interfere with recovery to normal sleep. However, the contribution of cognitive processes to insomnia in breast cancer has not been investigated. Cognitive models of

insomnia recognize that sleep disturbances following acute stressors may become chronic if cognitive arousal and/or compensatory sleep effort interfere with recovery to normal sleep. Female gender is a risk for both breast cancer and insomnia and both are related to anxiety and depression. Furthermore, health anxiety in chronically ill populations has been implicated in insomnia and may function to increase pre-sleep cognitive arousal or compensatory sleep effort, but these relationships are also poorly understood.

Hypotheses and Aims

Aim: To evaluate whether cognitions, specifically health anxiety, cognitive arousal and compensatory sleep effort are risk factors for insomnia in women with breast cancer after diagnosis and after treatment and in yoked age- and gender-matched healthy controls.

Hypothesis 1a: Increased health anxiety (as measured by the Short Health Anxiety Inventory), pre-sleep cognitive arousal (as measured by Glasgow Content of Thoughts Inventory) and compensatory sleep effort (as measured by Glasgow Sleep Effort Scale) will be higher in patients with breast cancer than in controls both before and after treatment.

Hypothesis 1b: Depressive symptoms and generalized anxiety (as measured by the Brief Symptom Inventory and the Center of Epidemiological Studies-Depression Scale) will be higher in patients with breast cancer than in controls both before and after treatment.

Hypothesis 1c: Increased health anxiety, pre-sleep cognitive arousal and compensatory sleep effort will be risk factors for insomnia (as measured objectively

with actigraphy and subjectively by the Insomnia Severity Scale) for both patients and controls beyond depression and anxiety and other confounding factors (i.e., climacteric symptoms).

Research Design and Method

Research Design

The current project used a longitudinal, quasi-experimental case-control design to compare breast cancer patients and healthy control participants on sleep, cognitive and psychiatric variables assessed at two time points: post-diagnosis, pre-chemotherapy (baseline; BL) and the last week of the fourth cycle of chemotherapy (end of treatment; C4). The second time point was selected to allow breast cancer patients the longest possible exposure to chemotherapy before re-test; nearly all eligible participants diagnosed with breast cancer would be scheduled for at least four cycles of chemotherapy. The controls were yoked to the same protocol as the breast cancer patients but did not receive chemotherapy; for conciseness, end of treatment (C4) denotes the second time point for all participants. The theoretical model (Figure 1) was based on two empirically-supported cognitive models of insomnia with the addition of health anxiety as a potentially relevant risk factor.

Recruitment. As a part of a larger, longitudinal study of cognition, sleep and fatigue in breast cancer, 23 women with breast cancer were referred to this study from various sources, including oncologists practicing in the Rebecca and John Moores UCSD Cancer Center, and 33 women without breast cancer were referred by study participants, friends and colleagues as well as through community sources. The breast cancer patients were diagnosed by the referring oncologist with stage I-IIIA breast cancer using the 5th edition American Joint Committee on Cancer Staging Manual (Quan et al., 1997) and had been scheduled for at least four cycles of adjuvant or neo-

adjuvant chemotherapy. Peer nomination was primarily used to recruit matching controls (n = 9), with the majority of controls ultimately obtained through community sources (e.g., health fairs, word-of-mouth, flyers; n = 11). The controls were non-relative women with no history of cancer with 5 years of the matching patient's age. Of the 57 women that participated in this portion of the larger study, 17 did not complete the second phase and/or could not be matched. Forty women completed both study phases, comprising 20 breast cancer patients and 20 matched healthy controls.

Patients' breast cancer diagnosis information. All patients were diagnosed with breast cancer and completed four cycles of chemotherapy for breast cancer. Two patients reported having been diagnosed with an invasive lobular carcinoma, 16 reported invasive ductal carcinoma, 2 reported a mixed ductal and lobular carcinoma and 1 reported other pathology ("triple negative"). Six participants were diagnosed with stage I cancer, 8 with stage II cancer, 6 with stage III cancer and 0 with stage IIIA cancer.

Patients' breast cancer treatment information. All patients underwent adjuvant (pre-chemotherapy) surgery. Ten had a lumpectomy, 8 had a mastectomy and 2 had a double mastectomy. Most participants received a combination of chemotherapy agents.

Study protocol. The inclusion criteria for the patient group were: (a) adult women who have been diagnosed with stage I-IIIA breast cancer and (b) have been referred for at least four cycles of adjuvant or neo-adjuvant chemotherapy. Inclusion criteria for the control group were any non-relative woman with no history of cancer and within 5 years of the patient's age.

Exclusion criteria (at study entry) were: (a) pregnancy; (b) metastatic or stage IIIB (including inflammatory) breast cancer (patient group only); (c) confounding underlying medical illnesses such as significant pre-existing anemia (Hb < 10gm/dl) or (d) any other physical or psychological impairment which would have limited participation. In addition, participants were excluded if they were currently receiving treatment for sleep apnea or periodic limb movements in sleep or reported chronic use of medication known to influence sleep (e.g., sedative hypnotics, narcotics) for three months prior to enrollment. These participants were excluded in order to avoid discontinuing already established treatment, and to avoid any carry over confounding effect of treatment on cognition. Also, participants were excluded if they were employed as shift workers or had traveled across time zones within the previous 30 days. Finally, patients or controls were excluded if they reported a current diagnosis of major depression, anxiety or psychotic disorder.

In addition to the above exclusion criteria, additional exclusion criteria for control women were: (a) history of cancer (excluding non-melanoma skin cancer); and (b) hormone replacement therapy within 6 months preceding enrollment.

Measures.

Objective measures of sleep. Sleep/wake activity was recorded with actigraphy. Activity was recorded with the Actiwatch® actigraph (Respironics, Inc), which is a small device, worn on the wrist, 22mm diameter x 10mm height, weighing 16 grams. It has non-volatile 32K memory, 32 Hz. sample rate and one mode of operation (maximum signal integration over 1-s range then over the epoch). Data are

averaged and stored in 1 minute epoch lengths to yield up to 91 days of continuous recording time per initialization.

Participants also recorded pertinent information (i.e., clock time in bed, clock time upon awakening) using a 72-hour sleep diary. These sleep diary data were used in the scoring of the actigraphy data and in particular, to designate time in and out of bed and periods when the actigraph was not worn (e.g., bathing).

The objective sleep variables calculated from actigraphy data include: night-time total sleep time (TST), night-time wake after sleep onset (WASO) and night-time sleep percentage (time asleep/time in bed).

Subjective measures of sleep. Subjective measures of sleep were obtained by self-report using the Insomnia Severity Index (ISI; Bastien, Vallieres, & Morin, 2001), the Glasgow Content of Thoughts Inventory (GCTI; K. J. Harvey & Espie, 2004) and the Glasgow Sleep Effort Scale (GSES; Broomfield & Espie, 2005).

ISI: The ISI is a 7-item insomnia severity questionnaire that assesses 7 aspects of insomnia: difficulty falling asleep, nighttime awakenings, early morning awakenings, impairment of daytime functioning, noticeability of impairments, distress and worry about sleep, and current dissatisfaction with sleep. Each item is rated on a Likert scale ranging from 0 (not at all) to 4 (extremely). The ISI total score is obtained by adding the scores on the 7 items (range 0-28). The ISI internal consistency is high (i.e., 0.78). Any score below 8 is considered not clinically significant insomnia (Bastien et al., 2001). The ISI has been validated as a screening tool in cancer patients and norms have been developed for women with breast cancer (M. H. Savard, Savard, Simard, & Ivers, 2005).

GSES: The Glasgow Sleep Effort Scale (GSES; Broomfield & Espie, 2005) is a 7-item scale designed to measure effortful preoccupation with sleep (i.e., efforts to sleep, attempts to control sleep, worry over failure to sleep). It is rated on a 3-point scale (very much, to some extent, not at all) and was reported to have an internal consistency of 0.70 (Cronbach's alpha). Using a cut-off score of 2, the GSES has discriminated 92.1% insomnia patients and 87.3% good sleepers (Broomfield & Espie, 2005). An *a priori* power analysis (Preacher & Hayes, 2008b; see Table 3) estimated that a total sample of N = 10 (n = 5 per group) would provide power of 97% to detect a significant mean difference between groups.

In the current study, the GSES total score had good internal consistency in the full sample at baseline (Cronbach's alpha = 0.82) but questionnable internal consistency in the full sample at the end of treatment (Cronbach's alpha = 0.67). When the patient and control groups were considered separately, the GSES total score's internal consistency was good for both groups at baseline (patients' Cronbach's alpha = 0.81, controls Cronbach's alpha = 0.83) but had poor to acceptable internal consistency at the end of treatment (patients' Cronbach's alpha = 0.57, controls Cronbach's alpha = 0.78).

GCTI: The Glasgow Content of Thoughts Inventory (GCTI; K. J. Harvey & Espie, 2004) measures the nature, content and frequency of 25 pre-sleep cognitions related to active problem-solving, sleep and wakeful and somatic and sensory engagement. Ratings range from 1 (never) to 4 (always). A total score ranging from 9-36 is computed for the problem solving and sleep and wakefulness subscale and 7-28 for the somatic scale. The GCTI has demonstrated good test- retest reliability (ICC =

0.88) and the authors reported good internal consistency (Cronbach's alpha = 0.87). An *a priori* power analysis (see Table 3) estimated that a total sample of N = 12 (n = 6 per group) would provide power of 97% to detect a significant mean difference between groups.

In the current study, the GCTI total score had excellent internal consistency in the full sample at both time points (BL Cronbach's alpha = 0.91, C4 Cronbach's alpha = 0.93) and in the patient and control groups at both time points (patients' Cronbach's alpha at BL and C4 = 0.91; controls' Cronbach's alpha at BL = 0.92 and C4 = 0.95) A global score cutoff of 42 has been estimated to discriminate good sleepers from insomniacs (Harvey & Espie, 2003).

Depression. Subjective measures of mood were obtained by self-report using the Center of Epidemiological Studies-Depression scale (CES-D; Radloff, 1977) and the Brief Symptom Inventory (BSI-18; Zabora et al., 2001).

CES-D: The Center of Epidemiological Studies-Depression (CES-D) scale (Radloff, 1977) was used to measure depression. The CES-D is a 20-item scale of depressive symptoms. Answers to the items on the scale are based on the degree to which symptoms were experienced during the last week. This scale has been shown to have high reliability and validity in the assessment of depressive symptoms (Radloff, 1977), yet it is brief and easy to administer which makes it appropriate for use in this population of patients in the context of the current study. Since the CES-D reflects cognitive and affective symptoms rather than somatic symptoms of depression, it is highly recommended for use with patients with medical problems.

Beeber et al. (1998) used the CES-D to assess symptoms of depression in a group of newly diagnosed cancer patients. Their data supported the use of the CES-D as a valid and reliable tool for assessing depressive symptoms in this population. In order to avoid confounding depression symptoms with positive affect, only the 16-item Depressed Affect factor identified by Shroevers et al., 2000 was employed as the CES-D score in this study.

Anxiety.

BSI: The Brief Symptom Inventory (BSI-18; Zabora et al., 2001) was used to measure psychological distress due to anxiety and depression symptoms. The BSI-18 has six questions each for depression, anxiety, and somatic symptoms. Each item is rated on a 5-point Likert scale from 0 (not at all) to 4 (always). The patient is asked to respond to each item in terms of "how they have been feeling during the past 7 days". Each participant receives a score on the Global Severity Index, as well as the 3 symptom specific subscales. The BSI-18 has been tested in 1,543 cancer patients (48% female patients) and has an internal consistency reliability of 0.89 (Cronbach alpha; Zabora et al., 2001).

SHAI: The Short Health Anxiety Inventory (SHAI; Salkovskis et al., 2002) is a measure of health anxiety designed for use in both psychological and medical contexts. The SHAI comprises 14 groups of four statements, each of which is ranked on a 4-point scale (0–3) and summed to give a total score that ranges from 0 to 42. The last group of statements instructs the participant to consider the negative consequences of becoming ill. A cut-off point of 18 or higher in the SHAI reliably identifies people meeting diagnostic criteria for hypochondriasis (an extreme form of health anxiety),

whilst a score between 15 and 17 represents a mixture of both hypochondriacal patients and people who are very health anxious but just miss criteria for clinical diagnosis.

The authors of the SHAI reported good internal consistency (alpha = 0.89) and strong concurrent validity (correlation with clinician's rating of health anxiety is 0.85; Salkovskis, et al., 2002). Based on these data, an *a priori* power analysis (see Table 3) estimated that a total sample of N = 48 (n= 24 per group) would provide power of 95% to detect a significant mean difference between groups.

In the current study, the SHAI total score has good internal consistency for the full sample (BL Cronbach's alpha = 0.82, C4 Cronbach's alpha = 0.84) and good internal consistency for the total score in the current patient group (BL Cronbach's alpha = 0.83, C4 Cronbach's alpha = 0.85). The SHAI total score has questionable internal consistency in the current control group at baseline (BL Cronbach's alpha = 0.67) but has good internal consistency in the control group at the end of treatment (C4 Cronbach's alpha = 0.80). As discussed by its authors, the SHAI was designed to minimize the endorsement of statements concerning the belief that one is seriously ill (which tends to be elevated in people who are actually ill or in pain). The SHAI is sensitive to state health anxiety (i.e., treatment effects) if referenced 'over the past week'; therefore, in this study, the reference period at baseline was 6 months for assessment of trait or stable health anxiety and 1 week at the end of treatment for assessment of current health anxiety state.

Subsequent factor analysis has determined two factors: *Illness Likelihood* and *Illness Severity*; the last group of statements comprises the *Illness Severity* factor

(Wheaton et al., 2010). In the current study, the *Illness Severity* subscale score had very poor internal consistency in the full sample at baseline (BL Cronbach's alpha = 0.44) but improved somewhat to questionable internal consistency at the end of treatment (C4 Cronbach's alpha = 0.64). The *Illness Severity* subscale score internal consistency differs between the patient and control group at both time points (BL: alpha = 0.59 for controls, alpha = 0.63 for patients; C4: alpha = 0.37 for controls, alpha = 0.77 for patients).

Menopausal symptoms.

Greene Climacteric Scale: The Greene Climacteric Scale (GCS; Greene, 1998) is a self-rated questionnaire that provides a comprehensive measure of wide-ranging symptoms experienced by menopausal women. It consists of 21 items with 5 separate subscales measuring vasomotor, somatic, and psychological complaints, with higher scores reflecting a severe menopausal problem. The sum of scores from each subscale generates one GCS score. The GCS provides total score and subscores of psychological (anxiety, depression), physical (e.g. muscle and joint pains, headaches), and vasomotor symptoms (hot flashes, night sweats). Its predictive and construct validity have been established in several studies (McPhail & Smith, 2000; Schneider, 2008).

