

THE EVOLUTION OF SECONDARY INSOMNIA
IN WOMEN WITH BREAST CANCER

by

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ABSTRACT

Secondary insomnia resulting from the onset of a health problem often persists beyond the course of the instigating stressor, suggesting that secondary insomnia evolves into a self-sustaining primary disorder. However, the course of secondary insomnia and how it relates to a primary medical or psychological disorder is poorly understood. Newly diagnosed breast cancer provides an opportunity to study secondary insomnia at the onset of an instigating stressor. The current study explored the feasibility of a methodology to examine the relationship between insomnia and breast cancer over a 2 month period in 29 women newly diagnosed (< 6 weeks) with breast cancer.

Primary analyses included exploratory descriptive techniques. A multilevel modeling framework was also applied to the data to examine changes in sleep and cancer symptoms over time. The results show a significant relationship between insomnia severity and breast cancer symptom severity. Evidence is also presented regarding differences in the experience of this relationship for individuals with primary and secondary insomnia. Further evidence is presented supporting a change in the relationship between sleep and stress over time for individuals with secondary insomnia. Implications for timing of intervention and future research are discussed.

DEDICATION

This dissertation is dedicated to everyone who helped me, guided me, and stood by me through the process of completing this research study and manuscript. In particular, to my wife, Sarah, who encouraged and supported me through the ups and downs of graduate school.

LIST OF ABBREVIATIONS AND SYMBOLS

r	Pearson product-moment correlation
p	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
t	Computed value of a t test
Z	Standardized z-score value
n	Number of measurements or participants
β	Standardized coefficient value
b	Unstandardized coefficient value
δ	Delta: a measure of effect size
SE	Standard error
ns	Not significant
\geq	Greater than or equal to
$>$	Greater than
\leq	Less than or equal to
$<$	Less than
$=$	Equal to

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CHAPTER 1

INTRODUCTION

Numerous physical and mental health problems have been well documented as potential instigators of poor sleep (American Academy of Sleep Medicine, 2005; Ohayon, Caulet, & Lemoine, 1998; Taylor et al., 2007). How poor sleep and health problems influence each other over time has been more difficult to determine. Historically, insomnia connected with the onset of a medical or psychological illness has been categorized as secondary insomnia (American Academy of Sleep Medicine, 2005). More recently it has been recommended that the term “secondary insomnia” be replaced by “comorbid insomnia,” a term that does not imply unidirectional causality (National Institute of Health, 2005). However, we believe that a causal relationship does exist between co-occurring medical illness and insomnia symptoms, particularly close to the onset of the medical illness, and that this relationship changes quickly over time (Lichstein, 2006). The current study will attempt to document evidence for this dynamic relationship between co-occurring illness and secondary insomnia symptoms.

It is important to define secondary insomnia and how it is different from other forms of insomnia. This can be done through an examination of differences between secondary insomnia and other diagnostic categories. Secondary insomnia is the appropriate diagnosis when the insomnia symptoms stem from the onset of another co-occurring disorder. The International Classification of Sleep Disorders-2 (ICSD-2; American Academy of Sleep Medicine, 2005) identifies medical illness, psychological disorders, substance use, and other sleep disorders as common primary instigators of secondary insomnia. The most extensively researched co-

occurring health problems include cancer, chronic pain, and depression (Smith, Huang, & Manber, 2005). These instigators can have chronic durations and indistinct resolutions, making it difficult to determine how their symptoms influence insomnia over time. Secondary insomnia is distinct from insomnia resulting from transient stressors, such as environmental changes (i.e. jet lag), biological disturbance, stress, and worry. Stressors that induce transient insomnia have identifiable onsets and clear resolutions (Roehrs, Zorick, & Roth, 2000). Transient insomnia typically lasts for the duration of the stressor, which is usually short term, and then resolves (Krystal, 2005; Roth & Roehrs, 2003).

The differences between secondary insomnia and primary or psychophysiological insomnia are poorly understood and have long been a matter of debate and theorizing (Lichstein, McCrae, & Wilson, 2003). Nighttime sleep disturbance and daytime functioning deficits are criteria for both disorders (American Academy of Sleep Medicine, 2005). However, whereas secondary insomnia is precipitated by a psychiatric condition, medical condition, or substance (Hu & Silberfarb, 1991), primary insomnia is not associated with an intrusive psychological problem or medical disorder. Primary insomnia is therefore unrelated to the onset of a specific stressor, but is thought to result from behavioral or physiological factors that interfere with sleep, such as hyperarousal, negative conditioning, and worry (Drake, Richardson, Roehrs, Scofield, & Roth, 2004; Smith, Smith, Nowakowski, & Perlis, 2003; Stepanski & Rybarczyk, 2006).

Literature also reveals one other differentiation point between secondary and primary insomnia related to the strength of the relationship between insomnia symptoms and daytime functioning deficits. Secondary insomnia should be closely linked to daytime stressors assigned a primary role, but primary insomnia appears to show a sleep pattern that functions independently of fluctuations in daytime symptoms (Lichstein, Durrence, Riedel, & Bayen,

2001; Moul et al., 2002). This is intuitive to some extent. If symptoms of a primary disorder are fueling the insomnia, as is the case with secondary insomnia, the severity of those daytime symptoms and the severity of sleep disturbance should be correlated. In the same way, if there is no apparent primary condition fueling insomnia, as in primary insomnia, the severity of poor sleep and severity of those same daytime functioning symptoms would be unrelated.

One study illustrated this difference by examining the relationship between daytime functioning and insomnia symptoms in individuals with primary insomnia and individuals with insomnia secondary to depression (Moul et al., 2002). They found a linear relationship between these symptom sets in individuals with insomnia secondary to depression. For these individuals, as their daytime functioning decreased in quality, their insomnia symptoms increased in severity. However, for individuals with primary insomnia, results showed no relationship between daytime functioning and insomnia symptom severity.

Within the spectrum of secondary insomnia, the strength of the connection between nighttime insomnia symptoms and symptoms of the co-occurring condition varies and is difficult to discern. If secondary insomnia is purely a symptom of the co-occurring condition, then the onset and resolution of the insomnia symptoms should mirror the course of that co-occurring condition. This is rarely the case (Lichstein, 2000). Often, the symptoms of insomnia are present before the onset of the co-occurring condition and can exacerbate that condition. For example, insomnia has been shown to predict depression onset (Chang, Ford, Mead, Cooper-Patrick, & Klag, 1997), increase the likelihood of coronary events (Schwartz, McDowell Anderson, Cole, Cornoni-Huntley, Hays, & Blazer, 1999), and increase subjective pain reports (Affleck, Urrows, Tennen, Higgins, & Abeles, 1996; Morin, Gison, & Wade, 1998; Roizenblatt, Modofsky, Bendito-Silva, & Tufik, 2001). Also, effectively treating insomnia can improve

symptoms of the co-occurring condition, suggesting that insomnia reciprocally affects the co-occurring condition (Lichstein, Wilson, & Johnson, 2000; Morin, Kowatch, & Wade, 1989).

Furthermore, insomnia symptoms often persist following the successful resolution of the co-occurring condition (Cartwright & Wood, 1991; Katz & McHorney, 1998; Zeyfert & DeViva, 2004). For example, in a sample of individuals with co-occurring cancer and insomnia, the onset of disease and the onset of insomnia symptoms generally coincided but insomnia symptoms persisted beyond the stress surrounding their cancer diagnosis (Davidson, MacLean, Brundage, & Schulze, 2002). Another study found that although 58% of individuals who reported insomnia symptoms following the diagnosis and treatment of cancer attributed their insomnia to the cancer experience, nearly all patients with insomnia symptoms at the time of diagnosis reported that their sleep problems persisted well beyond the resolution of their cancer treatment (Savard, Simard, Blanchet, Ivers, & Morin, 2001). This evidence suggests that secondary insomnia symptoms do not necessarily follow the course and duration of the co-occurring condition.

Lichstein (2000) introduced a heuristic for understanding the complexity of the relationship between the primary condition and insomnia symptoms by dividing the diagnosis of secondary insomnia into three types. The first is absolute secondary insomnia. In this condition, the co-occurring disorder is the cause of insomnia symptoms and controls the course of insomnia. The second is partial secondary insomnia. Here, the comorbid condition most likely initiated or aggravated insomnia symptoms, but the insomnia to some degree functions independently of the co-occurring condition. The third type is spurious secondary insomnia. In this instance, the co-occurring condition and insomnia are functioning independently, suggesting any perceived connection between them is coincidental. This type of secondary insomnia is more often referred to as comorbid insomnia (Lichstein, 2000). However, even with truly

specious secondary insomnia, the sleep disturbance and co-occurring condition are still likely to influence each other (Lichstein, 2006). It is difficult to extrapolate which of these secondary insomnia types is present except perhaps through monitoring response to treatments for primary insomnia (Lichstein et al., 2003).

Lichstein's (2000) diagnostic specifications suggest that the strength of the relationship between secondary insomnia and the co-occurring condition can be thought of as occurring along a continuum, ranging from highly correlated to uncorrelated. This has contributed to the debate surrounding the issue of primary insomnia evolving from secondary insomnia. Spielman proposed a model that illustrated the potential mechanism for the transformation of insomnia symptoms from reactive to self-sustaining (Spielman, Caruso, & Glovinsky, 1987). The model suggests that predisposing, precipitating, and perpetuating factors all play a different role in determining if an individual experiences acute, short term, or chronic sleep disturbance. In this model, predisposing influences, such as psychological, physiological, and hereditary factors, may act as a building block to increase the vulnerability of an individual to experience insomnia across acute, short term, and chronic durations (Spielman & Glovinsky, 1991). Precipitating factors, such as health, social, and occupational factors, act as the event that triggers the onset of insomnia symptoms and are more influential in acute and short term insomnia cases (Bastien, Vallieres, & Morin, 2004). However, as time progresses, the influence of the precipitating event often lessens and perpetuating factors, such as worry and misguided compensatory behaviors, become the more dominant influence on the persistence of insomnia symptoms. Roth and Drake (2004) further hypothesize that a hyper-responsivity to predisposing factors combined with stress lead to the onset of insomnia, which is then maintained by insomnia-promoting behaviors and cognitive hyperarousal. These models, along with Lichstein's diagnostic differentiations for

secondary insomnia, suggest an evolution in the way secondary insomnia and the co-occurring condition relate that may predict the extent to which insomnia symptoms become chronic, self-sustaining problems. Specifically, it appears that a shift occurs in the category of symptoms that fuel insomnia; a shift from the precipitating co-occurring condition to perpetuating factors such as hyperarousal and poor sleep behaviors.

Understanding how secondary insomnia relates to a co-occurring condition and how that relationship changes over time would provide information crucial to determining where we intervene with insomnia specific treatments. It would also provide a knowledge base for determining the risk of secondary insomnia to develop into a chronic primary condition. However, there is currently no empirical support for this underlying belief that secondary insomnia evolves into a primary insomnia, and establishing evidence for this shift has proven difficult. This is most likely due to two factors: difficulties that arise when trying to diagnose secondary insomnia and the methodological limitations of previous studies of secondary insomnia.