Data collection.

Data were collected at two time points which were prompted by the chemotherapy regimen of each breast cancer patient: BL was post-diagnosis but at least 72 hours before the first chemotherapy infusion and C4 was the onset of the last

week of the fourth cycle of chemotherapy. The intervening period was twelve weeks in duration. Controls were yoked to the same time points.

Demographic and medical information was collected at BL. All measures were administered at BL and C4. To minimize participant burden, the GSES, GCTI, SHAI and ISI were completed immediately prior to the 72-hour period during which the actigraphy was worn and the BSI, CES-D, and GCS were completed as part of a questionnaire packet related to the larger study.

Data analysis. All questionnaire data were double-entered and checked by research assistants and the study PI. Actigraphy data were scored by a trained scorer using Actiware® 5.0 and the objective sleep variables were calculated using SAS software (SAS Institute Inc., 2000-2004). All analyses were performed using IBM® SPSS® Statistics version 19 (SPSS Inc., 2010). Although there were no missing data for the primary outcome measures (i.e., SHAI, GSES & GCTI) any and all missing data from the remaining measures were not substituted or inferred but were included in all analyses as empty cells. First, standard repeated measures ANOVA and post-hoc t-tests were used to identify significant group and time differences on all of the measures. Secondly, Pearson product-moment correlations were performed to evaluate associations between groups of variables and identify covariates.

Thirdly, linear regression-based mediation analyses where used to determine whether any of the psychological measures directly or indirectly affected insomnia symptom severity (see Fig. 1 for theoretical model). The multiple mediation analyses were performed using the SPSS Macro for Multiple Mediation (INDIRECT; for details, see Mathieu & Taylor, 2006). The INDIRECT procedure estimates the path

coefficients in a multiple mediator model and generates bootstrap confidence intervals for total and specific indirect effects of *X* on *Y* through a one or more mediator variable(s) *M*.

For a graphical depiction of the pathways in a simple and multiple mediation model, see Figure 2. The INDIRECT procedure produces a regression coefficient (and associated *t*-test) for following paths: the effect of the independent variable (*X*) on the indirect variable (*M*; path a), the indirect variable on the dependent variable (*Y*; path b), the independent variable on the dependent variable without the indirect variable (*X* → *Y*; path c), and the independent variable on the dependent variable after the indirect effect was included (*X* → *M* → *Y*; path c').

The method of estimating path coefficients employed by the INDIRECT procedure is considered superior to the product-of-coefficients method (Sobel, 1982), as it allows for more than one mediator and adjusts all paths for the potential influence of covariates not proposed to be mediators in the model. Also, bootstrapping is an accepted, non-parametric resampling technique that can be used to derive summary statistics for a given sample (e.g., Efron and Tibshirani, 1993). Bootstrapping is also recommended for regression-based mediation, because indirect, mediating effects are only normally distributed in very large samples (Chmura Kraemer, Kiernan, Essex, & Kupfer, 2008; Dalrymple, Fiorentino, Politi, & Posner, 2010).

The bootstrapping procedure involves randomly sampling (with replacement) a subset of the data and calculating a statistic of interest. This is repeated thousands of times to give a sampling distribution for that statistic. Then, the statistic of interest is derived from this sampling distribution. In the current study, the indirect, mediating

effect within a mediation model was calculated 1000 times (using random sampling with replacement) to build a sampling distribution. Then, the point estimate for the indirect effect was derived from this (more normally shaped) sampling distribution and the corresponding confidence intervals for this estimate were also determined from this distribution.

Mediation analyses were performed for the full sample and repeated separately for the patient and control groups. In order to test the complex relationships proposed by the theoretical model, two mediation models were tested in each analysis: (a) the SHAI total score as the independent variable *X*, ISI total score as the dependent variable *Y*, the GSES, GCTI and CES-D total scores and the BSI Anxiety and Depression symptoms subscales as mediators (*M*j-1); and (b) the GCTI total score as *X*, ISI total score as *Y* and GSES total score as single mediator. Path coefficients were considered significant if the alpha level was less than or equal to 0.05. Point estimates of indirect effects were interpreted as significant if zero is not contained within the confidence intervals (Preacher and Hayes, 2004). For all models with C4 ISI score as the dependent variable *Y*, BL ISI score was included as a covariate.

Results

Sample Characteristics

The sample size included in the final analysis consisted of 40 adult women, 20 patients recently diagnosed with breast cancer and 20 healthy controls. The demographic characteristics of the sample are shown in Table 1; this indicates that the average age of the patient group was 53.6 years (SD = 7.5, range = 36-64) and the control group was 54.6 years (SD = 7.9, range = 38-69). There were no group differences on age, race, ethnicity, marital status, income, occupation or education. The sample was primarily Caucasian, non-Hispanic, married, college-educated with professional occupations and income above $100,000 per year.

The medical characteristics for the patient group are shown in Table 2. Within the patient group, there were no differences on cancer stage (Stage I = 6, Stage II = 8, Stage III = 6, Stage IIIA = 0), surgery type (lumpectomy = 10, mastectomy = 8, double mastectomy = 2) or chemotherapy regimen (14 had 4 exactly 4 cycles of AC). Most patients were diagnosed with invasive ductal carcinoma (n = 16).

Hypothesis 1a

Increased health anxiety (as measured by the Short Health Anxiety Inventory), cognitive arousal (as measured by Glasgow Content of Thoughts Inventory) and/or compensatory sleep effort (as measured by Glasgow Sleep Effort Scale) will be higher in patients with breast cancer than in controls at both BL and C4.

The descriptive and significance statistics related to hypothesis 1a are shown in Tables 4 and 5. Separate 2 x 2 ANOVAs of the health anxiety measures revealed no

significant group or time main effects and no group by time interaction for the SHAI total score, *Illness Likelihood* or *Illness Severity* subscales. A similar pattern of outcomes was observed for pre-sleep cognitive arousal and compensatory sleep effort, with no significant group or time main effects or interactions evident for the GSES total score and the GCTI total score.

Hypothesis 1b

Depressive symptoms and generalized anxiety (as measured by the Brief Symptom Inventory and the Center of Epidemiological Studies-Depression Scale) will be higher in patients with breast cancer than in controls both at BL and C4.

The descriptive and significance statistics related to hypothesis 1b are shown in Table 5. A 2 x 2 ANOVA of the depression symptom measure revealed significant main group and time effects and a significant group by time interaction for the CES-D depressed affect score [$F(1,35) = 5.203$, $P = 0.029$]. Follow-up independent *t*-tests revealed significantly higher depression symptoms in the patient group at BL as compared to the control group [$t(23.16) = 3.376$, $P = 0.003$]. There was no difference in depression between the patient and control groups at C4. A paired *t*-test revealed that depression symptoms significantly decreased from BL to C4 in the patient group [$t(16) = 2.180$, $P = 0.045$].

A 2 x 2 ANOVA of the psychological distress measure revealed no significant main effect of time or group by time interaction for the BSI total score; however, there was a significant main effect of group for the BSI total score. Follow-up independent *t*-tests revealed that the patient group had higher psychological distress than the

controls at both BL and C4 [BL*: t*(22.05) = -2.716, *P* = 0.013; C4: *t*(23.18) = -2.637, *P* = 0.015].

Separate 2 x 2 ANOVAs of the psychological distress subscales revealed that while there were no significant main effect or group by time interaction for the Depressive Symptom subscale, there were significant main effects of group and time and significant group by time interaction for the Anxiety Symptoms subscale [*F*(1,35) = 8.142, *P* = 0.007]. Follow-up independent *t*-tests revealed significantly higher anxiety symptoms in the patient group at BL as compared to the controls [*t*(21.25) = -2.987, *P* = 0.007]. There was no difference A paired *t*-test revealed that the patient group evidenced a significant decrease in anxiety symptoms from BL to C4 [*t*(16) = 2.828, *P* = 0.012].

Hypothesis 1c

Increased health anxiety, cognitive arousal and/or compensatory sleep effort will be risk factors for insomnia (as measured objectively with actigraphy and subjectively by the Insomnia Severity Scale) beyond depression and anxiety (as measured by the Brief Symptom Inventory and the Center for Epidemiologic Studies–Depression Scale) and other confounding factors (e.g., climacteric symptoms) in the patient group at both BL and C4.

Objective and subjective sleep variables. The descriptive and significance statistics related to the objective sleep variables are shown in Table 6. Separate 2 x 2 ANOVAs of the objective insomnia measures revealed no significant group or time main effects and no group by time interactions for TST, WASO or Sleep %. A similar

pattern of outcomes was observed for subjective insomnia, with no significant group or time main effects or interaction evident for the ISI total score.

Climacteric symptoms. The descriptive and significance statistics related to climacteric symptoms are shown in Table 7. A 2 x 2 ANOVA revealed no significant group or time main effect or group by time interaction for GCS total score.

Association between model variables. Examination of the intercorrelation coefficients and significance tests reveal no associations at BL or C4 (a) between the objective and subjective sleep variables; or (b) between the objective sleep variables and the menopausal symptoms.

Examination of the intercorrelation coefficients and significance tests reveal moderate to high correlations at BL and C4 for associations (a) within the subjective sleep variables (Table 8); (b) between the subjective sleep variables and the psychiatric symptom measures (Table 9); and (c) between the subjective sleep variables and menopausal symptoms (Table 10) at BL and C4.

Mediation Models

Baseline measures.

Full sample. The mediation model for the full sample is shown in Figure 3. This demonstrates that, at BL, health anxiety was significantly associated with compensatory sleep effort ($\beta = 0.172$, $P = 0.019$), depression symptoms ($\beta = 0.572$, $P < 0.001$), distress due to depression ($\beta = 0.245$, $P < 0.001$) and distress due to anxiety ($\beta = 0.221$, $P < 0.001$). Health anxiety was not significantly associated with pre-sleep cognitive arousal. After accounting for the significant associations, health anxiety remained directly associated with insomnia symptoms ($\beta = 0.309$, $P = 0.031$).

Compensatory sleep effort was the only mediator associated with insomnia symptoms [b1; $\beta = 1.364$, $P < 0.001$]. No other significant association was found with insomnia symptoms.

In the second mediation model at BL, pre-sleep cognitive arousal was significantly associated with compensatory sleep effort (a2; $\beta = 0.153$, $P < 0.001$) but not with insomnia symptoms. Compensatory sleep effort was also associated with insomnia symptoms (b2; $\beta = 1.522$, $P < 0.001$).

Full sample indirect effects. The bootstrap tests indicated that compensatory sleep effort indirectly mediated the association between health anxiety and insomnia symptoms in the first model (M1; $\beta = 0.234$, [0.234, 0.471] as well as the association between pre-sleep cognitive arousal and insomnia symptoms in the second model (M2; $\beta = 0.233$ [0.116, 0.425].

Patient group. The mediation model for the patient group is shown in Figure 4. This demonstrates that, at BL, health anxiety was positively associated with depression symptoms ($\beta = 0.555$, $P = 0.003$), distress due to depression ($\beta = 0.315$, $P < 0.001$) and distress due to anxiety ($\beta = 0.220$, $P = 0.023$). After accounting for these associations, health anxiety was also directly associated with insomnia symptoms ($\beta = 0.444$, $P = 0.034$.). Health anxiety was not associated with pre-sleep cognitive arousal or compensatory sleep effort. Compensatory sleep effort was positively associated with insomnia symptoms [b1; $\beta = 1.370$, $P < 0.001$]. No other association was found with insomnia symptoms.

In the second mediation model at BL, compensatory sleep effort was positively associated with insomnia symptoms (b2; $\beta = 1.522$, $P < 0.001$). Pre-sleep cognitive arousal was not associated with compensatory sleep effort or insomnia symptoms.

Patient group indirect effects. The bootstrap tests indicated that while compensatory sleep effort did not indirectly mediate the association between health anxiety and insomnia symptoms in the first model, sleep effort did indirectly mediated the association between pre-sleep cognitive arousal and insomnia symptoms in the second model (M2; $\beta = 0.182$ [0.024, 0.491].

Control group. The mediation model for the control group is shown in Figure 5. This demonstrates that, at BL, health anxiety was positively associated with depression symptoms ($\beta = 0.324$, $P = 0.031$). Health anxiety was not associated with distress due to depression or anxiety, pre-sleep cognitive arousal or compensatory sleep effort. Compensatory sleep effort was positively associated with insomnia symptoms [b1; $\beta = 1.048$, $P = 0.403$]. No other association was found with insomnia symptoms.

In the second mediation model at BL, compensatory sleep effort was positively associated with insomnia symptoms (b2; $\beta = 1.051$, $P = 0.031$). Pre-sleep cognitive arousal was positively associated with compensatory sleep effort (a2; $\beta = 0.198$, $P < 0.001$) but not with insomnia symptoms.

Control group indirect effects. The bootstrap tests indicated that while compensatory sleep effort did not indirectly mediate the association between health anxiety and insomnia symptoms in the first model, sleep effort did indirectly mediated

the association between pre-sleep cognitive arousal and insomnia symptoms in the second model (M2; $\beta = 0.208$ [0.038, 0.483].

End of treatment measures.

Full sample. The mediation model for the full sample is shown in Figure 6. The resulting model demonstrates that, in the full sample at C4, health anxiety was positively associated with compensatory sleep effort ($\beta = 0.119$, $P = 0.048$), but not associated with depression symptoms, distress due to depression or anxiety or pre-sleep cognitive arousal. Pre-sleep cognitive arousal was associated with insomnia symptoms (b1; $\beta = 0.167$, $P = 0.034$). No other association was found with insomnia symptoms.

In the second mediation model at C4, pre-sleep cognitive arousal was positively associated with compensatory sleep effort (a2; $\beta = 0.120$, $P < 0.001$); after controlling for this association, pre-sleep cognitive arousal was directly associated with insomnia symptoms (c'2; $\beta = 0.165$, $P = 0.025$). Compensatory sleep effort was not associated with insomnia symptoms.

Full sample indirect effects. The bootstrap tests for the full sample at C4 indicated that while compensatory sleep effort did not indirectly mediate the association between health anxiety and insomnia symptoms in the first model, sleep effort did indirectly mediated the association between pre-sleep cognitive arousal and insomnia symptoms in the second model (M2; $\beta = 0.208$ [0.038, 0.483].

Patient group. The mediation model for the patient sample is shown in Figure 7. The resulting model demonstrates that, at C4, health anxiety was positively associated with compensatory sleep effort ($\beta = 0.156$, $P = 0.007$). There was no other

association with health anxiety. There was no association with insomnia symptoms. Pre-sleep cognitive arousal was associated with insomnia symptoms (b1; $\beta = 0.167$, $P = 0.034$). No other association was found with insomnia symptoms.

In the second mediation model at C4, pre-sleep cognitive arousal was positively associated with compensatory sleep effort (a2; $\beta = 0.114$, $P = 0.015$). Neither pre-sleep cognitive arousal nor compensatory sleep effort were associated with insomnia symptoms.

Patient group indirect effects. The bootstrap tests in the patient group at C4 indicated that while compensatory sleep effort did not indirectly mediate the association between health anxiety and insomnia symptoms in the first model, sleep effort did indirectly mediate the association between pre-sleep cognitive arousal and insomnia symptoms in the second model (M2; $\beta = 0.141$ [0.003, 0.394].

Control group. The mediation model for the control group is shown in Figure 8. The resulting model demonstrates that, at C4, health anxiety was positively associated with pre-sleep cognitive arousal ($\beta = 0.934$, $P = 0.037$). There was no other association with health anxiety. Pre-sleep cognitive arousal was positively associated with insomnia symptoms (b1; $\beta = 0.386$, $P = 0.013$). No other association was found with insomnia symptoms.

In the second mediation model at C4, pre-sleep cognitive arousal was positively associated with compensatory sleep effort (a2; $\beta = 0.167$, $P <= 0.001$). Neither pre-sleep cognitive arousal nor compensatory sleep effort were associated with insomnia symptoms in this second model.

Control group indirect effects. The bootstrap tests indicated that pre-sleep cognitive arousal indirectly mediated the association between health anxiety and insomnia symptoms in the first model (*M1*; $\beta = 0.361$ [0.029, 0.994]. There were no indirect effects in the second model.

Discussion

The results of this study suggest that both women diagnosed and undergoing chemotherapy for breast cancer and healthy women experience health anxiety, pre-sleep cognitive arousal and compensatory sleep effort associated with insomnia symptoms. Furthermore, these results support the relevance of cognitive models of insomnia to women undergoing chemotherapy for breast cancer. However, the relationships between these experiences appear to change over time or with medical therapy.

Using a standardized insomnia assessment questionnaire, ISI, this study found that, at baseline, 55% of controls and 45% of breast cancer patients were suffering from insomnia severe and distressing enough to warrant clinical intervention and, at the end of treatment, 45% of controls and 55% of breast cancer patients met the same criteria. The overall prevalence rate of clinical insomnia in the control group is higher than those reported by previous studies and the overall rate in the breast cancer group is similar.

Hypothesis 1a

The first hypothesis of this study, that increased health anxiety, pre-sleep cognitive arousal and compensatory sleep effort would be higher in patients with breast cancer than in controls both before and after treatment, was not confirmed. As this study was powered to evaluate health anxiety, pre-sleep cognitive arousal and compensatory sleep effort, it is likely that the lack of observed differences between the patient and control groups is a valid, albeit surprising finding. This funding suggests

that women with and without breast cancer experience similar levels of health anxiety, pre-sleep cognitive arousal and compensatory sleep effort.

Using the clinical cut-off criteria of these measures, at baseline 70% of controls and 60% of patients were poor sleepers according to the GCTI score; 35% of controls and 30% of patients met the same criteria at the end of treatment. According to the clinical cut-off criteria for the GSES score, 60% of controls and 55% of patients were poor sleepers at baseline; at the end of treatment 55% of patients and controls met the same criteria. According to the clinical cut-off criteria for the SHAI, 5% of the controls and 35% of the patients met criteria for elevated health anxiety at baseline; 15% of the controls and 35% of patients met the same criteria at the end of treatment. These results suggest that women with and without breast cancer may experience poor sleep and health anxiety at roughly the same extent whether or not there is also a concurrent life-threatening illness.

Of note is the observation that controls reported slightly more negative consequence of illness (*Illness Severity*) than patients at both baseline and the end of treatment. The authors of the SHAI included this feature of health anxiety in their measure to evaluate threat as related to the anticipated burden or 'awfulness' of having a severe illness. Although this effect may be spurious, particularly given that the subscale consists of only 4 items, it is possible that the patients' experience of having been diagnosed and treated for breast cancer may have reduced the evaluation of the anticipated burden of a severe illness. That is to say, even before the onset of chemotherapy, breast cancer patients may have had significant experience facing and surviving a health-related threat. Again, the implication is that health anxiety may be

elevated in healthy women if there is more perceived negative consequence of illness, and such a perception may be influenced by a lack of experience coping with a significant illness.

Perhaps more surprisingly, although the Short Health Anxiety Questionnaire was designed to minimize the effect of a present medical disorder, the patient group did not report significantly more health anxiety than the control group. As suggested by the cognitive behavioral and interpersonal models of health anxiety, the perception of an illness may be influenced by personal or social experience with illness or by thinking errors associated with concurrent or remitted mood or anxiety disorders.

Hypothesis 1b

The second hypothesis of this study, that depression and generalized anxiety would be higher in patients than controls both at baseline and at the end of treatment, was supported. As previous research has demonstrated, breast cancer patients report more depression symptoms and psychological distress than similarly-aged healthy women both pre- and post-treatment, particularly distress due to anxiety symptoms. The decrease in depression symptoms at the end of treatment observed in the patient group has also been observed in breast cancer patients following adjuvant chemotherapy (Burgess et al., 2005). Such a decrease may be explained by effective pharmacological therapy or a decrease in factors that contribute to depression in this population. Unfortunately, this study did not adjust for either pharmacological therapy or other psycho-social factors (i.e., social support and quality of life).

Hypothesis 1c

The third hypothesis of this study, that increased health anxiety, pre-sleep cognitive arousal and compensatory sleep effort would be risk factors for insomnia beyond depression and anxiety and other confounding factors in breast cancer patients was partially supported. First, the lack of any difference in objectively-measured sleep between the patient and control group was unexpected. Previous research had found that breast cancer patients report worse sleep both pre- and post-chemotherapy. One possible explanation is that sleep/wake actigraphy is sensitive only to night-by-night differences and treatment effects in insomnia, and, in particular, wrist actigraphy may overestimate sleep for insomniacs lying in bed motionless or for participants with hypnotic use (Lichstein Actigraphy validation in insomnia 2006). It is also possible that the sample size was too small to find group differences in objectively-measured sleep; in particular, the subjective results suggest that the patient group experienced higher insomnia symptoms than the controls at both baseline and end of treatment, although these differences were not statistically significant.

Unlike the lack of group differences in sleep, the lack of association between subjective and objective sleep is unsurprising. Previous research has found that objective and subjective sleep measures are often unrelated as sleep time may be overestimated and the time to fall asleep underestimated (Ancoli-Israel et al., 2006). Furthermore, as in previous studies, the time frame for the objective and subjective measures was different, as both the ISI and PSQI measure sleep over the previous 7 days as compared to 3 days of actigraphic recording. More importantly, the positive associations between insomnia symptoms, compensatory sleep-effort and pre-sleep

cognitive arousal are consistent with previous research and provide support for the constructs and relationships proposed by this study's theoretical model.

Consistent with previous research, menopausal symptoms were higher in the patient group at the end of treatment. However, menopausal symptoms were not associated with objectively- or subjectively-measured sleep in the full sample. As previously discussed, research findings are inconsistent with respect to the disturbance of sleep by menopausal symptoms in normal aging. Again, sample size is a potential issue. With a larger patient sample, this study would have been able to categorize women according to menopausal status. Previous research has found that sleep is most disturbed in women that remain pre-menopausal after chemotherapy (Rissling, Liu, Natarajan, He, & Ancoli-Israel, 2010).

Mediation Models

Arguably, the most interesting results in the current study were found in the tests of the mediation effects in the proposed theoretical model. With the caveat that without random assignment and experimental manipulation, the direction of associations cannot be credibly deduced (Chmura Kraemer et al., 2008), these results appear to support the proposed theoretical model with slight revision at baseline and the end of treatment.

First mediation model. At baseline, health anxiety was directly associated with insomnia symptoms in the full sample and the patient group. This relationship had been previously found, to a lesser extent, in a sample of chronic back pain patients (Tang et al., 2007). However, this relationship was no longer present at the end of treatment. More research is needed to explain the course of health anxiety in chronic illness.

Health anxiety was also associated with compensatory sleep effort in the full sample at both baseline and the end of treatment. However, when the patient and control groups were analyzed separately, this relationship was not present in either group at baseline and only present in the patients at the end of treatment. Although replication of a significant effect in a subsample may be affected by a substantially reduced sample size, these results also suggest that at the end of treatment health anxiety and compensatory sleep effort may be more strongly associated in breast cancer patients.

This consideration also applies to the finding that health anxiety and pre-sleep cognitive arousal were associated only in the control group at the end of treatment. As the same was not found in either the full sample or the patient group, this finding suggests that health anxiety and pre-sleep cognitive arousal may be more strongly associated in women without breast cancer. However, no other finding suggests what may have contributed to elevated health anxiety in the control group or why the relationship between health anxiety and pre-sleep cognitive arousal in the control group should change over time. Although the women in the control group were relatively both physically and mentally healthy, it is possible that a portion were

experiencing significant but short-term health issues in themselves or in someone close and this experience was associated with pre-sleep cognitive arousal These results suggest that not only may healthy women experience health anxiety; the effect of health anxiety on cognitive processes related to sleep may change according to an unmeasured and unexpected construct. Further research on these phenomena is warranted.

Although health anxiety was modeled separately from depression and anxiety in the first two hypotheses, the relationship between these constructs was tested in the mediation models and found to be altered from baseline to the end of treatment. At baseline, health anxiety was positively associated with both depression and anxiety in the full sample (Figure 3) and patient group (Figure 4) and only depression as measured by the CES-D in the control group (Figure 5).

These results support previous research that suggests considerable overlap between health anxiety, generalized anxiety and depression, with health anxiety as a discrete but commensurate psychological construct. Especially in women recently diagnosed with breast cancer, health anxiety may contribute to higher depression, anxiety and insomnia. However, unlike previous research, no association was found between insomnia symptoms and depression or anxiety. While these associations may have been under-powered, these findings may also suggest the presence of untested moderators, moderated mediators or vice versa. Replication of these findings with a larger sample size and a more sophisticated model is warranted.

The expected overlap between psychiatric constructs was not found at the end of treatment; instead, health anxiety was no longer associated with either depression or

anxiety in the full sample (Figure 6) or patient group (Figure 7). These findings may be related to the study's design. The SHAI is able to estimate both trait (baseline) and state (end of treatment) health anxiety according to the period of time specified; health anxiety is estimated either over the previous six months (trait) or the previous week (state). In this study, the intention was to provide an estimate of trait (baseline) and state (end of treatment) health anxiety, as well as to avoid confounding overlap between these estimations. However, as these estimations were similar between baseline and the end of treatment, it is unlikely these findings represent a change in the amount of health anxiety experienced.

These results may suggest that being health anxious at the end of treatment is less a risk factor for concurrent anxiety, depression or insomnia in women with breast cancer. As discussed with respect to hypothesis 1a, the experience of having to cope with a serious illness over an extended period may moderate the degree to which the illness represents a psychological threat. As suggested by the cognitive-behavioral and interpersonal models of health anxiety, illness-related threat may change over time with personal or vicarious experience. Longitudinal study of this phenomenon with comprehensive and long-term measurement is needed to test this conclusion.

Finally, the relationship between compensatory sleep effort and insomnia symptoms changed between baseline and the end of treatment. As expected, increased compensatory sleep effort was associated with increased insomnia symptoms both in the full model and in the patient and control groups at baseline. Additionally, compensatory sleep effort also mediated the relationship between health anxiety and insomnia at baseline. As the most consistent finding, these results strongly support the

role of maladaptive compensatory sleep effort in the severity of insomnia in women with and without breast cancer. However, this finding is completely absent at the end of treatment. The reason for this disappearance may be related to another cognitive process, pre-sleep cognitive arousal.

Second mediation model. As pre-sleep cognitive arousal was modeled separately as a mediator and as an independent variable, the findings related to this construct are complicated and also potentially evidential of model overfit. However, the results also appear to reinforce the theoretical model. As with compensatory sleep effort, pre-sleep cognitive arousal also appears to change roles between baseline and the end of treatment. Pre-sleep cognitive arousal was directly associated with insomnia in the full sample at the end of treatment. This finding, taken in isolation, may suggest that pre-sleep cognitive arousal disturbs sleep more in the absence of a direct effect between health anxiety and insomnia. However, the second model (with pre-sleep cognitive arousal as the IV) demonstrates that pre-sleep cognitive arousal and compensatory sleep effort are consistently associated. The only exception to this rule is in the patient group at baseline; however, in this model, compensatory sleep effort acts to mediate the relationship between pre-sleep cognitive arousal and insomnia. One plausible explanation is that as pre-sleep cognitive arousal increases, the individual may respond by increasing the effort to sleep, which in turn increases insomnia. Similar mediating relationships were also found in the patients at the end of treatment and the controls at baseline.

These results support the contributory role of both cognitive processes to insomnia as posited by the models of Espie and Harvey. Both compensatory sleep

effort and pre-sleep cognitive arousal appear to play critically influential but diminished roles in insomnia at the end of treatment. However, the relationship between these processes appears to change not only with time, but also with the population. One explanation may be that breast cancer patients that use antidepressant, anxiolytic or hypnotic medication during the course of chemotherapy (Rissling et al, 2009) may exhibit less compensatory sleep effort at the end of treatment. In particular, sedative medication may reduce compensatory sleep effort by improving the perceived quality of sleep (i.e., increased ability to fall asleep in a desirable timeframe). However much sedative medication may assist sleep onset, it may not preclude the ability to worry or ruminate during the pre-sleep process. Thus, one plausible explanation for the pattern of results found at the end of treatment is that, under certain conditions, significant pre-sleep cognitive arousal may be necessary to achieve the relationship between compensatory sleep effort and insomnia.

Overall, the mediation models suggest that compensatory sleep effort may function as a "cognitive-behavioral linchpin" between health anxiety, pre-sleep cognitive arousal and insomnia. By implication, if compensatory sleep effort were mitigated, i.e., by psychological therapy, then the relationship between health anxiety, pre-sleep cognitive arousal and insomnia may weaken, and in turn, improve sleep.

The general aim of this study was to understand the relationship between the risk factors of cancer diagnosis and treatment, physiological and psychiatric symptoms, and cognitive processes to insomnia. As a preliminary and exploratory study, these aims were achieved. The results support the applicability of a cognitive model of insomnia in women with and without breast cancer. This is the first study to

examine both health anxiety and cognitive processes in relation to sleep in any population. Moreover, it is the first longitudinal, case control study of health anxiety and cognitive processes in relation to sleep in breast cancer. However, due to the observational nature of this study, conclusions about the directions of effects cannot be credibly deduced.