Lichstein, Wilson, and Johnson (2000) summarize the difficulties that arise in making a diagnosis of secondary insomnia. Insomnia diagnoses are usually made some time after symptom onset, at which time the relationship between the co-occurring condition and sleep disturbance will have most likely already evolved into a purely comorbid or specious relationship. Furthermore, the data used to make a diagnosis of secondary insomnia amounts to single-estimate correlations of poor sleep and the co-occurring stressor, which cannot be used as causal evidence.

Previous research has not been able to effectively monitor this transition from secondary to primary insomnia symptoms. Methodologies typically focus on measuring sleep and daytime

symptoms at single time points in a cross-sectional manner. Even studies that take long term follow-up measures do so at discreet time points. This allows for the ability to establish predictors of long term insomnia and daytime dysfunction, but does not allow for close monitoring of fluctuations in daytime and nighttime symptoms and how they relate to each other.

The relationship between secondary insomnia and its primary condition is poorly understood because a void exists in the longitudinal methodology surrounding the onset and early stages of the primary condition. Sudden onset acute illness that reliably triggers sleep disturbance is the ideal circumstance to study processes underlying secondary insomnia. Furthermore, longitudinal study beginning at or around the diagnosis of the co-occurring condition presents the opportunity to investigate the transformation of secondary insomnia into chronic, primary insomnia. If secondary insomnia evolves into self-sustaining primary insomnia, the expectation would be for the relationship between symptoms of the co-occurring condition and sleep to weaken over time. Newly diagnosed breast cancer patients are just such a population that would provide this opportunity to study the evolution of secondary insomnia.

Sleep disturbance is one of the most commonly reported problems associated with the diagnosis and treatment of cancer (Ancoli-Israel, 2006; Savard et al., 2001) and studies have linked poor sleep with numerous health, treatment, and psychosocial factors in cancer patients (Bardwell et al., 2008; Palesh et al., 2007). However, not everyone diagnosed with cancer develops disturbed sleep, and for those who do, the severity and course vary greatly. Roughly one half to three quarters of cancer patients report some sort of sleep disturbance that, for a majority of these individuals, is frequent (nightly) and moderate to severe (Davidson et al., 2002; Portenoy et al., 1994; Savard et al., 2001). Although the most prominently reported problem is with frequent awakenings, a majority of patients report a combination of sleep problems that also

include difficulty initiating sleep, waking for a long time during the night, and early morning awakenings (Davidson et al., 2002; Kaye, Kaye, & Madow, 1983).

For individuals with co-occurring cancer and insomnia, almost half report that the onset of their sleep difficulties occurred at or shortly after the diagnosis of cancer (Davidson et al., 2002; Savard, Simard, Hervouet, Ivers, Lacombe et al., 2005), with many more reporting that their symptoms began within one month post cancer diagnosis (Savard et al., 2001). This means that for many patients, cancer-related sleep difficulties emerge before cancer treatment is begun (Ancoli-Israel et al., 2006; Berger et al., 2007; Liu et al., 2009). Roughly 50% of patients with insomnia and cancer report that their cancer experience either caused or exacerbated their insomnia symptoms, and most commonly attribute their insomnia symptoms to stress, worry, pain and discomfort, concerns about their health and family, and the physical effects of cancer (Davidson et al., 2002; Savard et al., 2001). For a significant number of individuals with cancer and insomnia, their insomnia symptoms persist for years following the end of cancer treatment (Alfano et al., 2011; Couzi, Helzlsouer, & Fetting, 1995; Lindley, Vasa, Sawyer, & Winer, 1998).

Compared across cancer diagnoses, breast cancer may have the highest prevalence of sleep difficulties (Davidson et al., 2002; Savard, Simard, Ivers, & Morin, 2005), with one study showing the prevalence of sleep problems to be as high as 63% (Koopman, 2002). Research on distress surrounding the onset and early treatment of breast cancer indicates that insomnia is a highly prevalent problem for newly diagnosed individuals (Cimptich, 1999). One study found that 66% of women reported poor sleep quality before the initiation of chemotherapy (Liu et al., 2009), and insomnia has been shown to be a persistent problem through the course of chemotherapy treatment (Boehmke, 2004). Insomnia is also one of the most prevalent problems

immediately following surgical treatment for breast cancer (Kenefick, 2006), with symptoms persisting through recovery in the weeks that follow (Wang, Lee, Chang, & Lin, 2005).

The threat of breast cancer alone is associated with increased insomnia incidence. One study examined worry about breast cancer in a population of women with no prior history of breast cancer (Jean-Louis et al., 2009). They found higher rates of insomnia in women who worry about breast cancer compared to women who do not worry about breast cancer, controlling for family history of breast cancer and perceived risk. Another study showed evidence for increased emotional, physical, and social distress in women recalled for follow-up testing from a breast mammography (Lowe, Balanda, Del Mar, & Hawes, 1999). This distress, which included insomnia symptoms, persisted at one month following the recall, even though no diagnosis of breast cancer was made. Overall, insomnia appears to be a highly prevalent problem from the outset of the cancer experience for women with breast cancer.

Despite the high prevalence of insomnia symptoms, individuals with breast cancer certainly are not doomed to poor sleep (Silberfarb, Hauri, Oxman, & Schnurr, 1993). However, for those who do find themselves sleeping poorly, other serious symptoms and consequences accompany their sleeping difficulty, such as depression (Carlson, Campbell, Garlands, & Grossman, 2007; Liu et al., 2009; Palesh et al., 2007; Savard, Simard, Hervouet et al., 2005), fatigue (Ancoli-Israel, 2006; Anderson et al., 2003; Kozachik & Bandeen-Roche, 2008), increased pain severity (Kozachik & Bandeen-Roche, 2008), and decreased quality of life (Bardwell, et al., 2008; Golden-Kreutz, et al., 2005; Lis, Gupta, & Grutsch, 2008). For example, one study of women with metastatic breast cancer found that difficulties with falling asleep, staying asleep, and terminal awakening were associated with higher levels of depression and pain (Koopman et al., 2002).

Though there are numerous factors linked to poor sleep in breast cancer patients, the exact role they play in precipitating or perpetuating insomnia has never been documented. Physical symptoms commonly associated with breast cancer, such as pain, fatigue, and nausea, have been related to poor sleep and are the most likely culprit for precipitating insomnia (Savard & Morin, 2001; Strang & Qvarner, 1990). For example, women experiencing pain are more likely to report difficulties falling asleep and are more likely to use sleep medication to help them sleep than women with breast cancer who are not experiencing pain (Koopman et al., 2002). Worry about health and family also appears to contribute to the development of insomnia symptoms (Davidson et al., 2002; Savard et al., 2001).

A number of cancer specific factors such as disease stage, treatment duration, and treatment dose have been shown to influence insomnia in breast cancer patients. Surgery, radiation and chemotherapy have all been shown to disrupt sleep throughout the course of treatment (Given, Given, Azzouz, & Stommel, 2001; Liu et al., 2008; Savard et al., 2001; Wang et al., 2005) and chemotherapy has recently been shown to disrupt sleep-wake activity rhythms (Savard et al., 2009). However, research indicates there is little evidence that any one of these treatments affect insomnia symptoms to a greater extent than the others (Bardwell et al., 2008; Given et al., 2001).

Factors linked to perpetuating chronic insomnia symptoms in women with co-occurring breast cancer include stress and hyperarousal, as well as other co-occurring disorders such as depression (Bardwell et al., 2008; Golden-Kreutz, et al., 2005; Koopman et al., 2002; Taylor, Espie, & White, 2003). Particularly, two factors have shown promise as potential predictors of chronic insomnia following the treatment and resolution of breast cancer: hyperarousal and premorbid insomnia. In general, physical and cognitive hyperarousal is a key factor in the

development and maintenance of chronic insomnia. Individuals with chronic insomnia have higher levels of daytime alertness and arousal both at sleep onset and upon awakening (Bastien, St-Jean, Morin, Turcotte, & Carrier, 2008; Stepanski, Zorick, & Roehrs, 1988). Hyperarousal has been shown to also contribute to the persistence of insomnia symptoms in women with breast cancer. Women who develop persistent sleep problems following breast cancer treatment show higher levels of sleep related cognitive arousal (Taylor, Espie, & White, 2003), although objective measures of stress and arousal may not differentiate women with breast cancer and poor sleep quality from normal controls (Carlson et al., 2007).

Another potential risk factor for the development of chronic insomnia symptoms is a history of premorbid insomnia symptoms (Klink, Quan, Kaltenborn, & Lebowitz, 1992). One study found that previous insomnia was the only significant predictor of chronic insomnia symptoms following hospitalization for cancer-related procedures (Griffiths & Peerson, 2005). This finding may stem from an increased likelihood for individuals with previous insomnia to already display behaviors and cognitions that would sustain insomnia symptoms. This is supported by their finding that individuals with chronic insomnia symptoms report higher levels of pre-sleep arousal (Griffiths & Peerson, 2005). Essentially, individuals with a previous insomnia history are more likely to experience sleep disturbance that is primary in nature than individuals without a prior history.

The current study was interested in addressing three goals related to secondary insomnia and breast cancer. The first was to document the association between insomnia symptoms and breast cancer symptoms of distress near the time of the cancer diagnosis. The nature of secondary insomnia indicates that cancer-related distress should directly affect insomnia symptoms. To date, evidence has shown that insomnia is a prevalent problem at diagnosis for

women with breast cancer, but evidence for the strength of the association between insomnia and the core cluster of physical and emotion symptoms of distress caused by breast cancer has not been established. It was hypothesized that as long as disturbed sleep is secondary to medical illness, there will be a positive correlation between self-reported sleep and cancer-related symptoms of distress.

The second goal was to explore differences in the association between insomnia severity and breast cancer symptom severity for two precipitating factors of chronic insomnia: prior history of insomnia, and presleep arousal. This was accomplished by examining participants with and without premorbid insomnia symptoms, and individuals with high and low levels of cognitive and physical presleep arousal. Because both of these variables are commonly implicated factors for chronic insomnia, they provided an opportunity for studying differences between primary and secondary insomnia characteristics. Specifically, individuals with premorbid insomnia history or who have higher levels of presleep arousal can be considered to have primary insomnia characteristics and individuals with no premorbid insomnia history or who have lower levels of presleep arousal can be considered to have secondary insomnia characteristics. It was hypothesized that there would be a positive association between cancer stress and insomnia severity for individuals with secondary insomnia characteristics, but not for individuals with primary insomnia characteristics.

The third goal was to fill a longitudinal void surrounding how breast cancer symptom severity and insomnia symptoms change following the diagnosis of breast cancer. The void was explored by examining the relation between insomnia symptoms and cancer symptoms using descriptive data techniques and through using a multilevel modeling framework. This allowed the examination of the growth trajectories of insomnia symptoms and breast cancer distress and

how their relation changes over time. It also allowed an examination of the potential differing effects of perpetuating symptoms of insomnia over time. It is believed that for some individuals, as disturbed sleep evolves into chronic primary insomnia, the strength of the association between insomnia severity and breast cancer stress will diminish over time. Therefore, it was hypothesized that there will be an observable diversion between growth patterns for insomnia symptoms and growth patterns for cancer-related distress across time. It was also hypothesized that differences in premorbid insomnia status and both cognitive and physical hyperarousal would result in different courses for insomnia and cancer symptoms over time.