Limitations and Future Directions

Along with this study's strengths, there are also limitations to consider. The small sample size is an obvious limitation. Although this sample size provided sufficient power to detect effects in health anxiety, pre-sleep cognitive arousal and compensatory sleep effort, it is likely that the sample size was not sufficient to detect the full contribution of all of the variables tested, especially when within group mediation effects were tested. The absence of any association between the objective and subjective sleep measures is a notable exception to this caveat; previous studies have also noted a similar discrepancy. It is arguable that such a discrepancy provides support for the substantially subjective nature of insomnia. According to the cognitive models of insomnia reviewed previously, the subjective perception of sleep disturbance may persist beyond objective sleep disturbance.

The lack of objective sleep disturbance, however, does not lessen the severity of the insomnia experience. Rather, a persistent subjective perception of sleep disturbance is theorized to contribute to the persistence of the insomnia complaint. Psychophysiological insomnia is defined by the subjective experience of sleep-interfering cognitive arousal. The cognitive models of insomnia suggest that

replication of this study with a larger sample is likely to provide further support for this conclusion.

This study is also limited by being observational rather than experimental in design. Especially with respect to the use of mediation analyses to test the proposed theoretical model, Kraemer et al. (2004) stated that ,"the ultimate goal of moderation/mediation analyses is to detect possible causal chains among variables leading to the outcome" (p. S102). The lack of experimental manipulation in this study weakens any conclusion regarding temporal precedence of any variable and thus, critically weakens any statement of causality. By the same token, the exploratory and observational nature of the current study does not provide for discrimination between moderating versus mediating effects. Therefore, randomized clinical trials (RCT) are necessary to further test the conclusions of this study.

The generalizability and representativeness of these results are limited by the relatively skewed demographic characteristics of both the patient and control groups. In particular, participants in the current study were predominantly Caucasian, non-Hispanic, highly educated and affluent. It is possible that a more diverse demographic sample would have provided significantly different results.

Another limitation is a lack of information on the experience of acute or chronic pain in this sample. As discussed, pain is a potent interfering factor in sleep. Given that all of the women with breast cancer entered this study subsequent to lumpectomy or mastectomy, it is possible that at least part of this sample experienced pain or discomfort. While replication of this study should include assessment of pain, it is notable that the breast cancer group reported similar levels of insomnia

pharmacotherapy in this sample, i.e., medications for depression, anxiety or sleep disturbances.

It is likely that the majority of the breast cancer patients and a smaller portion of the control group may have received anxiolytic, antidepressant, or hypnotic medication prior to or during the study. Such medication may have reduced the experience or perception of anxiety, depression or insomnia symptoms. However, given evidence that these drugs are often prescribed to breast cancer patients in order to mitigate side effects of chemotherapy, it is also likely that pharmacotherapy was insufficient to sufficiently mitigate the effects of health anxiety, pre-sleep cognitive arousal and compensatory sleep effort in the breast cancer sample.

Further limitations may be the result of both the study's design and chosen statistical methods. As with the several instances when compensatory sleep effort indirectly affected the insomnia symptom outcome, it may be argued that such an indirect effect cannot be found in the absence of a direct effect; however, recent statistical literature provides support for such a finding (Dalrymple et al., 2010). Another criticism is the high degree of multicollinearity present between the independent variables and the mediators in the models. As Preacher and Hayes (2008b) explain, indirect effects may be washed out via multicollinearity between mediators. Given the multilevel nature of both the theoretical model and the mediation model results, future studies of these phenomena may consider employing more appropriate statistical methods, i.e., structural equation modeling, to more accurately analyze and interpret such findings (Preacher et al., 2010). Finally, this study, while

longitudinal in design, only included two time points twelve weeks apart. Future studies should have additional and longer-term follow-up assessments.

Despite these limitations, the results of this study support future investigations of health anxiety, pre-sleep cognitive arousal and compensatory sleep effort in RCTs; in particular, studies exploring the effect of psychological interventions on insomnia [i.e., Cognitive Behavioral Treatment of Insomnia (CBT-I), Acceptance and Commitment Therapy (ACT), and Mindfulness]. A large body of evidence supports the efficacy of CBT-I in both healthy (Morin, Bootzin, et al., 2006) and breast cancer populations (Berger et al., 2003; J. Savard et al., 2005; S. Taylor, Asmundson, & Coons, 2005). Although in the exploratory stage, the theoretical tenets of ACT have been recognized as compatible with cognitive models of insomnia (Dalrymple et al., 2010; Lundh, 2005). The tenets and structure of CBT therapy for depression and anxiety disorders has already been adapted to health anxiety (S. Taylor & Asmundson, 2004) although efficacy studies are not yet evident.

Lastly, recognition of health anxiety as both an independent anxiety disorder and a risk of significant psychiatric sequalae (i.e., insomnia) in breast cancer and other medical populations may lead to the development and testing of effective and early interventions. Therefore, replication of these results may be considered secondary to randomized clinical trials that can provide experimental manipulation of these constructs and lead to empirically-supported interventions.

Tables

Table 1
Demographic characteristics of patients and controls at BL (N = 40)

Characteristic	Patients (n=20)	Controls (n=20)
Age: mean years (SD)	54.6 (7.9)	53.6 (7.5)
Marital Status: [n (%)]		
Never Married	2 (10.0)	1 (5.0)
Divorced	2 (10.0)	3 (15.0)
Widowed	0 (0.0)	1 (5.0)
Married	16 (80.0)	15 (75.0)
Ethnicity/Race: [n (%)]		
Hispanic	0 (0.0)	1 (5.0)
Not Hispanic	20 (100.0)	19 (95.0)
African American	1 (5.0)	1 (5.0)
Asian	2 (10.0)	1 (5.0)
Caucasian	17 (85.0)	18 (90.0)
Other	0 (0.0)	0 (0.0)
Education: [n (%)]		
Some High School or Less	0 (0.0)	1 (5.0)
Completed High School	0 (0.0)	1 (5.0)
Some College	7 (35.0)	4 (20.0)
College Degree	13 (65.0)	14 (70.0)
Annual Family Income: [n (%)]		
≤ $15,000	1 (5.0)	0 (0.0)
≤ $30,000	1 (5.0)	1 (5.0)
≤ $50,000	1 (5.0)	4 (20.0)
≤ $100,000	2 (10.0)	6 (30.0)
> $100,000	9 (45.0)	8 (40.0)
Did not Answer	6 (30.0)	2 (10.0)

Table 2
Medical characteristics of patients and controls at BL (N = 40)

Characteristic	Patients (n=20)	Controls (n=20)
Menopausal Status Pre-chemotherapy: [n (%)]		
Premenopausal	8 (40.0)	3 (15.0)
Perimenopausal	2 (10.0)	4 (20.0)
Postmenopausal	8 (40.0)	10 (50.0)
Post-Hysterectomy	2 (10.0)	3 (15.0)
Unknown	0 (0.0)	0 (0.0)
Cancer Stage: [n (%)]		
Stage I	6 (30.0)	
Stage II	8 (40.0)	
Stage III	6 (30.0)	NA
Stage IIIA	0 (0.0)	
Unknown	0 (0.0)	
Surgery: [n (%)]		
Lumpectomy	10 (50.0)	
Mastectomy	8 (40.0)	
Double Mastectomy	2 (10.0)	NA
Pre-Op Chemotherapy	0 (0.0)	
Unknown	0 (0.0)	
Chemotherapy Regimen: [n (%)]		
Exactly 4 cycles of AC	5 (25.0)	
Exactly 4 cycles of AC + Taxotere	2 (1.0)	
Exactly 4 cycles of AC + Taxol	7 (35.0)	NA
6 cycles of TAC	1 (5.0)	
Other regimen	3 (15.0)	
Unknown	2 (1.0)	

Table 3
A priori power analysis results on main subjective outcome measures

Measure	Effect Size *d*	Group n	Total N	Actual Power
GCTI	> 0.99	6	12	0.97
GSES	> 0.99	5	10	0.97
SHAI	0.95	24	48	0.95

Note. Criterion for significance set at 0.05, 1-tailed.

Table 4

Mean (SD) on subjective sleep measures by group at BL and C4 (N = 40)

	Patients (n = 20)		Controls (n = 20)	
Measure	BL	C4	BL	C4
GSES	4.25 (3.28)	3.50 (2.01)	3.45 (2.69)	2.95 (2.50)
GCTI	46.55 (11.12)	46.50 (9.48)	47.35 (10.48)	46.55 (11.12)
Problem Solving	17.45 (4.14)	17.55 (3.63)	18.35 (4.17)	18.15 (4.60)
Sleep & Wake	16.70 (4.96)	16.30 (4.27)	16.40 (3.90)	16.45 (4.73)
Somatic/Sensory	12.40 (3.07)	12.65 (2.50)	12.60 (3.78)	12.65 (2.50)
ISI	10.30 (6.60)	9.90 (5.60)	7.60 (5.32)	7.70 (5.96)

Note: BL = baseline; C4 = end of treatment; GSES = Glasgow Sleep Effort Scale; GCTI = Glasgow Content of Thoughts Inventory; ISI = Insomnia Severity Index.

Table 5

Mean (SD) of mood and anxiety measures by group at BL and C4(N = 40)

	Patients (n = 20)		Controls (n = 20)	
Measure	BL	C4	BL	C4
SHAI	14.32 (7.23)	13.35 (6.78)	10.15 (4.90)	10.21 (5.24)
Section 1	13.05 (6.11)	11.80 (5.75)	8.30 (3.79)	8.00 (4.26)
Section 2	1.26 (1.59)	1.55 (2.04)	1.85 (1.73)	2.21 (1.48)
CES-D	10.63 (8.42)*†	7.17 (7.14)†	3.65 (3.30)*	3.80 (3.46)
BSI	9.79 (9.64)	8.11 (7.33)	3.45 (3.33)	3.15 (3.33)
Depression	3.47 (4.58)	2.44 (4.00)	1.30 (1.46)	1.40 (2.50)
Anxiety	4.26 (4.28)*	2.44 (4.00)	1.20 (1.32)*	1.40 (2.50)
Somatic	2.05 (1.99)	3.22 (2.13)	0.95 (1.23)	0.55 (0.89)

Note: BL = baseline; C4 = end of treatment; SHAI = Short Health Anxiety Inventory; CES-D = Center for Epidemiologic Studies Depression Scale; BSI = Brief Symptom Inventory.

*Independent *t*-test for equality of means significant at 0.05 (2-tailed).

†Paired *t*-test for equality of means significant at 0.05 (2-tailed).

Table 6

Mean (SD) of objective sleep measures by group at BL and C4 (N = 40)

	Patients (n = 20)		Controls (n = 20)	
Measure	BL	C4	BL	C4
TST (hours)	7.26 (1.00)	7.24 (0.88)	7.45 (0.88)	7.28 (0.87)
WASO (hours)	1.13 (0.47)	1.30 (0.52)	1.08 (0.35)	1.07 (0.36)
Sleep %	86.8 (4.8)	84.9 (5.2)	87.3 (4.3)	87.2 (4.3)

Note: BL = baseline; C4 = end of treatment; TST = total sleep time; WASO = wake after sleep onset; Sleep % = sleep percentage.

Table 7

Mean (SD) of menopausal symptoms by group at BL and C4(N = 40)

	Patients (n = 20)		Controls (n = 20)	
Measure	BL	C4	BL	C4
GCS				
Anxiety	4.44 (3.67)	4.06 (2.67)	2.95 (2.59)	2.84 (1.98(
Depression	3.72 (3.25)	3.67 (2.89)	1.85 (1.87)	1.32 (1.25)
Psychological	8.17 (6.59)	7.72 (5.15)	4.80 (3.97)	4.16 (2.87)
Somatic	2.11 (1.78)	3.33 (3.03)	1.70 (1.78)	1.26 (1.10)
Vasomotor	0.94 (1.59)	1.78 (1.87)	1.10 (1.55)	1.32 (1.42)
Sexual	0.76 (0.90)	1.06 (1.06)	0.85 (0.99)	0.74 (0.02)

Note: BL = baseline; C4 = end of treatment; GCS = Greene Climacteric Scale.

Table 8

Intercorrelations between subjective sleep variables at BL and C4 (N=40)

		BL			C4		
		ISI	GSES	GCTI	ISI	GSES	GCTI
BL	ISI	--	0.780**	0.468**	0.717**	0.547**	0.414**
	GSES		--	0.548**	0.699**	0.538**	0.518**
	GCTI			--	0.707**	0.516**	0.670**

Note: BL = baseline; C4 = end of treatment; GSES = Glasgow Sleep Effort Scale; GCTI = Glasgow Content of Thoughts Inventory; ISI = Insomnia Severity Index

*Correlation is significant at the 0.01 level (2-tailed)

** Correlation is significant at the 0.05 level (2-tailed)

Table 9

Intercorrelations between subjective sleep and psychiatric variables at BL and C4 (N=40)

		BL			C4		
		ISI	GSES	GCTI	ISI	GSES	GCTI
BL	SHAI	0.585**	0.374*	0.285	0.401*	0.435**	0.247
	CES-D	0.441**	0.450**	0.346	0.514**	0.450**	0.363*
	BSI	0.484**	0.544**	0.365**	0.594**	0.582**	0.400**
C4	SHAI	0.560**	0.430**	0.359*	0.445**	0.520**	0.278
	CES-D	0.424**	0.546**	0.258	0.619**	0.467**	0.247
	BSI	0.396**	0.495**	0.408*	0.541**	0.432**	0.414**

Note: BL = baseline; C4 = end of treatment; GSES = Glasgow Sleep Effort Scale; GCTI = Glasgow Content of Thoughts Inventory; ISI = Insomnia Severity Index; SHAI = Short Health Anxiety Inventory; CES-D = Center for Epidemiologic Studies Depression Scale; BSI = Brief Symptom Inventory

*Correlation is significant at the 0.01 level (2-tailed)

** Correlation is significant at the 0.05 level (2-tailed)

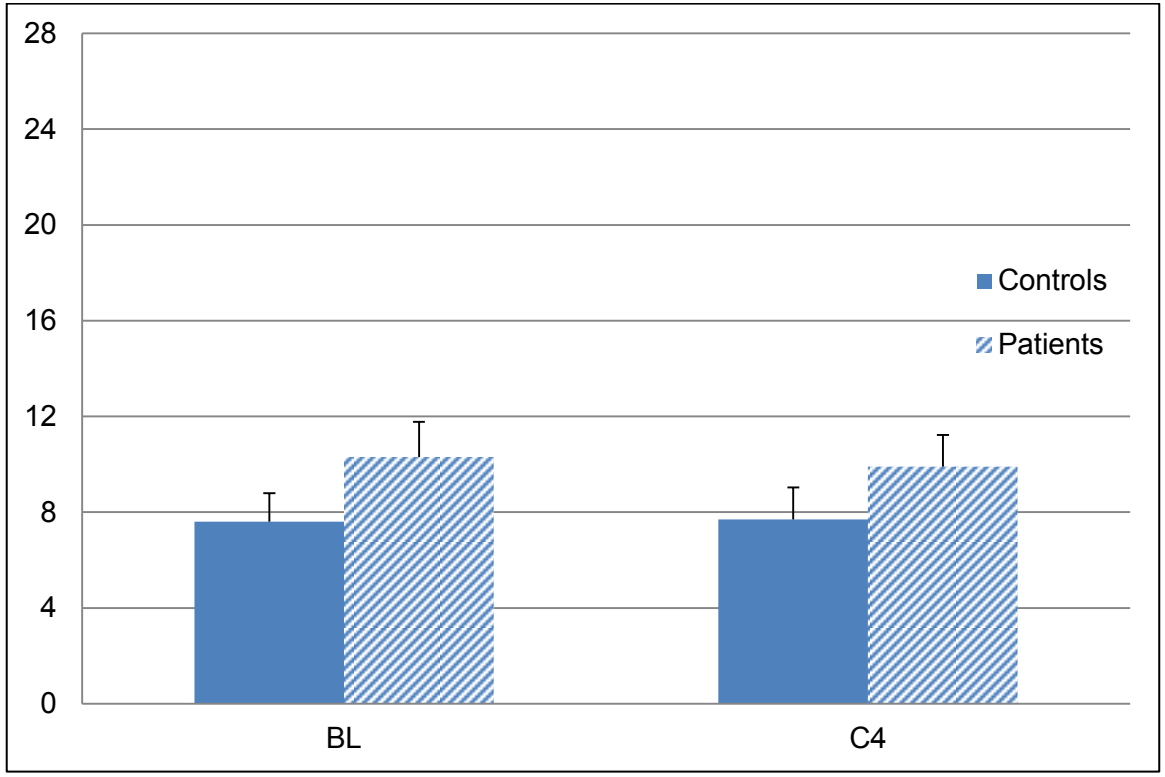
Table 10

Intercorrelations between subjective sleep and menopausal symptoms at BL and C4 (N=40)

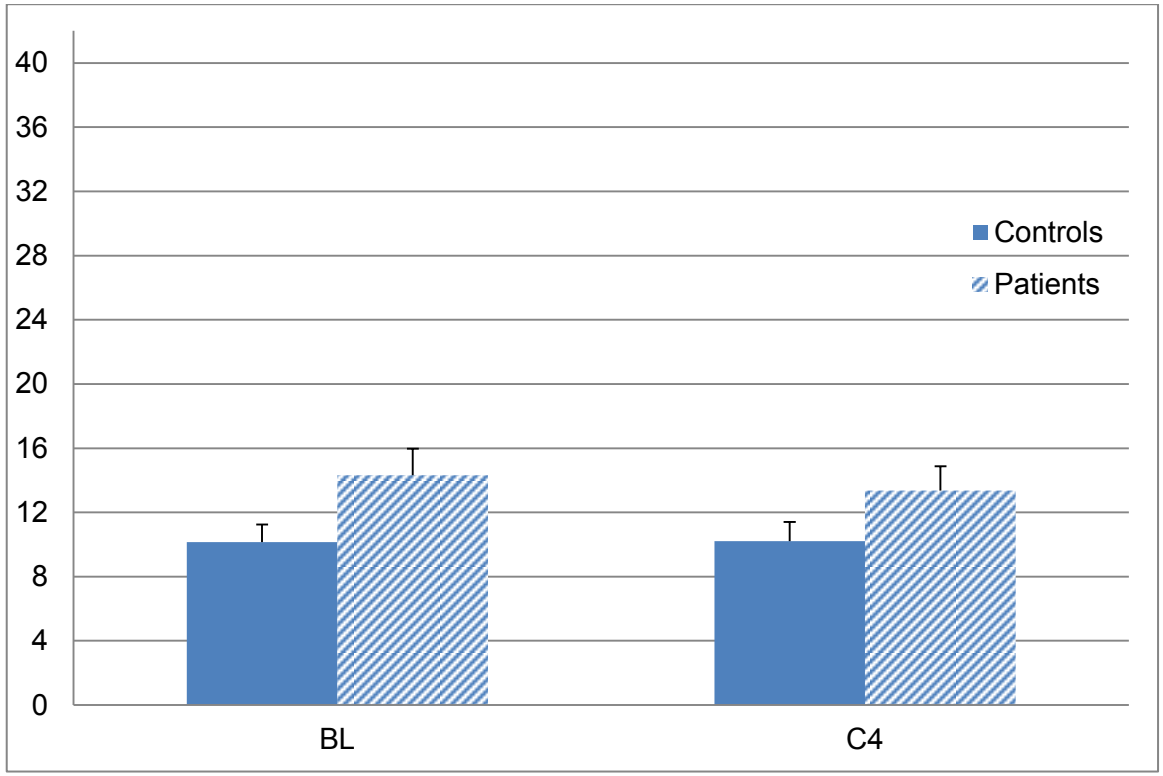
	BL			C4		
	ISI	GSES	GCTI	ISI	GSES	GCTI
BL GCS	0.569**	0.654**	0.449**	0.633**	0.546**	0.580**
C4 GCS	0.467**	0.501**	0.274	0.538**	0.308	0.412*

Note: BL = baseline; C4 = end of treatment; GSES = Glasgow Sleep Effort Scale; GCTI = Glasgow Content of Thoughts Inventory; ISI = Insomnia Severity Index; GCS = Greene Climacteric Scale.

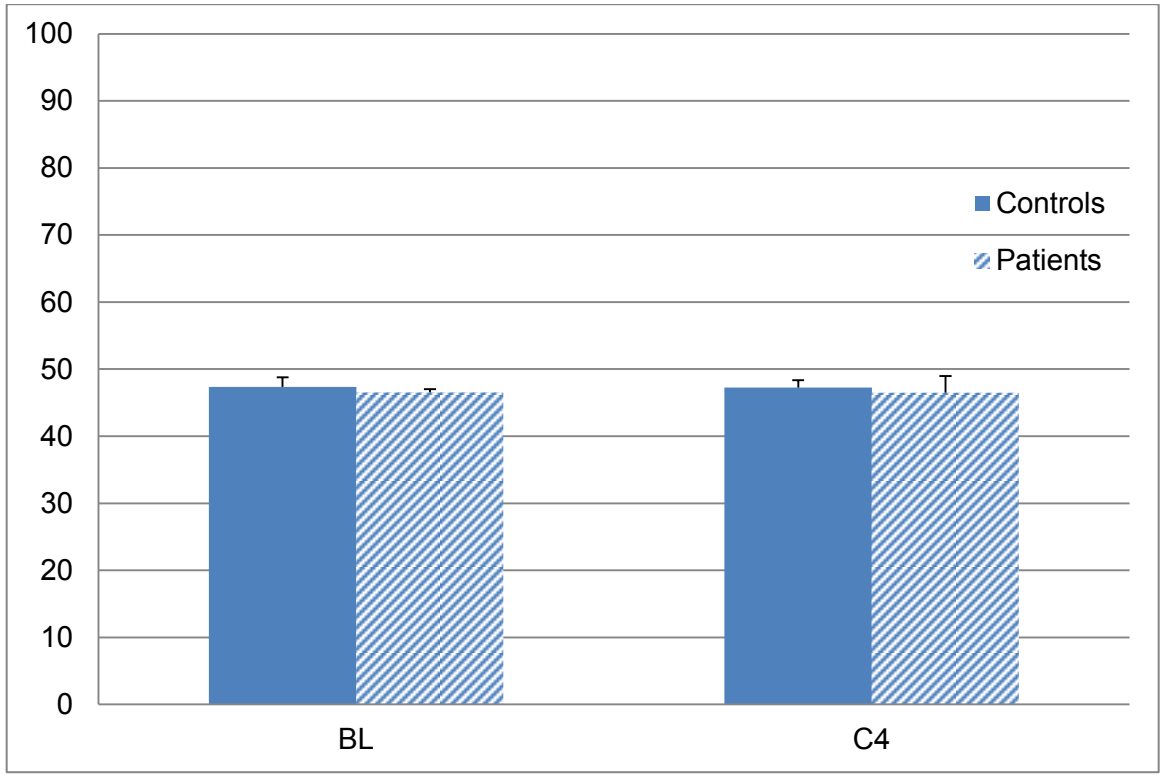
Graphs



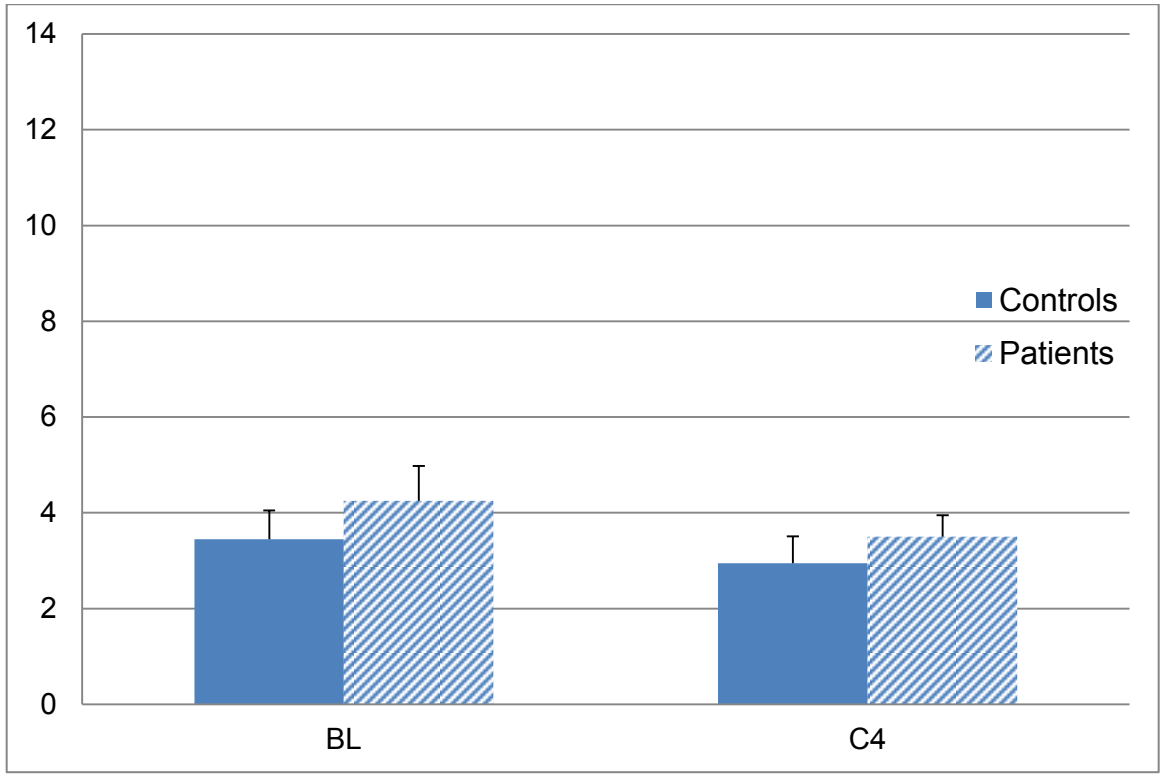
Graph 1. Mean ISI Total Scores at Baseline (BL) and End of Treatment (C4) by Group



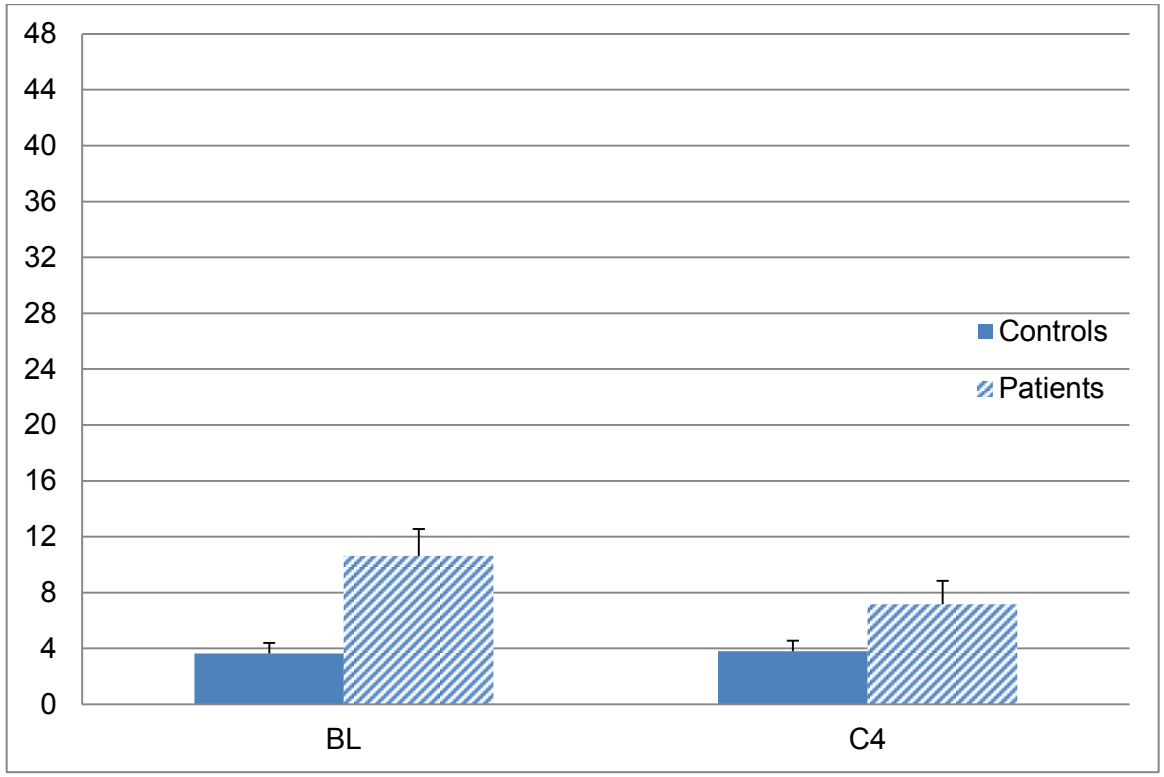
Graph 2. Mean SHAI Total Scores at Baseline (BL) and End of Treatment (C4) by Group