These three goals aim to provide evidence for the presence of secondary insomnia following the onset of a significant life stressor, to show differences between secondary insomnia characteristics and primary insomnia characteristics by exploring the influence of factors known to perpetuate chronic insomnia, and to catch an elusive glimpse of the theorized evolution of secondary insomnia into primary insomnia.

A last, overarching goal of this current study was to develop a methodology for effectively monitoring the longitudinal course of secondary insomnia symptoms. Particularly, we examined the feasibility and effectiveness of this method of data collection. Monitoring symptoms in a population of individuals who have very recently experienced a life-changing diagnosis is a delicate process. The current methodology introduced the complexity of balancing participant burden with adequate and robust data collection strategies. The current study aimed to provide insight into the willingness of newly diagnosed cancer patients to participate in research requiring daily monitoring of their symptoms.

CHAPTER 2

METHOD

Participants

Participants (n=29) were recruited from a pool of newly diagnosed breast cancer patients at the DCH Regional Medical Cancer Center. They must have met the following criteria to be included in the study: 40 to 70 years; within 6 weeks of their initial diagnosis of breast cancer; no current diagnosis of another actively sleep intrusive or unstable medical condition or sleep disorder (i.e. restless legs syndrome, sleep apnea); meet basic International Classification of Sleep Disorders (ICSD) insomnia criteria at the time of the initial assessment. To meet insomnia criteria, participants must report current sleep difficulties with adequate opportunity for sleep, and report daytime impairment symptoms (See Appendix A for the diagnostic interview). A third diagnostic criterion is the presence of insomnia symptoms for \geq one month (American Academy of Sleep Medicine, 2005). However, because one of the goals of the study was to establish the nature of the association between insomnia symptoms and cancer symptoms as close to the cancer diagnosis as possible, the nature of the study precludes the use of this diagnostic feature as criterion for inclusion in the study. Research has shown that women aged 40 to 70 have the highest prevalence of breast cancer (Jemal et al., 2008).

Out of potential participants identified as being willing to be approached about the study (n=55), 38 met criteria and were consented into the study. For those who did not meet criteria, the most typical reasons for not participating included the presence of another sleep disorder, lack of significant sleep disturbance, or a disinterest in participating once the study was

described to them. Of those 38 participants, 29 completed the entirety of the data collection procedure. For the participants who dropped out of the study, all but one discontinued completing the study material and was unresponsive to follow-up attempts. The other participant contacted the research and expressed a desire to discontinue the study because of other priorities.

The course of treatment for participants varied considerably. Most patients underwent surgery, either a lumpectomy ($n = 18$) or mastectomy ($n = 6$). Most patients also underwent chemo ($n = 12$) or radiation ($n = 7$) treatment during the course of data collection, with five undergoing both. We did not have data on treatment for five participants because it was not assessed. Breast cancer treatment type, treatment dose, and stage were not considered as possible exclusionary criteria, nor was there an attempt to use these as covariates. These illness-specific factors, along with other psychosocial variables such as depression, fatigue, and changes in social structure, are important to the process of insomnia in the context of breast cancer. However, the current study was primarily interested in describing trends in this population and in monitoring the interplay between insomnia symptoms and a core cluster of symptoms of distress resulting from the breast cancer experience. Also, limiting participant burden was crucial in establishing the feasibility of the data collection methodology. Therefore, the evaluation of these factors was left out of the current study.

The study was conducted at the DCH Cancer Center, which is a treatment center located at DCH hospital in Tuscaloosa, Alabama. All contact with the participants occurred directly following scheduled cancer center appointments or through phone and email contact. At the cancer center, participants were either seen in an examination room or, for those undergoing chemotherapy, in the large treatment room.

Measures

Pittsburgh Sleep Quality Index (PSQI).

The PSQI was used to gain a measure of pre-cancer sleep status (See Appendix B). It is an effective one-time self-report measure of sleep patterns and quality of sleep in the past month (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). Participants were asked to complete this measure specifically for the month before their cancer diagnosis was given. The assessment is composed of 23 items, 4 open-ended and 19 items rated on a scale of 0-3. The PSQI measures seven domains: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications, and daytime impairment due to sleep disturbance. Each domain score has good internal consistency and a reliability coefficient of .83 (Smyth, 1999). A total score of 0-21 is possible when domain scores are summed, with a cutoff score of >5 achieving specificity for a “poor” sleeper (Backhaus, Jughanns, Broocks, Riemann, & Hohagen, 2002). The PSQI has shown good reliability and validity as a measure of sleep quality and disturbance in a clinical sample of breast cancer patients (Carpenter & Andrykowski, 1998). The PSQI showed high internal consistency ($r = .80$) and moderate to high correlations between the global PSQI score and each PSQI component. The PSQI also showed good construct validity in that it was more highly correlated (0.69 or above) to other measures of sleep quality, sleep disturbance, and restlessness, and was poorly correlated (.37 or below) to unrelated constructs such as nausea and vomiting. Furthermore, the PSQI was able to distinguish between individuals with reported sleep disturbance, sleep restlessness, and poor sleep quality and those without (Carpenter & Andrykowski, 1998).

Insomnia Severity Index (ISI).

The ISI is a 7-item questionnaire designed to retrospectively measure perceived severity of insomnia symptoms for a period of two weeks (Morin, 1993; See Appendix C). Items relate to difficulty falling asleep, difficulty staying asleep, early morning awakenings, level of dissatisfaction with current sleep, level of interference of disturbed sleep on daytime functioning, level of distress caused by poor sleep, and degree to which other people notice their poor functioning. Each item is measured on a 5-point likert scale from 0 to 4 for a possible score ranging from 0 to 28, with higher scores indicating greater severity. The ISI shows good overall consistency (.74) and strong convergent validity with similar measures (Bastien, Vallieres, & Morin, 2001). Specifically within breast cancer populations, the ISI also shows high internal consistency (.91) and correlates highly with sleep diary data (Savard, Savard, Simard, & Ivers, 2005). The suggested cutoff score for clinically significant sleep difficulties in cancer populations is 8, which maximizes the sensitivity while holding false positives to a minimum (Savard, Savard, et al., 2005).

Pre-Sleep Arousal Scale (PSAS).

The PSAS is a measure of physical and cognitive arousal symptoms that people may experience during the time just prior to sleep onset (Nicassio, Mendlowitz, Fussell, & Petras, 1985; See Appendix D). It contains 16 items, 8 pertaining to each physical and cognitive arousal component, rated on a 5 point likert scale. The PSAS yields two separate measures of arousal, with scores ranging from 8 to 40. It shows good internal consistency for both the physical (.84) and cognitive (.67) components in individuals with insomnia and correlates well with other measures of sleep and arousal (Nicassio et al., 1985). Cancer patients have been shown to score

higher on the cognitive arousal subscale than the physical arousal subscale both at 2 months and 14 months post diagnosis (Taylor, Espie, & White, 2003).

FACT/NCCN Breast Symptom Index (FBSI).

Participants assessed their breast cancer symptom severity using the FBSI breast cancer symptoms survey (Yost, Yount, Eton, Silberman, Broughton-Heyes, & Cella, 2005; See Appendix E). The FBSI is composed of 8 Likert scales which measure daily symptoms associated with breast cancer diagnosis and treatment over a 7-day period. The FBSI items tap into physical symptoms, such as pain, nausea, lack of energy, and fatigue, as well as social, emotional, and functional well-being. Each item is specifically tailored to symptoms most frequently reported by individuals with breast cancer (Yost et al., 2005). The original Functional Assessment of Cancer Therapy-Breast (FACT-B) and the FBSI short form have both been shown to have adequate reliability (.90 internal consistency; .85 test-retest) and validity and sensitivity to change (Brady et al., 1997; Yost et al., 2005). This measure was used both as a 7-day and a 24-hour assessment tool.

Sleep Diary.

A sleep diary is a subjective measure of daily sleep and takes about 2 minutes to complete (Lichstein et al., 2004; See Appendix F). It includes estimates of a number of sleep parameters including bedtime, sleep onset latency (SOL), the number of awakening during the night (NWAK), the amount of wake time after sleep onset (WASO), final wake-up time, time out of bed, and a subjective sleep quality rating, which asks the respondent to rate their sleep quality on a scale from one (very poor) to five (excellent). A number of other sleep measures can be calculated from these parameters. Total time in bed is calculated by measuring the amount of time between bedtime and time out of bed. Terminal awakening time (TWAK) is calculated by

measuring the amount of time between the final wake-up time and the time out of bed. Total sleep time (TST) is calculated by subtracting SOL, WASO, and TWAK from the total time in bed. Sleep efficiency (SE) is calculated by dividing TST by total time in bed. A singular composite measure of overall sleep, called the sleep quotient, can be calculated by converting SOL, WASO, NWAK, TST, and SE into z-scores using normative means, finding the mean z-score of the five parameters, and transforming it into the sleep quotient, which has a mean of 100 and a standard deviation of 15 (Lichstein, 1997). Normative means were used for gender and age decade and were taken from Lichstein and colleague's (2004) epidemiological study of sleep. For the sleep quotient, values under 100 suggest worse sleep than the normative sample and values above 100 suggest better sleep compared to the normative sample. The sleep diary also provides space for participants to record any medications used and alcohol consumption at bed time.

These diaries are generally viewed as an adequate means of gathering information on sleep patterns (Lichstein et al., 2004). Sleep diaries are considered superior to and are more accurate than retrospective self-report measures of sleep in that they require the participant to recall only the previous night's sleep and record it in detail, and are the recommended standard for daily self-reported sleep (Buysse, Ancoli-Israel, Edinger, Lichstein, & Morin, 2006).

Procedure

Gaining contact with the participants as close to their diagnosis of breast cancer was crucial to be able to measure their sleep as close as possible to the onset of the stressor. Therefore, participants were recruited by their second contact at the treatment center. As part of their visit, potential participants were approached by a cancer center employee, most frequently the physician, to determine their initial interest. If they assented, the study was described in

detail and interested participants were consented and briefly screened to determine if they met study criteria. If they met criteria, they completed the baseline battery of questionnaires, which included the PSQI, the ISI, the FBSI 7-day version, and the PSAS.

Following the interview, participants underwent a 7-week data monitoring phase, during which they completed 28 days of sleep diary and breast cancer severity ratings. They completed these ratings in four, 7-day increments which were interspersed with three, 7-day periods where they were not completing the ratings. Each morning during the data collection phases, participants answered questions regarding their previous night's sleep and the previous day's cancer-related symptoms using the daily sleep diary and the FBSI 24-hour version. After they completed this data collection phase, they were approached at one of their cancer center appointments to complete a brief post-assessment battery which included the ISI, FBSI 7-day version, and the PSAS. Participants were given the option of completing their daily records using paper questionnaires or electronically. Roughly 50% chose the electronic data collection option ($n = 14$), and for those that did not choose this option, the primary reason cited was lack of computer or email access.