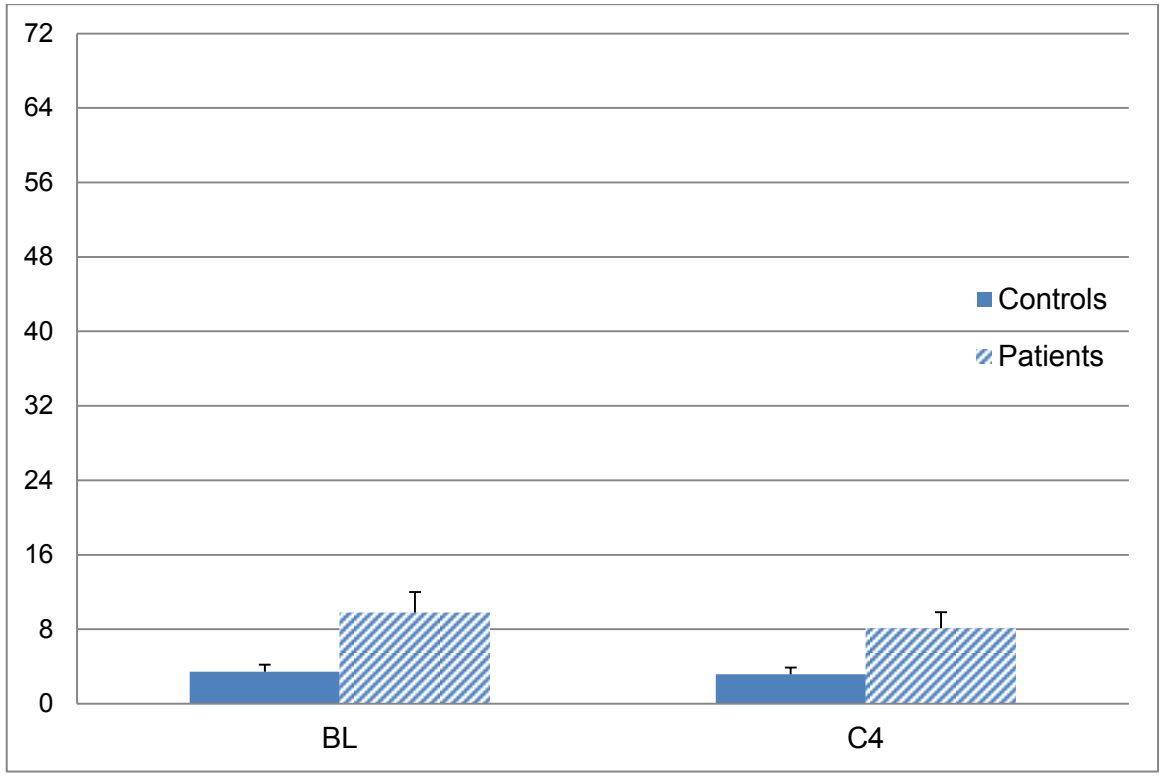
Graph 3. Mean GCTI Total Scores at Baseline (BL) and End of Treatment (C4) by Group



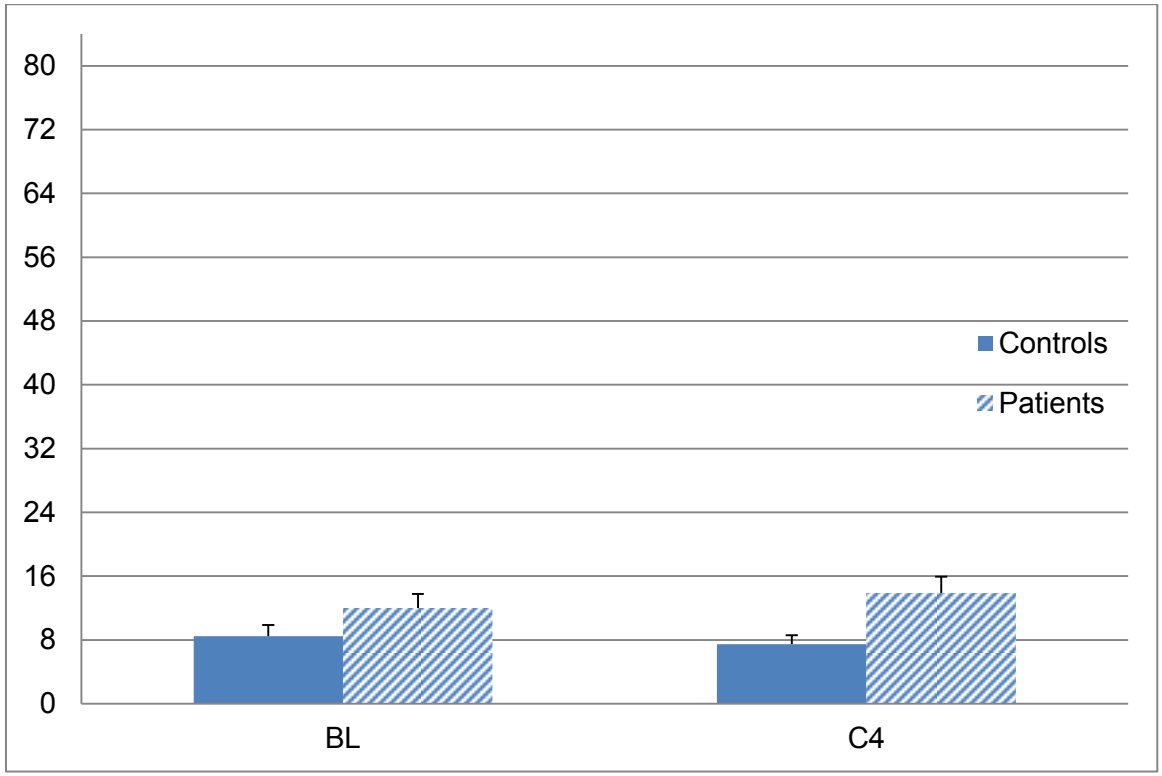
Graph 4. Mean GSES Total Scores at Baseline (BL) and End of Treatment (C4) by Group.



Graph 5. Mean CES-D total scores at Baseline (BL) and End of Treatment (C4) by Group



Graph 6. Mean BSI total scores at Baseline (BL) and End of Treatment (C4) by Group



Graph 7. Mean GCS total scores at Baseline (BL) and End of Treatment (C4) by Group

Figures

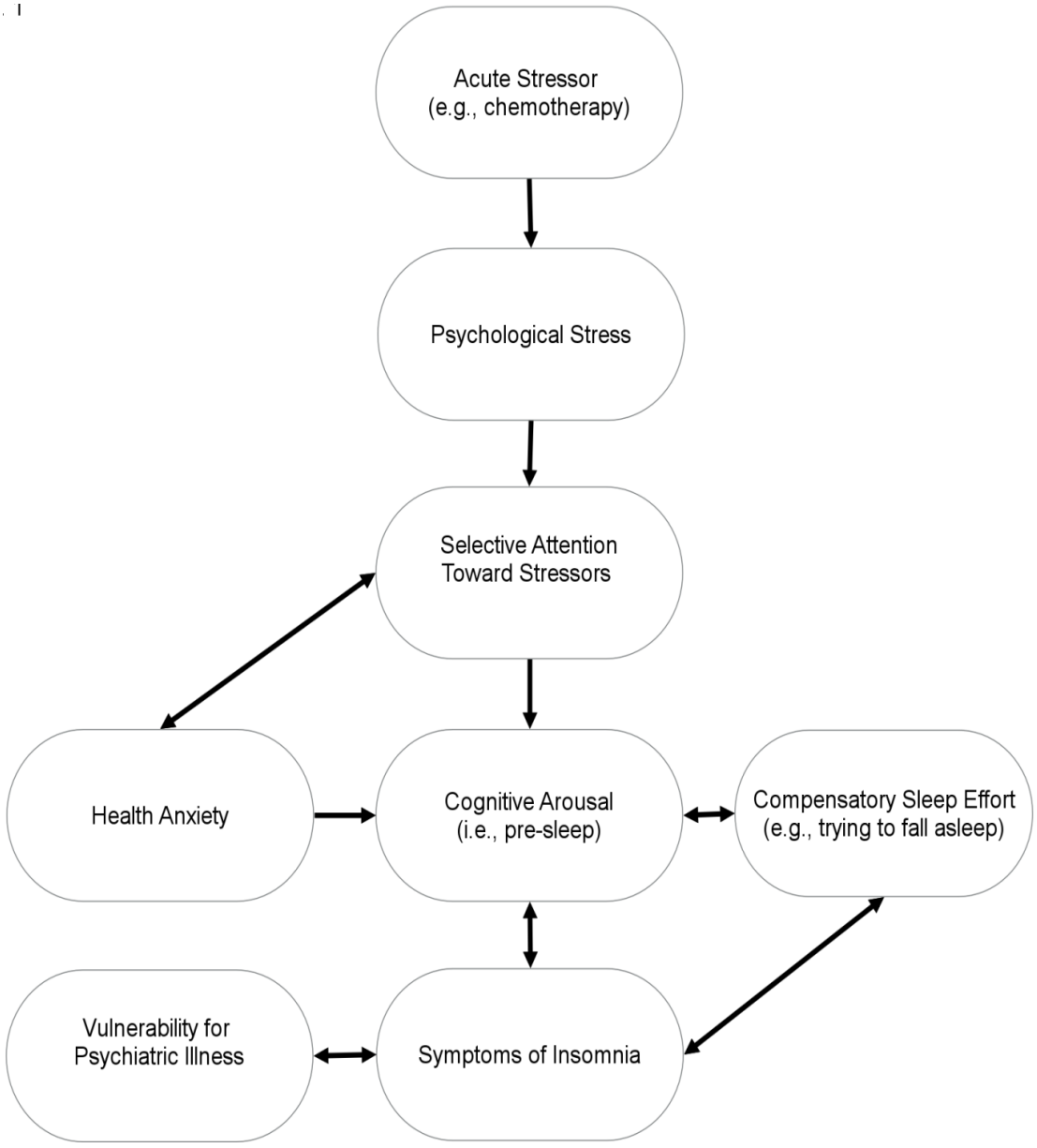


Figure 1. Theoretical model. Only the bottom two levels were studied.

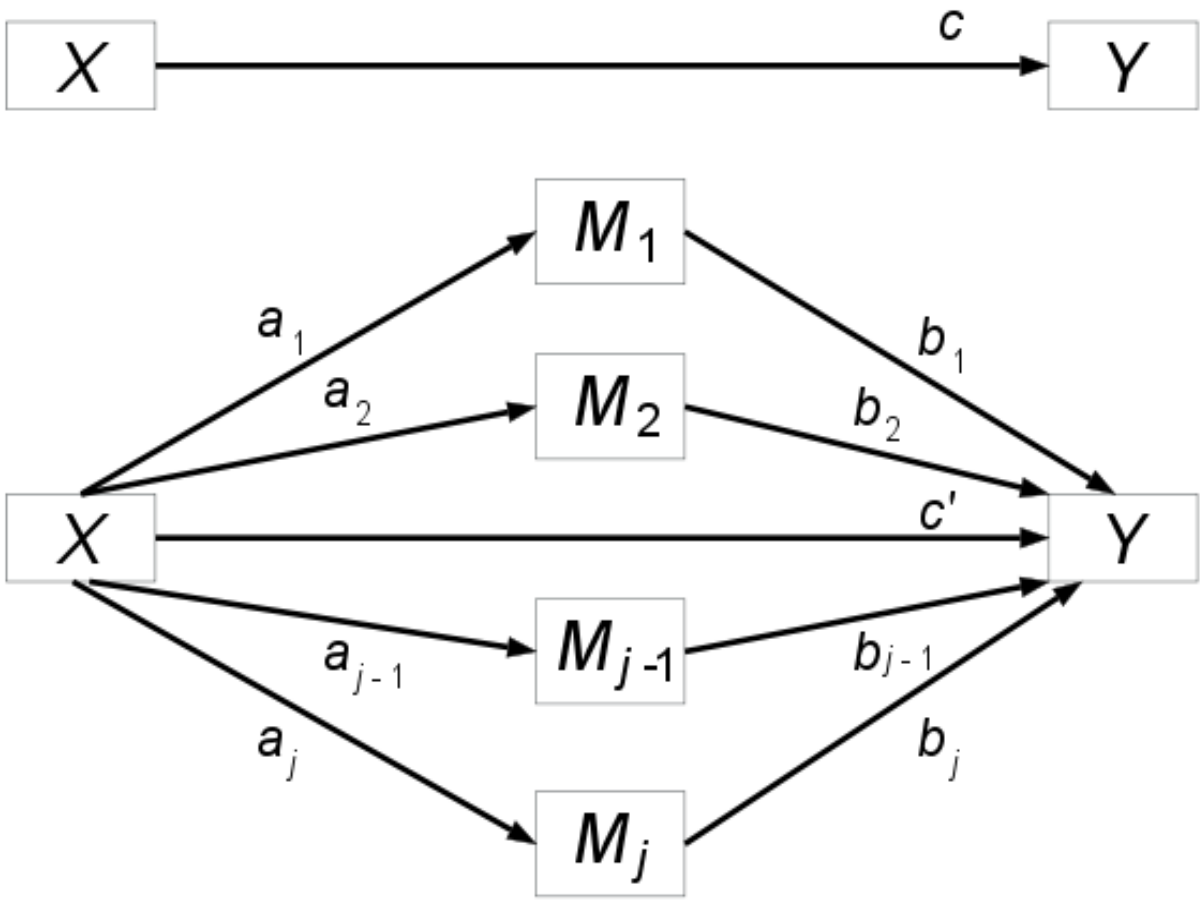


Figure 2. A single-step multiple mediator model. The top panel reflects independent variable X's effect on dependent variable Y (path c). The bottom panel reflects X's direct effect on Y (path c'). Mediators are denoted M, e.g., path a1 is the direct effect of X on M1 and path b1 is the direct effect of M1 on Y. M1 may indirectly affect Y even after controlling for all direct effects (a1b1).