At the end of data collection, participants were offered the opportunity to participate in a sleep workshop designed to introduce cognitive-behavioral techniques for treating insomnia. Through the workshop, participants would be exposed to sleep hygiene education, stimulus control instructions, and relaxation techniques. These behavioral interventions have been shown to be effective treatments for insomnia in individuals with breast cancer both in an individual and group setting (Davidson, Waisberg, Brundage, & MacLean, 2001; Quesnel, Savard, Simard, Ivers & Morin, 2003; Simeit, Deck, & Conta-Marx, 2004). The workshop consists of two separate meetings which allows for the patient to attempt the techniques they learn between

meetings and ask questions to help them better implement these interventions. However, when given this option, only 1 participant expressed interest.

CHAPTER 3

RESULTS

As this is an exploratory study, multiple statistical comparisons were conducted using a variety of techniques to best determine the relationships present in the data. To balance Type I and Type II error, statistical results will be reported without correction for multiple comparison. These exploratory methods are in line with other exploratory studies in sleep and cancer (Ancoli-Israel et al., 2006).

Descriptive Statistics.

A total of 29 participants were included in the study. Regarding ethnicity, nine participants were African American and 20 participants were Caucasian American. All 29 participants met criteria for insomnia at the initial interview. One participant reported a history of restless legs symptoms, but stated that she had not experienced them in over 2 years, so she was included in the study. No other comorbid sleep diagnoses were reported by the other participants. Four participants reported using some sort of sleep medication to help their sleep at night, with one reporting the use of a prescription (alprazolam) and the others reporting use of over the counter medication. Out of the 110 nights of data for these four individuals, 40 (36%) of them were nights when medication was used. Out of the 29 participants, 14 (52%) reported having other medical problems, with the most common problem being high blood pressure. Of the women that reported other medical problems, five (36%) reported having two additional medical problems and four (29%) reported having three additional medical problems. Women with additional medical problems did not differ significantly from women without additional

medical problems on age, $t(27) = -0.75$, ns, days between diagnosis and their initial assessment, $t(27) = -1.53$, ns, baseline ISI scores, $t(27) = -1.32$, ns, or baseline FBSI scores, $t(27) = -0.72$, ns.

Means and standard deviations for baseline characteristics, baseline measures, and daily measures of sleep and cancer symptoms are presented in Table 1. Each variable is presented for the entire sample and grouped by pre-cancer diagnosis insomnia status, high or low physical presleep arousal, and high or low cognitive presleep arousal. Pre-cancer diagnosis insomnia status, or premorbid insomnia, was determined using the individual's score on the PSQI, which was completed for the 1 month time period directly prior to the participant's cancer diagnosis. A cutoff of >5 was used to separate individuals with and without premorbid insomnia, with scores six or higher indicative of prior insomnia history. High and low levels of physical and cognitive presleep arousal were determined by using a median split of the data. The cutoffs were a score of 12 for physical presleep arousal and a score of 17 for cognitive presleep arousal. The mean value for physical (12.07) and cognitive (19.03) presleep arousal was used as the deciding factor for how individuals who scored directly at the median were placed into groups. This led to the decision to include those individuals in the 'low' group for each presleep arousal variable, as their scores fell below the mean for that measure. T-tests were used to examine differences in age and the number of days between diagnosis and starting the study separately for premorbid sleep groups, physical presleep arousal groups, and cognitive presleep arousal groups. All t-tests were non-significant, suggesting the groups are not significantly different on these two variables.

T-tests were also used to examine group differences in ISI and FBSI baseline scores. For pre-cancer diagnosis insomnia status groups, there were significant differences between ISI scores, $t(27) = -3.00$, $p < .01$, and FBSI scores, $t(27) = -3.07$, $p < .05$. Participants with premorbid insomnia ($n = 17$) have higher levels of insomnia severity and breast cancer symptom

Table 1

Means (standard deviations) of baseline characteristics, baseline measures, and daily measures of sleep and cancer symptoms for the overall sample and for groups defined by pre-cancer diagnosis insomnia status, physical presleep arousal, and cognitive presleep arousal.

	Overall Sample	Pre-cancer diagnosis insomnia status		Physical presleep arousal (median split at x=12)		Cognitive presleep arousal (median split at x=17)	
Baseline characteristics		No insomnia	Insomnia	Low: x≤12	High x>12	Low x≤17	High x>17
	(n=29)	(n=12)	(n=17)	(n=18)	(n=11)	(n=16)	(n=13)
Age	54.7 (9.29)	53.9 (8.59)	55.2 (9.99)	55.7 (8.13)	53.0 (11.16)	57.3 (8.96)	51.4 (8.95)
Days since diagnosis	28.0 (12.69)	29.67 (14.24)	16.82 (11.79)	26.28 (13.77)	30.82 (10.70)	25.50 (14.31)	31.08 (10.8)
Baseline measures							
ISI	7.7 (6.51)	3.92 (4.06)	10.41* (6.66)	5.6 (5.86)	11.3* (6.17)	3.9 (4.31)	12.4* (5.75)
FBSI	9.1 (6.90)	5.0 (3.69)	12.0* (7.25)	6.1 (4.33)	14.1* (7.58)	5.8 (4.25)	13.2* (7.43)
Cognitive presleep arousal	19.0 (9.00)	13.3 (5.15)	23.1 (8.98)	15.7 (8.78)	24.5 (6.59)	12.1 (3.40)	27.5 (5.69)
Physical presleep arousal	12.1 (3.90)	10.9 (4.01)	12.9 (3.64)	9.5 (1.72)	16.3 (2.28)	9.88 (2.80)	14.8 (3.24)
PSQI	6.7 (4.55)	2.6 (1.5)	9.6 (3.57)	5.7 (4.31)	8.4 (4.65)	4.25 (2.46)	9.8 (4.75)
Daily measures							
FBSI daily	10.2 (6.73)	8.6 (6.47)	11.3 (6.68)	8.3 (6.39)	12.7 (6.36)	7.7 (6.33)	13.1 (5.99)
Sleep onset latency	38.6 (56.56)	28.1 (30.67)	46.1 (68.42)	34.8 (39.15)	43.8 (73.53)	28.7 (31.45)	50.3 (74.48)
Number of awakenings	2.02 (1.37)	1.9 (1.06)	2.01 (1.55)	2.01 (1.15)	2.0 (1.61)	1.8 (1.10)	2.2 (1.59)
Wake time after sleep onset	35.2 (51.38)	33.6 (43.08)	36.4 (56.71)	32.0 (42.93)	39.6 (61.01)	30.2 (43.03)	40.9 (59.09)
Total sleep time	429.7 (130.42)	437.6 (100.95)	424.0 (148.13)	430.6 (131.07)	428.5 (129.80)	437.46 (125.46)	420.9 (135.58)
Sleep quotient	88.6 (27.70)	92.7 (20.14)	85.6 (31.80)	90.3 (21.83)	86.3 (34.12)	94.3 (19.66)	82.0 (33.54)

PSQI: Pittsburgh Sleep Quality Index ISI: Insomnia Severity Index FBSI: FACT Breast Severity Index

Note: T-tests were performed to determine differences between each dichotomized set of groups on age, days since diagnosis, ISI, and FBSI. *p < .05

severity than those without premorbid insomnia ($n = 12$). For physical presleep arousal groups, there were significant differences between ISI scores, $t(27) = -2.50$, $p < .05$, and FBSI scores, $t(27) = -3.65$, $p < .01$. Individuals with higher levels of physical presleep arousal ($n = 11$) have higher ISI and FBSI scores compared to those with lower levels ($n = 18$). Lastly, cognitive presleep arousal also showed group differences between ISI scores, $t(27) = -4.52$, $p < .001$, and FBSI scores, $t(27) = -3.41$, $p < .01$. Participants with higher levels of cognitive presleep arousal ($n = 13$) have higher ISI and FBSI scores compared to those with lower levels of cognitive presleep arousal ($n = 16$).

In general, this current sample showed levels of sleep disturbance indicative of insomnia, with mean levels of SOL and WASO that were greater than 30 minutes. The sample had a mean score of 9.1 on the baseline 7-day version of the FBSI and a mean of 10.2 on the daily FBSI version. This is lower than the average score of 16.7 found in the original validation study (Yost et al., 2005).

Association between Insomnia and Breast Cancer Stress.

The association between insomnia severity, as measured by the ISI, and breast cancer symptom severity, as measured by the FBSI 7-day version, was explored at baseline as well as at the post-data collection period. Insomnia severity was significantly correlated with breast cancer symptom severity at baseline, $r(29) = .57$, $p < .01$. At the post-evaluation assessment two months later, insomnia severity and breast cancer symptom severity were no longer correlated, $r(28) = .35$, ns.

Differences in the association between breast cancer symptom severity and insomnia severity were also examined separately for individuals who completed baseline within 3 weeks of their cancer diagnosis and those who completed baseline later than 3 weeks after their cancer

diagnosis. For both of these groups, initial ISI ratings were significantly correlated with initial FBSI scores (days from diagnosis ≤ 20 , $r(9) = .86$, $p = .003$; days from diagnosis >20 , $r(20) = .48$, $p = .031$). The only difference noted is that the correlation for those within 3 weeks of cancer diagnosis appears to be stronger than the correlation for those later than 3 weeks, but these two correlations are not significantly different, $Z = 1.61$, ns.

Premorbid Insomnia.

To examine differences in the association between insomnia and breast cancer for individuals with primary insomnia characteristics compared to individuals with secondary insomnia characteristics, correlations between insomnia severity and breast cancer symptom severity were explored separately for both premorbid sleep groups. There was a significant association between insomnia severity and breast cancer symptom severity at baseline for individuals with no history of insomnia symptoms, $r(12) = .60$, $p < .05$. This was not true for individuals with premorbid insomnia, $r(17) = .39$, ns. At the post-evaluation assessment, insomnia severity and breast cancer symptom severity were not significantly correlated for either group.

Presleep Arousal.

To further illuminate differences in the relation between breast cancer symptom severity and insomnia severity for those with primary and secondary insomnia characteristics, correlations were also explored separately for individuals high in cognitive and physical presleep arousal, and those low in cognitive and physical presleep arousal. For individuals low in cognitive presleep arousal, there was a significant correlation between breast cancer stress and insomnia severity at baseline, $r(16) = .57$, $p < .05$. This relationship was no longer significant after the assessment period, $r(16) = .33$, ns. For individuals high in cognitive presleep arousal,

insomnia severity and breast cancer stress was not significantly related at baseline, $r(13) = .21$, ns, or at post-assessment, $r(13) = .11$, ns.

A similar pattern was seen for individuals with high and low levels of physical presleep arousal. For those with low levels, there was a significant correlation between cancer stress and insomnia severity at baseline, $r(18) = .48$, $p < .05$, that persisted at the post-evaluation assessment, $r(18) = .50$, $p < .05$. For those high in physical presleep arousal, they again showed no significant association at baseline, $r(11) = .42$, ns, or post-evaluation, $r(11) = .05$, ns.

Association between Presleep Arousal and Breast Cancer Stress

The association between both cognitive and physical presleep arousal and breast cancer symptom severity was also explored. Breast cancer symptom severity was positively correlated with both cognitive presleep arousal, $r(29) = .73$, $p < .001$, and physical presleep arousal, $r(29) = .54$, $p < .01$. At follow up, a significant relation between breast cancer symptom severity and physical presleep arousal persisted, $r(29) = .60$, $p < .001$, but was not significant for cognitive presleep arousal, $r(29) = .27$, ns.

The relation between presleep arousal and breast cancer symptom severity was also examined separately for each premorbid sleep status. For individuals with no pre-cancer diagnosis of insomnia, presleep arousal and breast cancer symptom severity was significantly correlated at baseline for both physical presleep arousal, $r(12) = .75$, $p < .01$, and cognitive presleep arousal, $r(12) = .65$, $p < .05$. At follow up, the association between physical presleep arousal and breast cancer severity was no longer significant, $r(12) = .20$, ns, as was the relationship between cognitive presleep arousal and breast cancer stress, $r(12) = .17$, ns.

For individuals with premorbid insomnia, physical presleep arousal and breast cancer symptom severity was significantly related at baseline, $r(17) = .62$, $p < .01$, but cognitive

presleep arousal and cancer stress was not, $r(17) = .40$, ns. There were no significant correlations between presleep arousal and breast cancer symptom severity at follow up for individuals with premorbid sleep disturbances.

Exploratory Analysis of Insomnia Symptoms and Cancer Symptoms over Time.

In order to examine growth trajectories for sleep and cancer symptoms over time, individual regression models were fitted to each individual's data. This was done for 4 weekly averages of the daily measurements. Table 2 displays the regression parameters for a select sample of individuals for the variables SOL, WASO, the sleep quotient, and FBSI scores. This information is included to provide insight into the process of examining the data using descriptive methods. An average change trajectory across individuals was also calculated for each of the four aforementioned variables. Figure 1 represents a separate scatter plot for each dependent variable, with each individual's best fit line as well as an overall fit line plotted over time. The parameters for the best fit lines are presented in Table 3, which were examined after controlling for between subjects variability in the regression model. No significant slope coefficients were noted for the four outcome variables.

Differences in growth trajectories were also examined separately for pre-cancer diagnosis insomnia status groups and for different levels of physical and cognitive presleep arousal, again using 4 weekly averages as the measure of time. Table 4 presents regression parameters separately for pre-cancer diagnosis insomnia status for SOL, WASO, SQ, and FBSI scores. Table 5 presents the parameters for the same outcome variables separately for physical presleep arousal groups, and Table 6 shows the parameters for cognitive presleep arousal groups. Figure 2 shows graphs of the regression lines based on the coefficients for time for each outcome variable divided by pre-diagnosis insomnia groups, Figure 3 for physical presleep arousal, and

Table 2

Summary of simple regression analysis for a sample of individual participants across 4 weeks average scores ($n=4$) for SOL, WASO, SQ, and FBSI

ID	SOL			WASO			SQ			FBSI		
	B	SE(B)	β	B	SE(B)	β	B	SE(B)	β	B	SE(B)	β
300	46.12	10.57	.951*	13.94	21.95	.521	-18.42	6.52	-.894	-.23	.18	-.665
307	3.57	2.06	.866	-32.15	6.19	-.982	9.80	3.95	.928	--	.58	--
313	-10.11	.73	-.995**	-6.09	3.73	-.756	10.96	4.89	.846	2.08	.80	.878
325	-13.36	19.26	-.570	12.86	47.42	.262	4.76	1.76	.938	-2.00	3.55	-.491
335	4.50	5.54	.498	4.93	9.18	.355	-4.08	4.79	-.158	-.53	.31	-.772
338	17.27	9.85	.778	2.07	2.24	.547	-4.88	2.14	-.850	.46	.50	.545
343	-4.43	1.33	-.920	5.72	1.45	.942*	.48	.71	.434	-.07	.09	-.521
346	-1.30	1.81	-.453	-10.07	1.77	-.970*	9.97	1.01	.990**	-.47	.20	-.855
374	-5.06	2.86	-.781	4.37	4.46	.570	3.09	2.94	.596	-2.20	.53	-.947*
394	1.79	.42	.949*	16.43	8.16	.818	-3.59	4.00	-.536	.43	.21	.824
399	1.07	1.05	.585	4.57	7.19	-.410	2.26	2.81	.493	2.63	.45	.972*
400	3.67	9.74	.258	42.67	20.01	.833	-16.29	6.65	-.866	3.29	.05	1.00**

Note:

* $p < .05$ ** $p < .01$

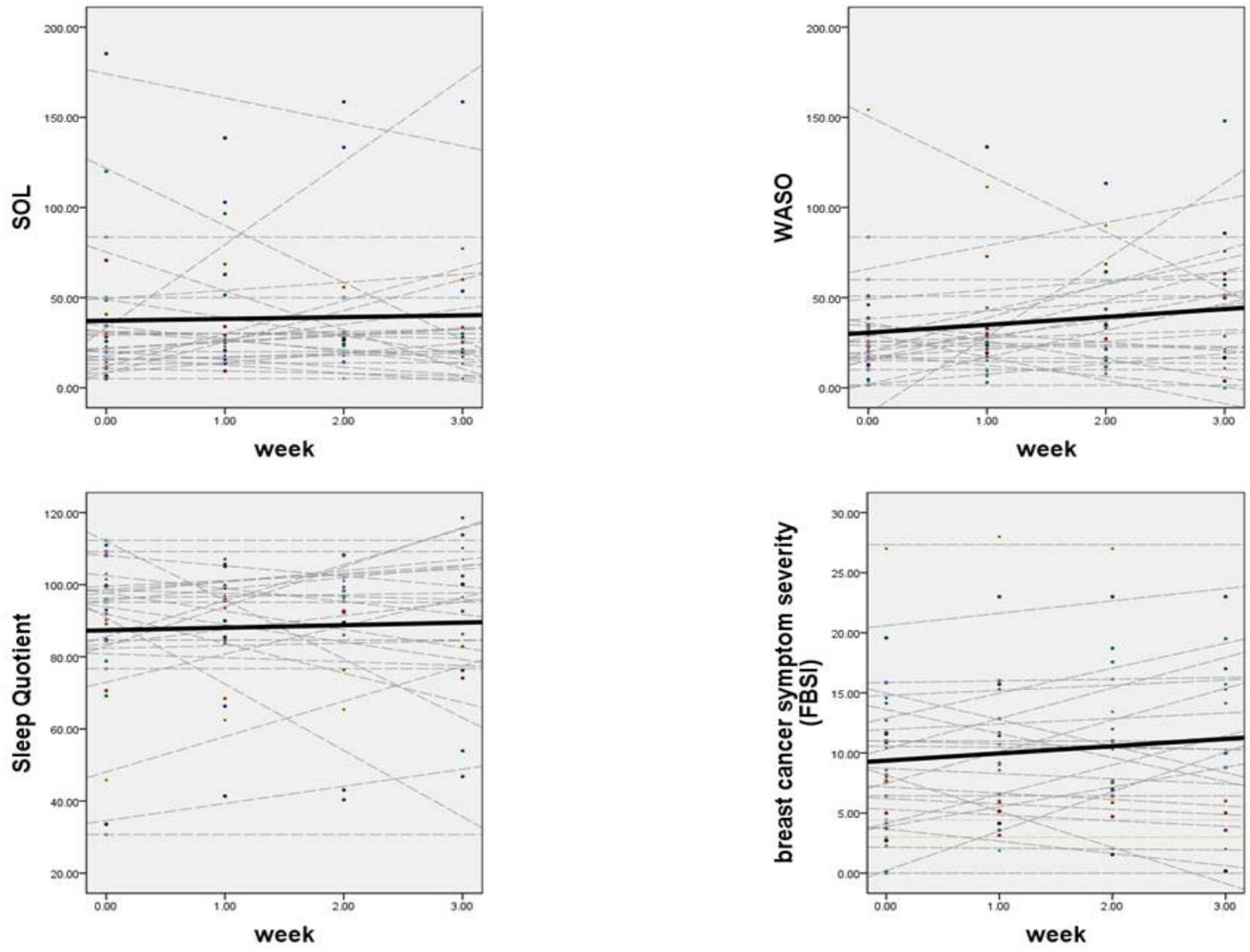


Figure 1: Scatter plots with individual best fit lines and a composite regression line for SOL, WASO, SQ, and FBSI over time

Table 3

Summary of regression analysis for time (n = 4 weekly averages) regressed on SOL, WASO, SQ and FBSI, controlling for within subject variability

Outcome variable	Predictor	B	SE(B)	β
SOL	Time	.701	3.354	.021
WASO	Time	4.307	3.210	.148
SQ	Time	.822	1.728	.047
FBSI	Time	.594	.646	.102

Note: all β values were nonsignificant

Table 4

Summary of regression parameters for time regressed on SOL, WASO, SQ, and FBSI divided by pre-cancer diagnosis insomnia status.

Outcome variable	Predictor	Pre-cancer diagnosis insomnia status					
		No insomnia			Insomnia		
		B	SE(B)	β	B	SE(B)	β
SOL	Time	2.768	2.392	1.69	-.737	5.517	-.018
WASO	Time	9.38	3.914	.390*	.270	4.759	.008
SQ	Time	-2.354	1.792	-.208	3.341	2.620	.162
FBSI	Time	.982	.945	.180	.368	.862	.063

*p < .05

Table 5

Summary of regression parameters for time regressed on SOL, WASO, SQ, and FBSI divided by physical presleep arousal levels.

Outcome variable	Predictor	Physical presleep arousal					
		Low			High		
		B	SE(B)	β	B	SE(B)	β
SOL	Time	-.537	2.949	-.024	2.509	7.043	.055
WASO	Time	8.160	3.295	.342*	-1.543	6.111	-.044
SQ	Time	-.427	1.792	-.033	2.747	3.325	.122
FBSI	Time	.785	.780	.147	.186	1.00	.033

*p < .05

Table 6

Summary of regression parameters for time regressed on SOL, WASO, SQ, and FBSI divided by cognitive presleep arousal levels.