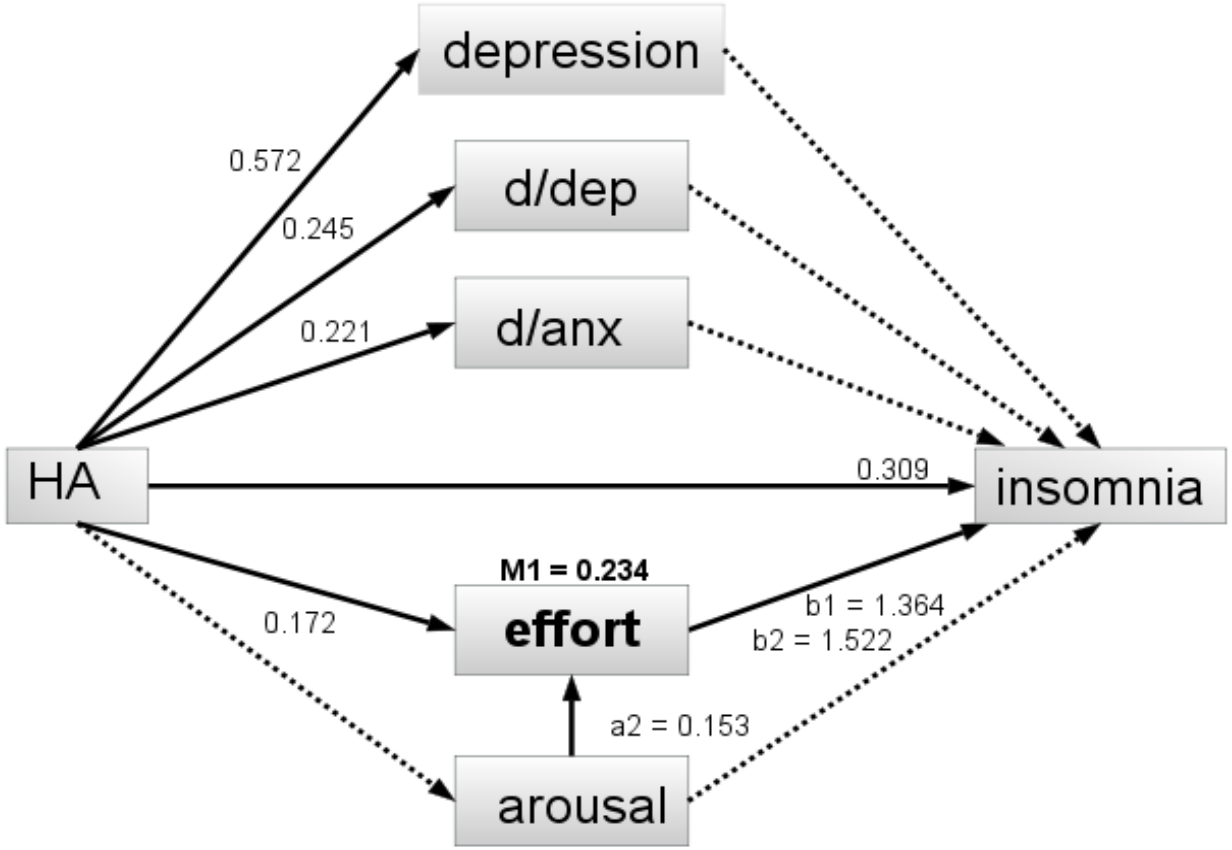


Figure 3. Baseline mediation model, full sample (N=38). HA = health anxiety (SHAI); depression (CES-D); d/dep = distress due to depression and d/anx = distress due to anxiety (BSI); effort (GSES); arousal (GCTI); insomnia (ISI). Significant paths have solid lines. Indirect effects are in **bold**.

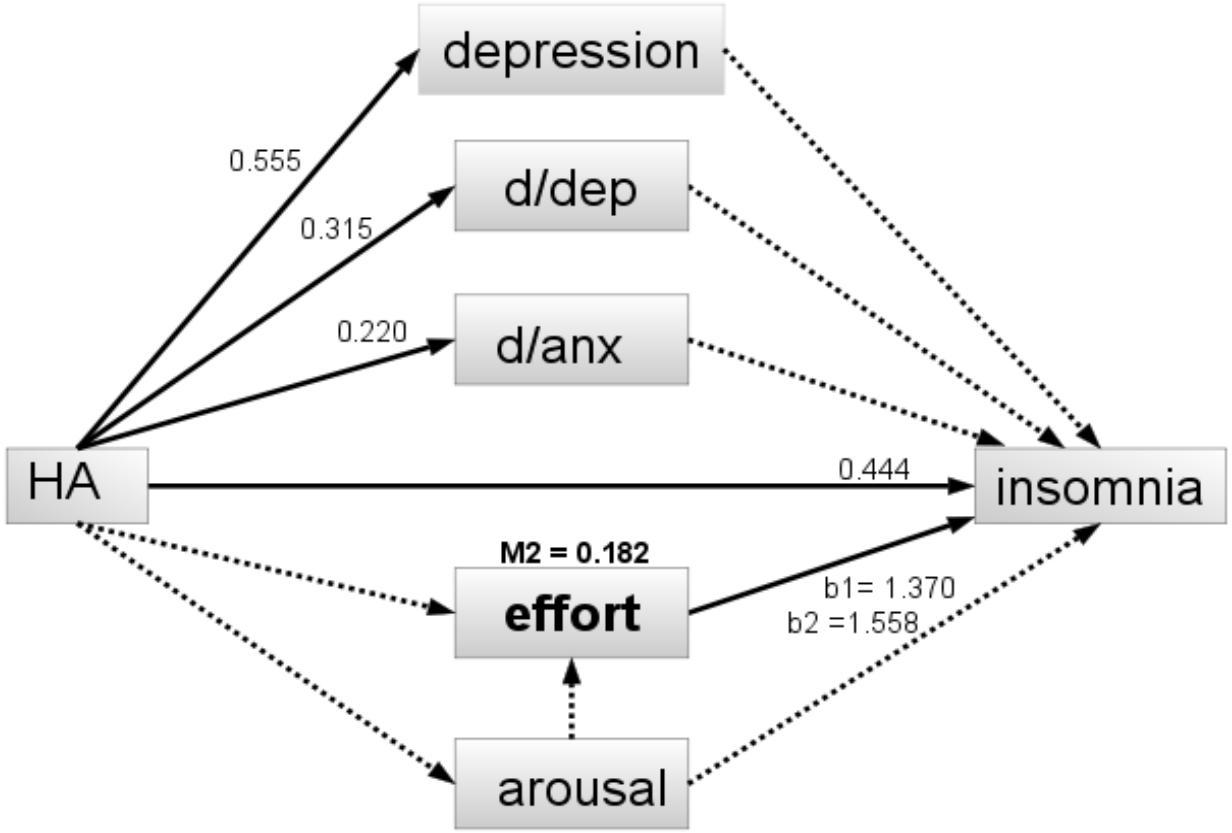


Figure 4. Baseline mediation model, patient group (n=19). HA = health anxiety (SHAI); depression (CES-D); d/dep = distress due to depression and d/anx = distress due to anxiety (BSI); effort (GSES); arousal (GCTI); insomnia (ISI). Significant paths have solid lines. Indirect effects are in **bold**.

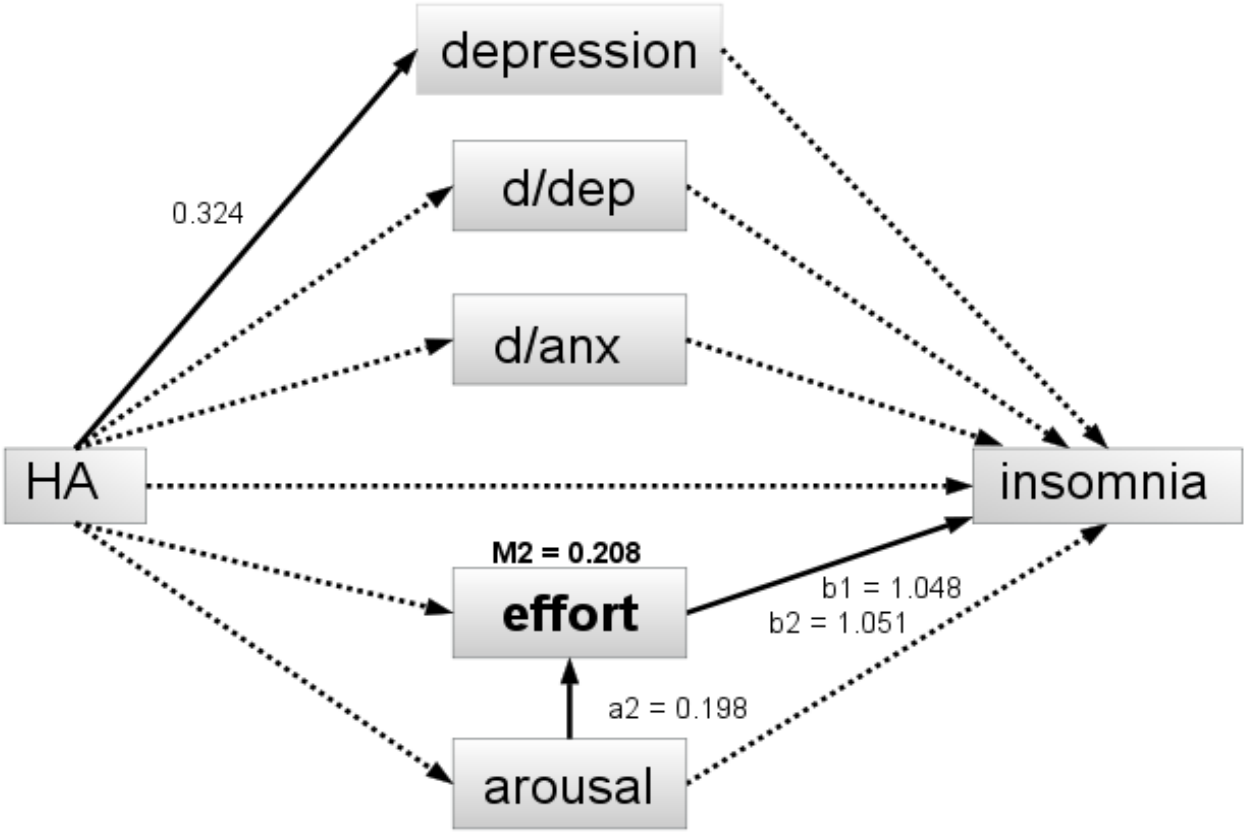


Figure 5. Baseline mediation model, control group (n =19). HA = health anxiety (SHAI); depression (CES-D); d/dep = distress due to depression and d/anx = distress due to anxiety (BSI); effort (GSES); arousal (GCTI); insomnia (ISI). Significant paths have solid lines. Indirect effects are in **bold.**

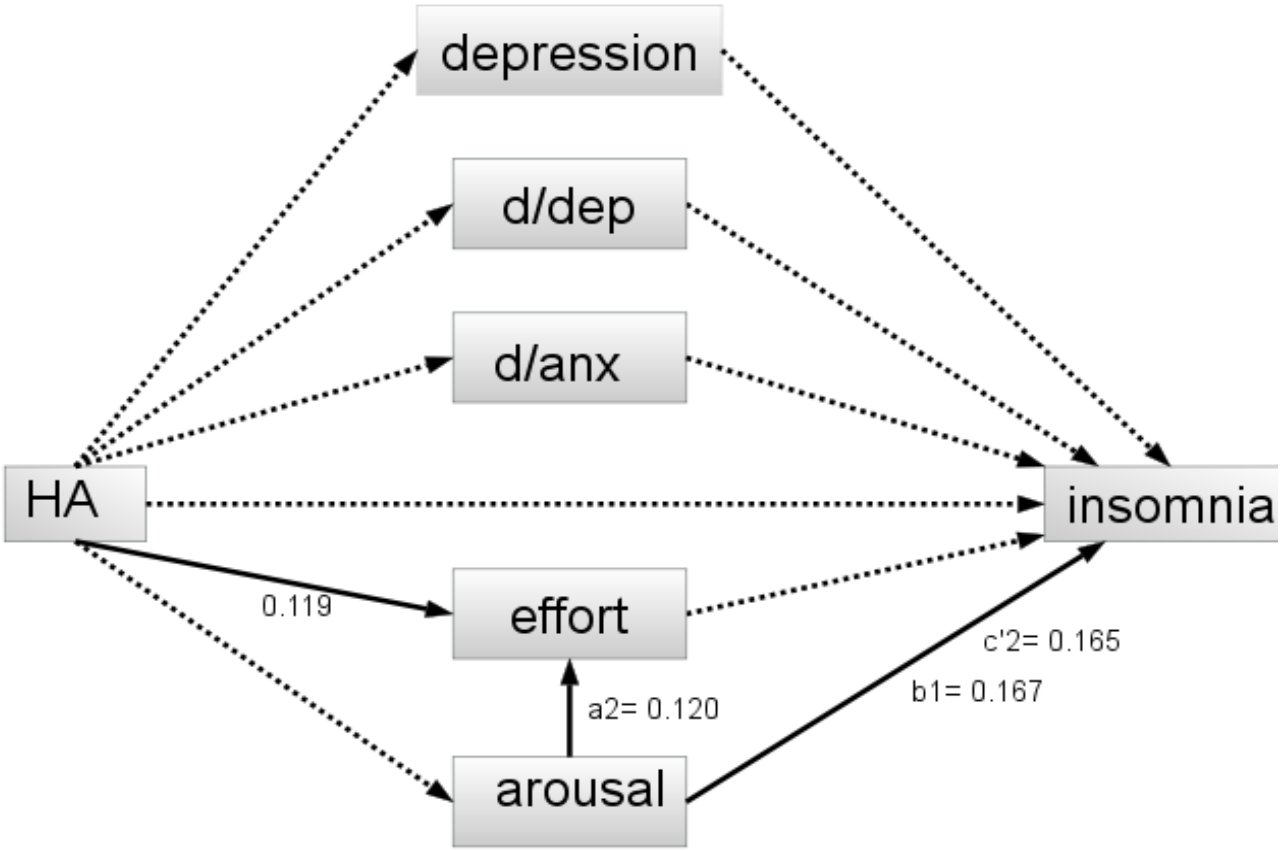


Figure 6. End of treatment mediation model, full sample (N=38). HA = health anxiety (SHAI); depression (CES-D); d/dep = distress due to depression and d/anx = distress due to anxiety (BSI); effort (GSES); arousal (GCTI); insomnia (ISI). Significant paths have solid lines. Indirect effects are in **bold**.