Outcome variable	Predictor	Cognitive presleep arousal					
		Low			High		
		B	SE(B)	β	B	SE(B)	β
SOL	Time	.928	2.254	.059	1.507	6.632	.034
WASO	Time	9.195	3.420	.386*	-.417	5.535	-.012
SQ	Time	-1.401	1.65	-.125	3.008	3.063	.141
FBSI	Time	-.008	.829	-.001	1.409	.822	.275

*p < .05

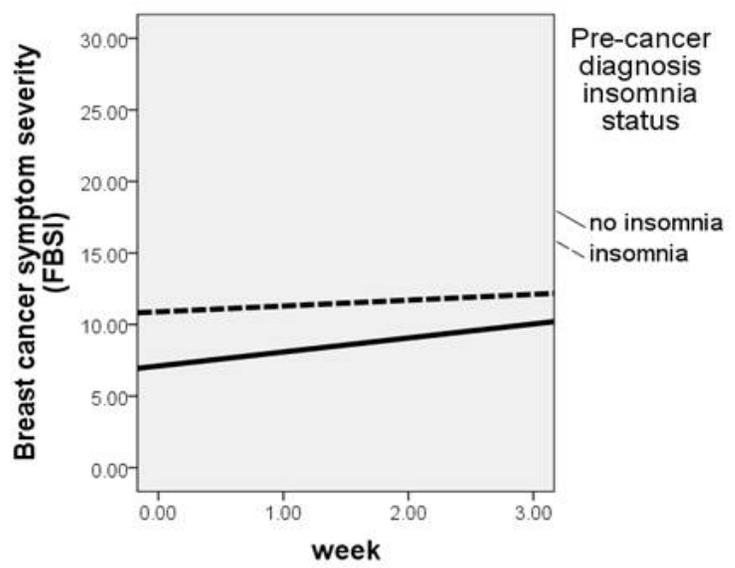
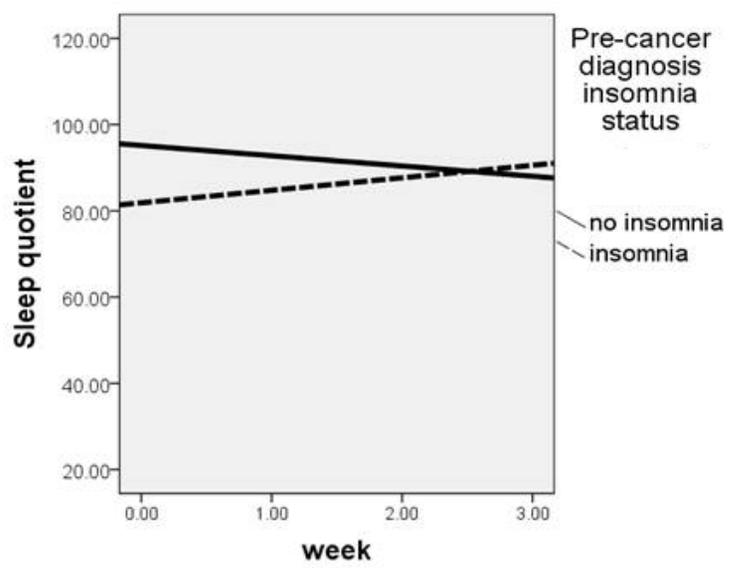
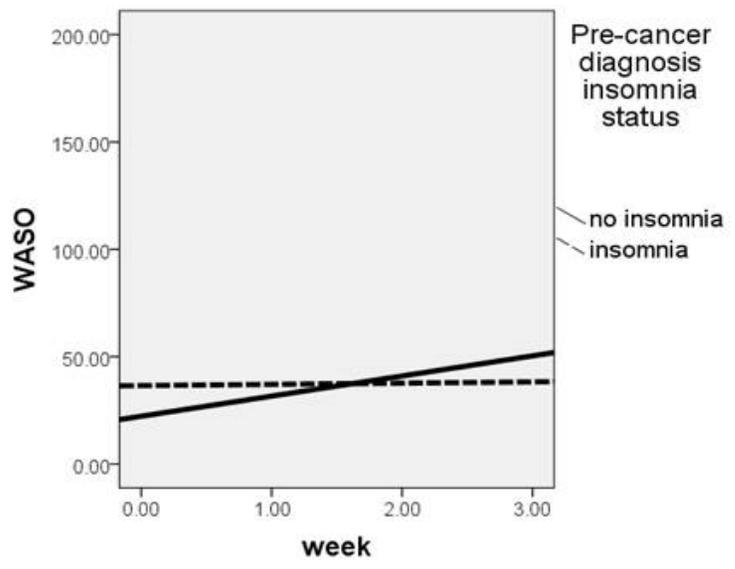
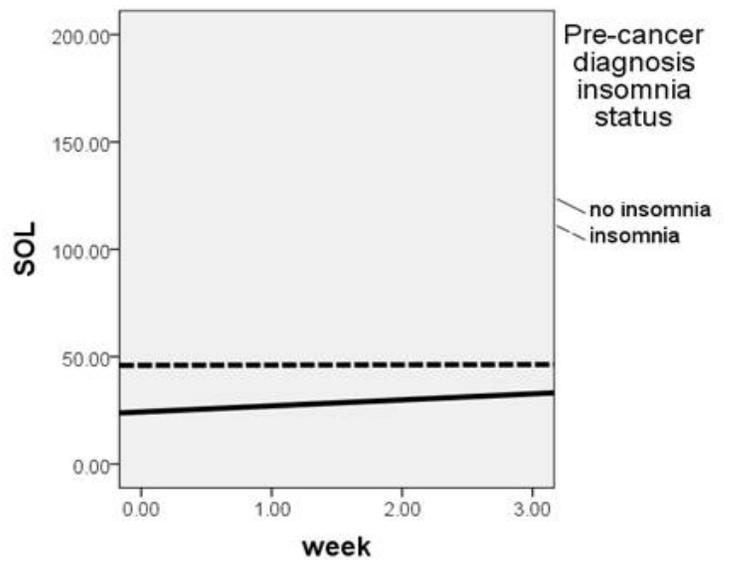


Figure 2: Comparison of change trajectories for individuals with and without premorbid insomnia

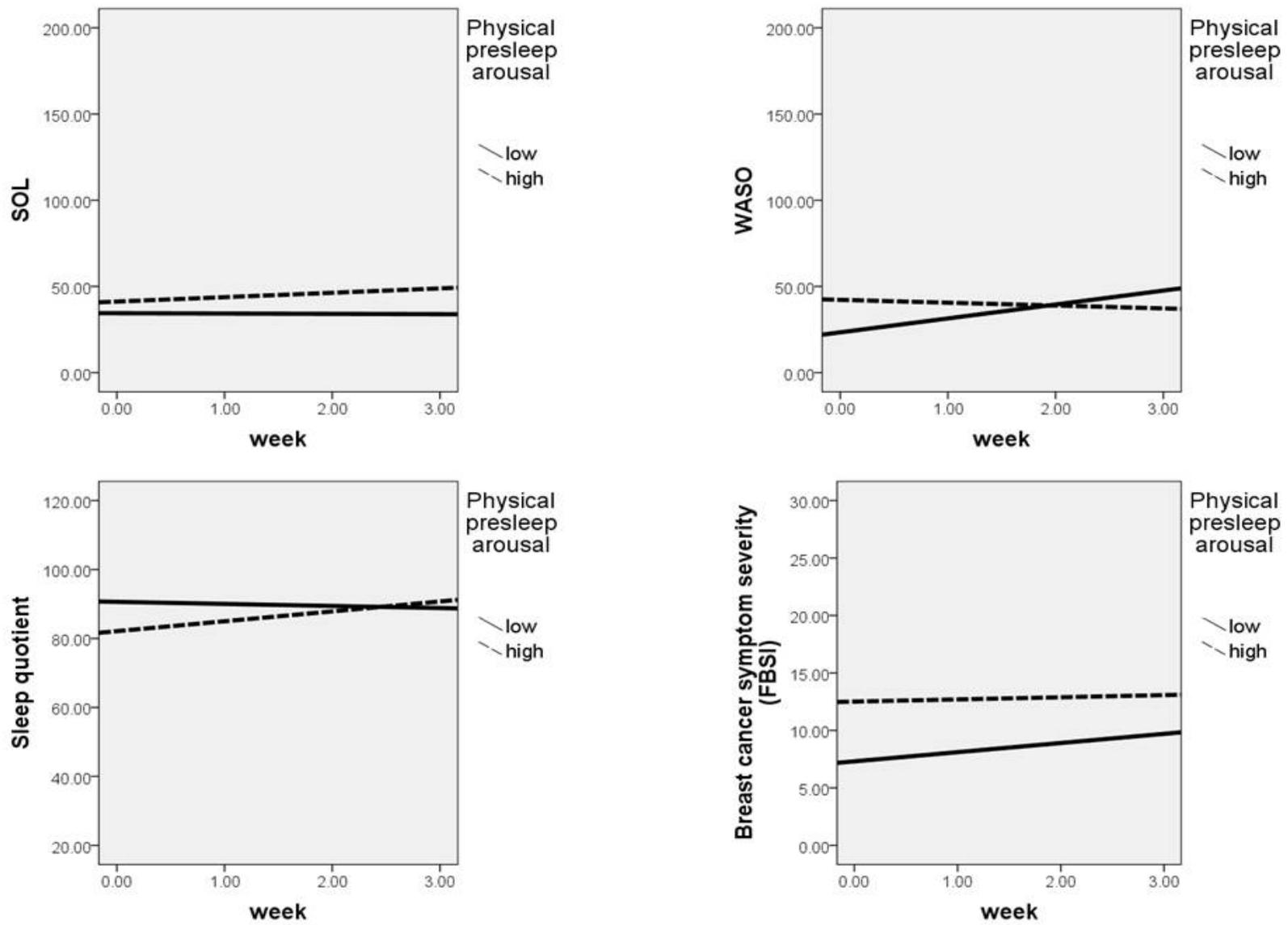


Figure 3: Comparison of change trajectories for individuals with low and high levels of physical presleep arousal

Figure 4 for cognitive presleep arousal. For all regression models, between subjects variability was controlled for by entering a variable that account for the presence of multiple scores for each individual.

The time coefficients for SOL, SQ, and FBSI were non-significant. For WASO, the coefficient for time was significant for individuals without premorbid insomnia ($\beta = .39$, $t(44) = 2.38$, $p < .05$), but not for those with premorbid insomnia ($\beta = .002$, $t(59) = .01$, ns). The unstandardized coefficient of 9.282 for the no premorbid insomnia group indicates a significant increase in WASO over time. The coefficients for individuals low in physical presleep arousal ($\beta = .33$, $t(72) = 2.37$, $p < .05$) and cognitive presleep arousal ($\beta = .38$, $t(58) = 2.67$, $p < .05$) were also significant in the positive direction, suggesting that those with low levels of presleep arousal at baseline show significant increases in WASO over time. Individuals with high levels of physical and cognitive presleep arousal showed no significant change over time for WASO. The graphs for WASO depicting differences in growth between these three sets of comparison groups all depict a similar pattern. Individuals without a history of insomnia start with lower levels of WASO than individuals with a history of insomnia, but then show significant increases in WASO over time to where they have higher levels of WASO than individuals with a history of insomnia at the end of the observation period. The same pattern was observed for low levels of physical and cognitive presleep arousal compared to those with higher levels.

Changes in the Association between Insomnia and Breast Cancer Stress over Time.

To examine the question of changes in the association between breast cancer stress and insomnia severity, correlation between FBSI scores and different sleep parameters were examined over time using daily measures of SOL, NWAK, WASO, TST, and SQ. These correlations represent the association between daytime cancer-related symptoms and sleep

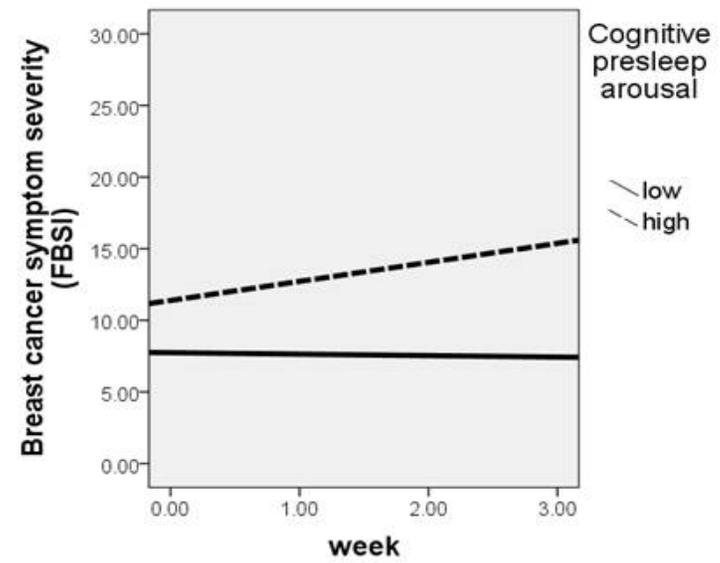
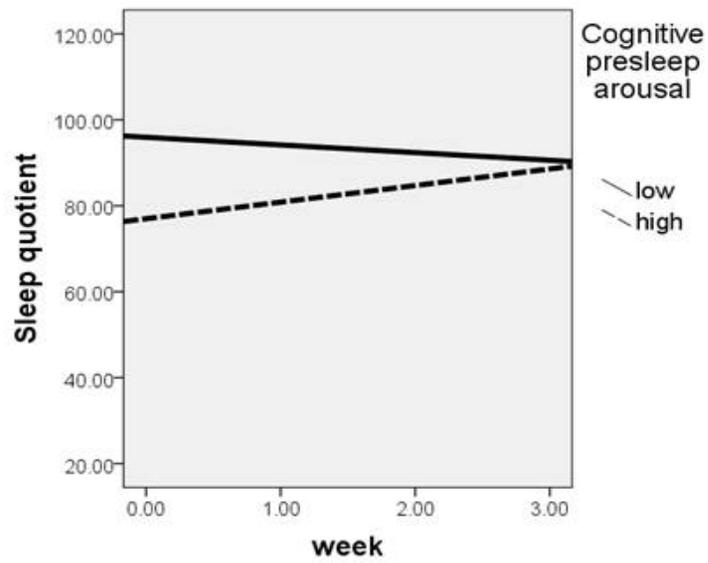
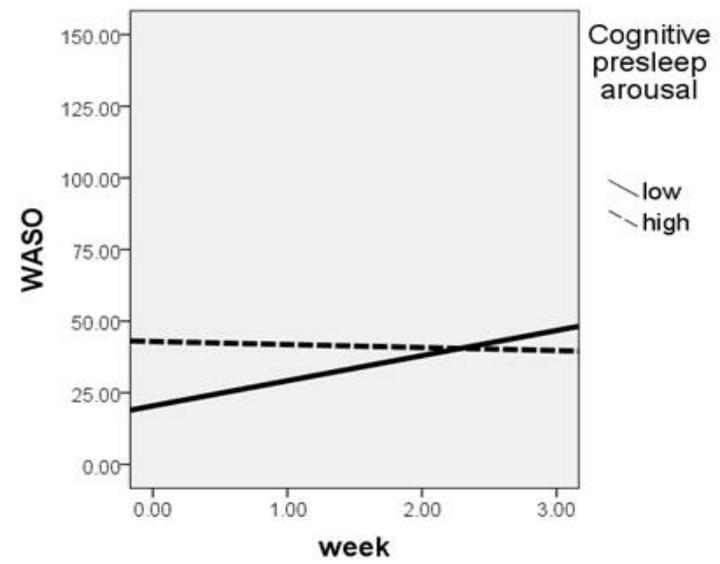
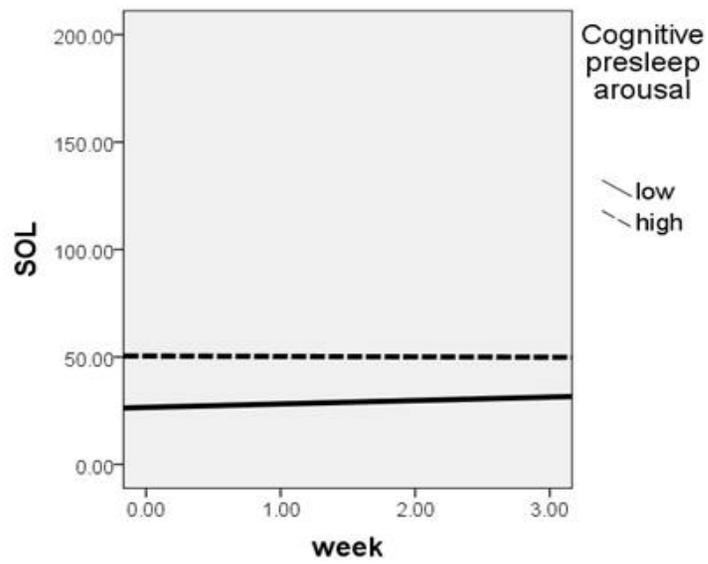
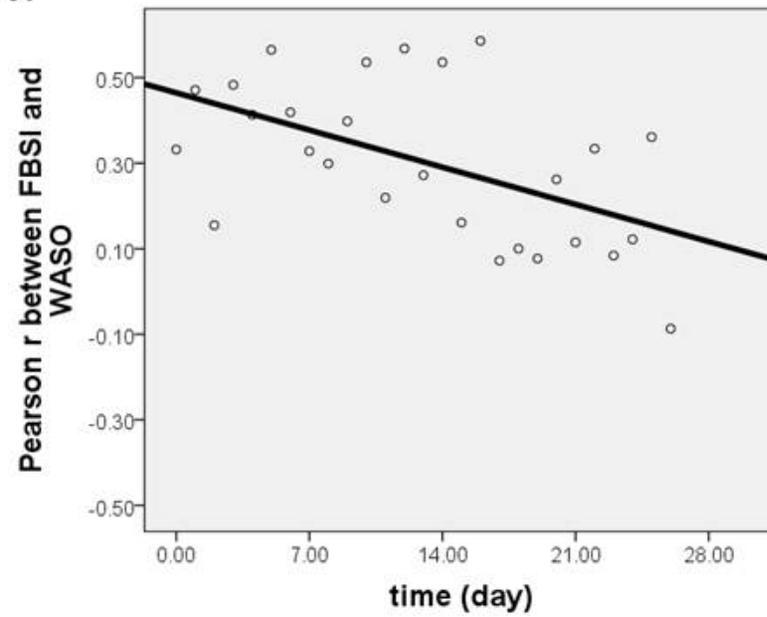
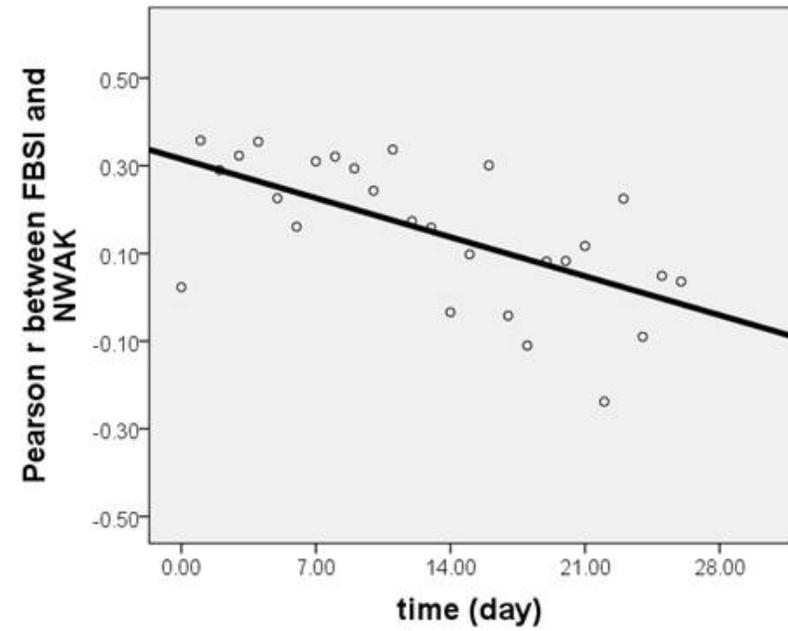
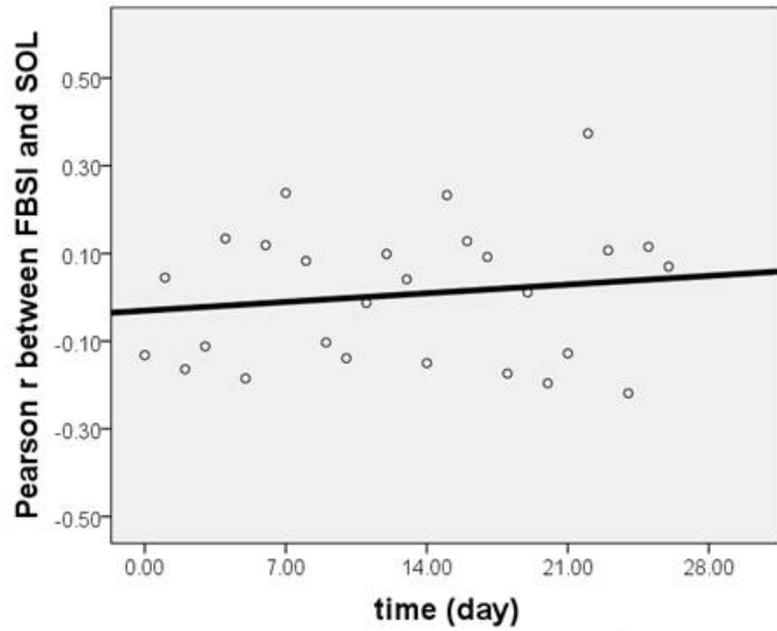


Figure 4: Comparison of change trajectories for individuals with low and high levels of cognitive presleep arousal

symptoms the following night. Figure 5 is a set of graphs depicting the change in correlation between the five sleep parameters and breast cancer symptom severity over time for the entire sample. Each time point represents the correlations between sleep parameters and FBSI scores across individuals for a given day. Table 7 shows the parameters for the best fit regression line for each of the 5 sets of correlations, and Figure 5 depicts each regression line. There is a significant change in the association between FBSI scores and WASO and the association between FBSI scores and NWAK over time, as is indicated by significant slope coefficients for the best fit line for these correlations. For both the correlations between FBSI and WASO and between FBSI and NWAK, there is a significant decrease in strength of a positive correlation over time, to where the correlations at the end of data collection were on average closer to zero than at the outset of the monitoring period. Both of these patterns fit with our hypothesis that the bond between cancer symptom severity and sleep parameters will weaken over time.

Graphs of the correlation between breast cancer stress and sleep parameters are also broken down based on premorbid sleep status, and are represented in Figure 6. When these growth patterns are examined based on this group distinction, changes over time become more difficult to consistently discern. No regression coefficients were significant for change in strength of correlation over time for the premorbid sleep groups.