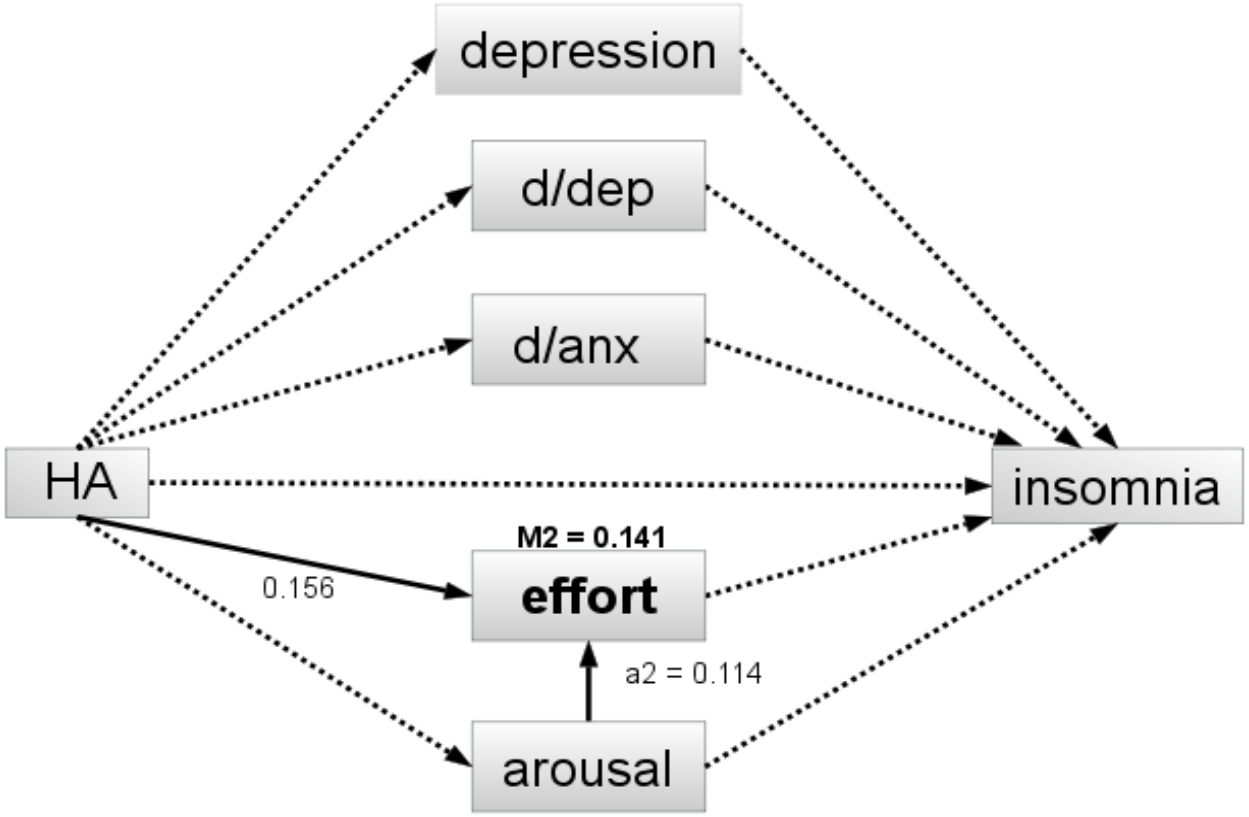


Figure 7. End of treatment mediation model, patient group (n=19). HA = health anxiety (SHAI); depression (CES-D); d/dep = distress due to depression and d/anx = distress due to anxiety (BSI); effort (GSES); arousal (GCTI); insomnia (ISI). Significant paths have solid lines. Indirect effects are in **bold**.

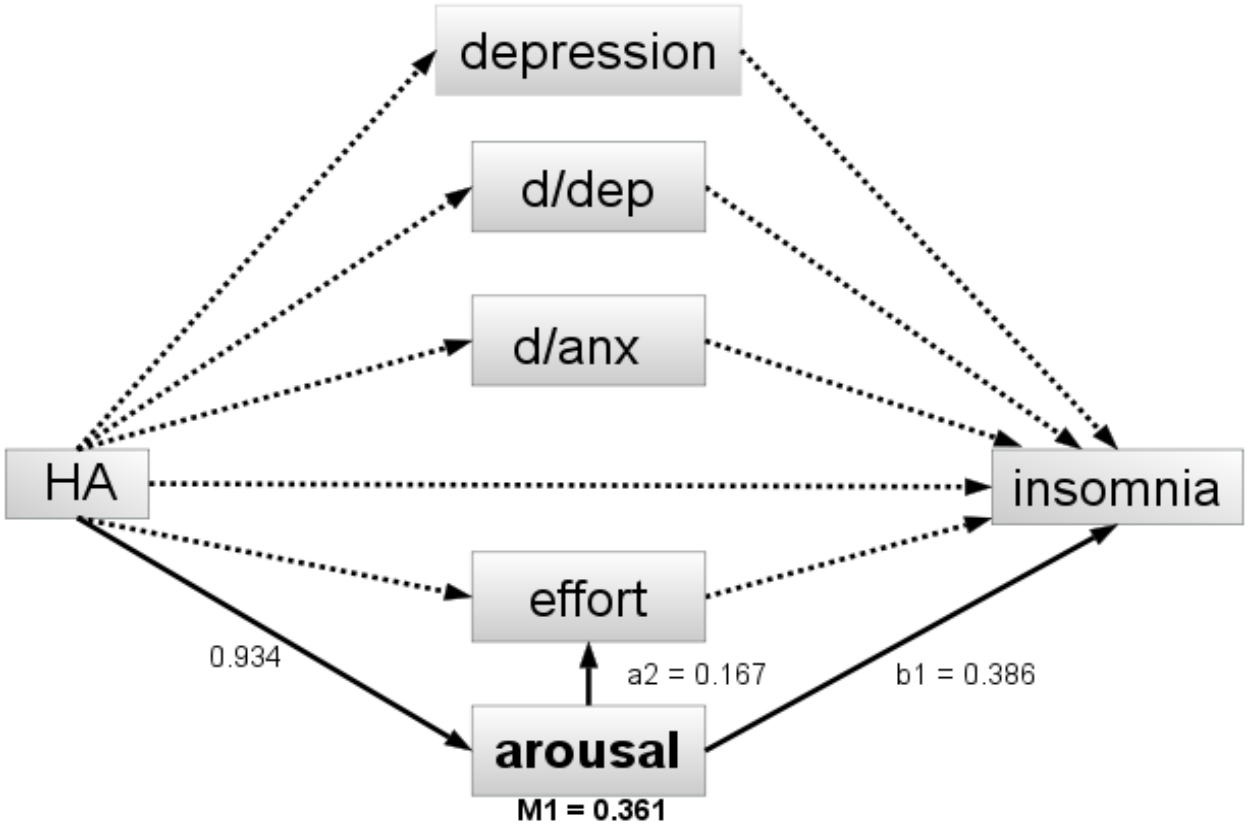


Figure 8. End of treatment mediation model, control group (n=19). HA = health anxiety (SHAI); depression (CES-D); d/dep = distress due to depression and d/anx = distress due to anxiety (BSI); effort (GSES); arousal (GCTI); insomnia (ISI). Significant paths have solid lines. Indirect effects are in **bold**.

Appendix

UCSD

Participant ID:		Date Completed:				
Phase:		Cycle:		Week:		
GSES			Collected and reviewed by:			

A. Do you *currently* consider yourself....

...a good OR a poor sleeper? (circle either "good" OR "poor")

...a worrier (someone that worries too much)? Yes No

B. Have you *always* considered yourself...

...a good OR a poor sleeper? (circle either "good" OR "poor")

...a worrier (someone that worries too much)? Yes No

C. Have you had problems sleeping at least three nights a week for the past six months? Yes No

Instructions:

The following seven statements relate to your night-time sleep pattern in the past week only. Please indicate by circling one response that best describes how true each statement is for you.

1. I put too much effort into sleeping at night when it should come naturally

Very much To some extent Not at all

2. I feel I should be able to control my sleep at night

Very much To some extent Not at all

3. I put off going to bed at night for fear of not being able to sleep

Very much To some extent Not at all

4. I worry about not sleeping if I am in bed at night and cannot sleep

Very much To some extent Not at all

5. I am no good at sleeping at night

Very much To some extent Not at all

6. I get anxious about sleeping before I go to bed at night

Very much To some extent Not at all

7. I worry about the long term consequences of not sleeping at night

Very much To some extent Not at all

Thank you for completing this questionnaire

Page 1 of 1

12. Things you have to do tomorrow			
Never	Sometimes	Often	Always
13. How hot/cold you feel			
Never	Sometimes	Often	Always
14. Your work/responsibilities			
Never	Sometimes	Often	Always
15. How frustrated/annoyed you feel			
Never	Sometimes	Often	Always
16. How light/dark the room is			
Never	Sometimes	Often	Always
17. Noises you hear			
Never	Sometimes	Often	Always
18. Being awake all night			
Never	Sometimes	Often	Always
19. Pictures in your mind			
Never	Sometimes	Often	Always
20. The effects of not sleeping well			
Never	Sometimes	Often	Always
21. Your personal life			
Never	Sometimes	Often	Always
22. How thinking too much is the problem			
Never	Sometimes	Often	Always
23. Things in your past			
Never	Sometimes	Often	Always
24. How bad you are at sleeping			
Never	Sometimes	Often	Always
25. Things to do to help you sleep			
Never	Sometimes	Often	Always

Thank you for completing this questionnaire

UCSD

Participant ID:			Date Completed:		
Phase:			Cycle:	Week:	
SHAI			Collected and reviewed by:		

Each question in this section consists of a group of four statements. Please read each group of statements carefully, and then select the one(s) which best describes your feelings over the past ☐six months ☐week (investigator to check one). Identify the statement(s) by ringing the letter next to it, i.e. if you think that statement (a) is correct, ring statement (a); it may be that more than one statement applies, in which case, please ring any that are applicable.

1. (a) I do not worry about my health.
   (b) I occasionally worry about my health.
   (c) I spend much of my time worrying about my health.
   (d) I spend most of my time worrying about my health.

2. (a) I notice aches/pains less than most other people (of my age).
   (b) I notice aches/pains as much as most other people (of my age).
   (c) I notice aches/pains more than most other people (of my age).
   (d) I am aware of aches/pains in my body all the time.

3. (a) As a rule I am not aware of bodily sensations or changes.
   (b) Sometimes I am aware of bodily sensations or changes.
   (c) I am often aware of bodily sensations or changes.
   (d) I am constantly aware of bodily sensations or changes.

4. (a) Resisting thoughts of illness is never a problem.
   (b) Most of the time I can resist thoughts of illness.
   (c) I try to resist thoughts of illness but am often unable to do so.
   (d) Thoughts of illness are so strong that I no longer even try to resist them.

5. (a) As a rule I am not afraid that I have a serious illness.
   (b) I am sometimes afraid that I have a serious illness.
   (c) I am often afraid that I have a serious illness.
   (d) I am always afraid that I have a serious illness.

6. (a) I do not have images (mental pictures) of myself being ill.
   (b) I occasionally have images of myself being ill.
   (c) I frequently have images of myself being ill.
   (d) I constantly have images of myself being ill.

7. (a) I do not have any difficulty taking my mind off thoughts about my health.
   (b) I sometimes have difficulty taking my mind off thoughts about my health.
   (c) I often have difficulty in taking my mind off thoughts about my health.
   (d) Nothing can take my mind off thoughts about my health.

8. (a) I am lastingly relieved if my doctor tells me there is nothing wrong.
   (b) I am initially relieved but the worries sometimes return later.
   (c) I am initially relieved but the worries always return later.
   (d) I am not relieved if my doctor tells me there is nothing wrong.

9. (a) If I hear about an illness I never think I have it myself.
   (b) If I hear about an illness I sometimes think I have it myself.
   (c) If I hear about an illness I often think I have it myself.
   (d) If I hear about an illness I always think I have it myself.

10. (a) If I have a bodily sensation or change I rarely wonder what it means.
    (b) If I have a bodily sensation or change I often wonder what it means.
    (c) If I have a bodily sensation or change I always wonder what it means.
    (d) If I have a bodily sensation or change I must know what it means.

11. (a) I usually feel at very low risk for developing a serious illness.
    (b) I usually feel at fairly low risk for developing a serious illness.
    (c) I usually feel at moderate risk for developing a serious illness.
    (d) I usually feel at high risk for developing a serious illness.

12. (a) I never think I have a serious illness.
    (b) I sometimes think I have a serious illness.
    (c) I often think I have a serious illness.
    (d) I usually think that I am seriously ill.

13. If I notice an unexplained bodily sensation…
    (a) I don't find it difficult to think about other things.
    (b) I sometimes find it difficult to think about other things.
    (c) I often find it difficult to think about other things.
    (d) I always find it difficult to think about other things.

14. (a) My family/friends would say I do not worry enough about my health.
    (b) My family/friends would say I have a normal attitude to my health.
    (c) My family/friends would say I worry too much about my health.
    (d) My family/friends would say I am a hypochondriac.

Please continue to the next section

For the following questions, please think about the experience of a serious illness of a type which particularly concerns you (such as heart disease, cancer, multiple sclerosis and so on). Please give your best estimate of what you think might happen, basing your estimate on what you know about yourself and serious illness in general.

15. If I had a serious illness…
    (a) I would still be able to enjoy things in my life quite a lot.
    (b) I would still be able to enjoy things in my life a little.
    (c) I would be almost completely unable to enjoy things in my life.
    (d) I would be completely unable to enjoy life at all.

16. If I developed a serious illness…
    (a) There is a good chance that modern medicine would be able to cure me.
    (b) There is a moderate chance that modern medicine would be able to cure me.
    (c) There is a very small chance that modern medicine would be able to cure me.
    (d) There is no chance that modern medicine would be able to cure me.

17. (a) A serious illness would ruin some aspects of my life.
    (b) A serious illness would ruin many aspects of my life.
    (c) A serious illness would ruin almost every aspect of my life.
    (d) A serious illness would ruin every aspect of my life.

18. If I had a serious illness…
    (a) I would not feel that I had lost my dignity.
    (b) I would feel that I had lost a little of my dignity.
    (c) I would feel that I had lost quite a lot of my dignity.
    (d) I would feel that I had totally lost my dignity.

Thank you for completing this questionnaire

UCSD

Participant ID:			*Date Completed:*		
Phase:			*Cycle:*	*Week:*	
ISI			*Collected and reviewed by:*		

Please answer each of the questions below by circling the number that best describes your sleep patterns. Please answer all the questions.

1. Please rate the current (last 2 weeks) severity of your insomnia problems.

	None	Mild	Moderate	Severe	Very Severe
Difficulty falling asleep	0	1	2	3	4
Difficulty staying asleep	0	1	2	3	4
Problem waking up too early	0	1	2	3	4

2. How Satisfied/Dissatisfied are you with your sleep pattern?

Very Satisfied 0 1 2 3 4 Very Dissatisfied

3. To what extent do you think your sleep problem interfere with your daily functioning (daytime fatigue, ability to function at work or daily chores, concentration, memory, mood, etc)?

Does Not Interfere 0 1 2 3 4 Significant Interfering

4. How noticeable to others are your sleeping problem in terms of impairing the quality of your life?

Not at all Noticeable 0 1 2 3 4 Very Noticeable

5. How worried/distressed are you about your current sleep problem?

Not at all 0 1 2 3 4 Very Distressed

Thank you for completing this questionnaire

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