Correlations over time were also examined through creating a weekly average correlation for each of the four weeks. These graphs are represented in Figure 7. This distinction was made to determine if the changes in magnitude of correlation over time would be easier to visualize using fewer data points. Again, the change over time for WASO and NWAK appear to move in the expected direction.



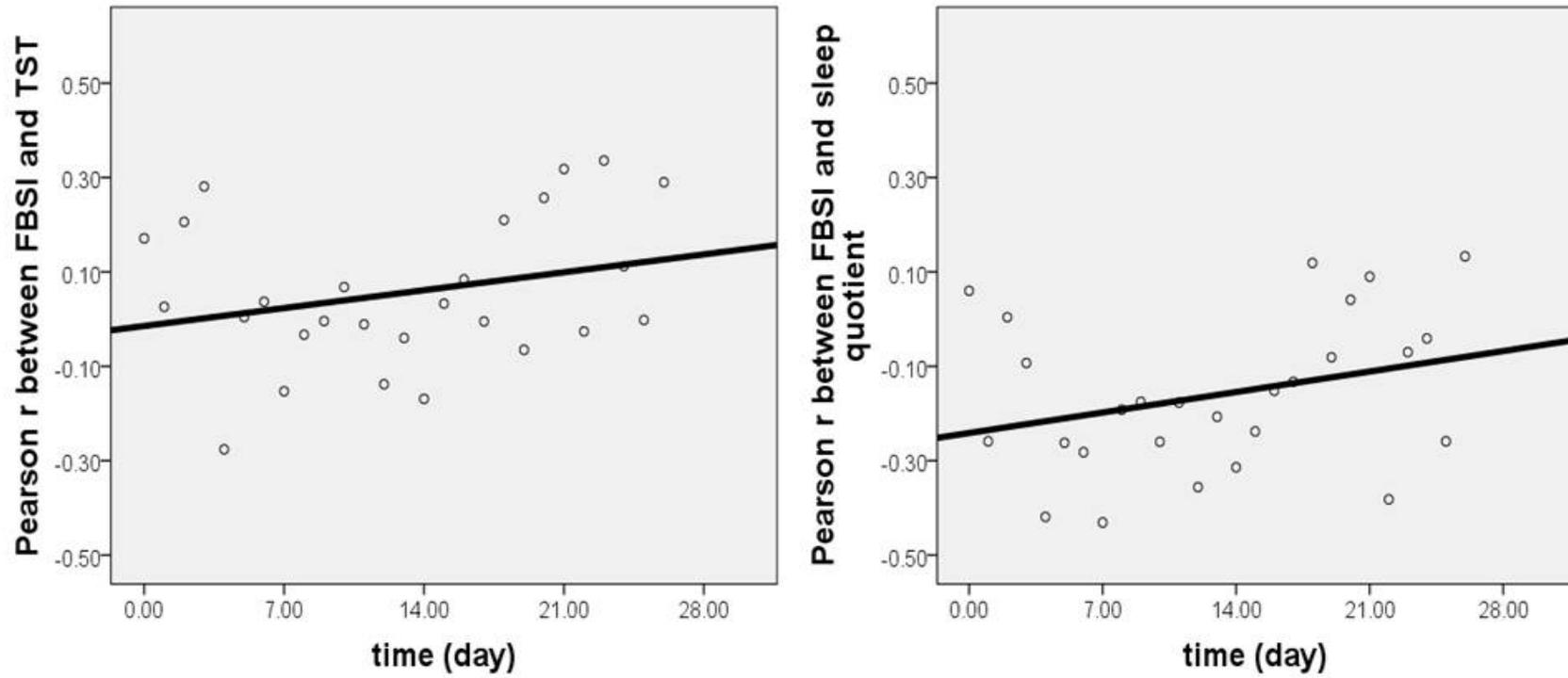


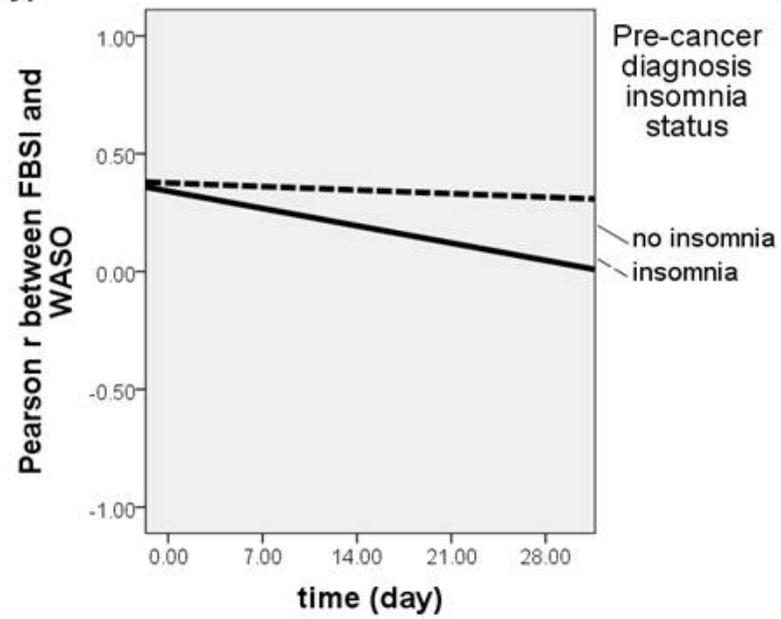
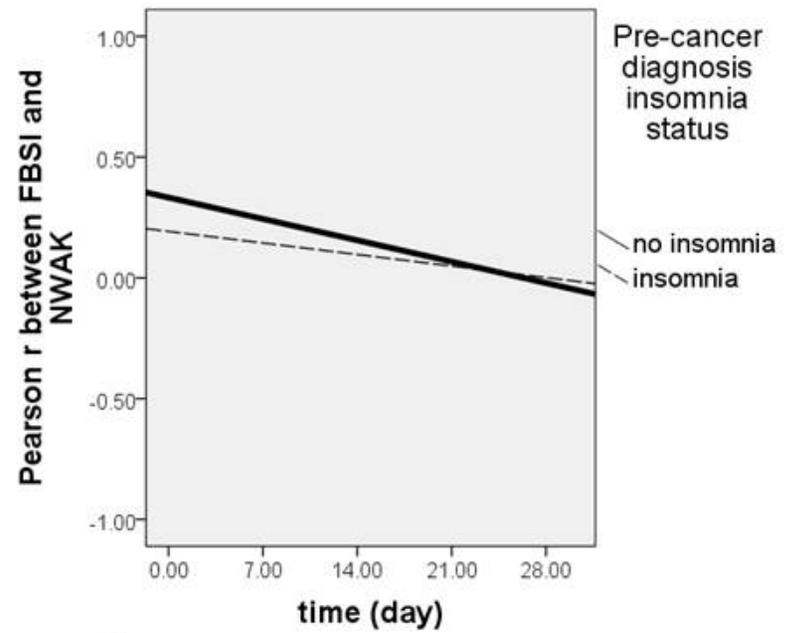
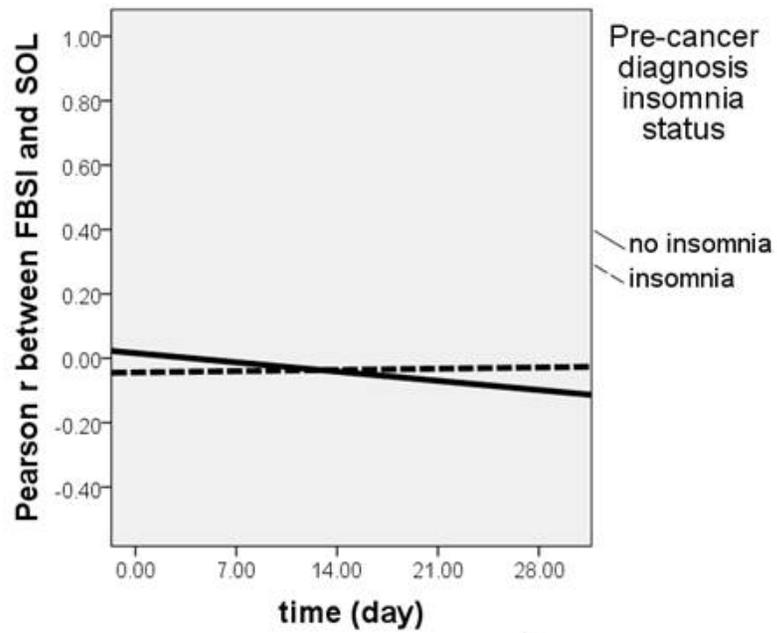
Figure 5: Change trajectories for strength of the relationship between FBSI and sleep parameters over time

Table 7

Regression parameters for the correlations between FBSI and SOL, NWAK, WASO, TST, and SQ over time (n=28)

Outcome variable	B	SE(B)	β
Correlation between FBSI and SOL	.003	.004	.144
Correlation between FBSI and NWAK	-.013	.003	-.621*
Correlation between FBSI and WASO	-.012	.004	-.531*
Correlation between FBSI and TST	.005	.004	.271
Correlation between FBSI and SQ	.006	.004	.302

*p < .01



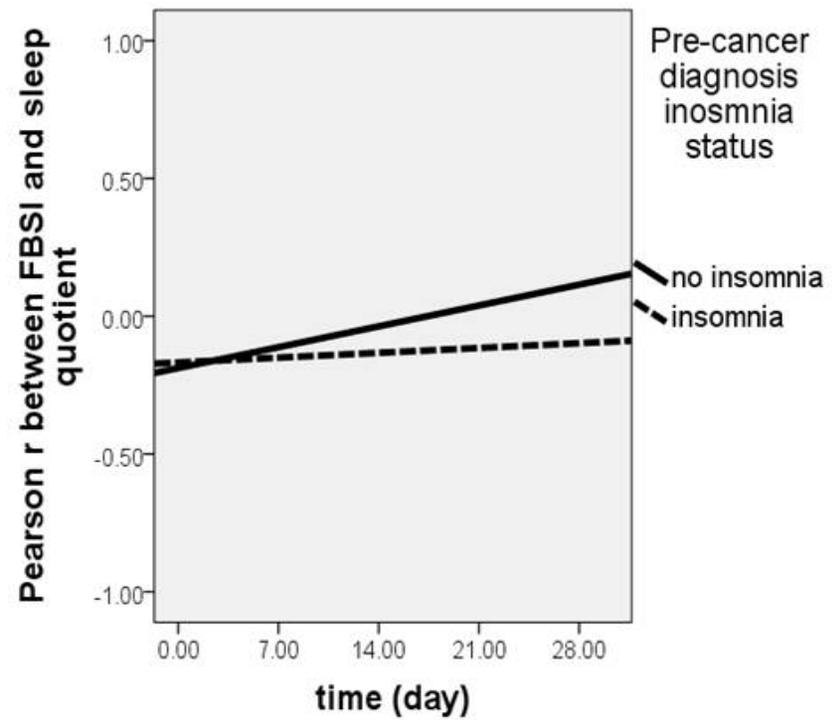
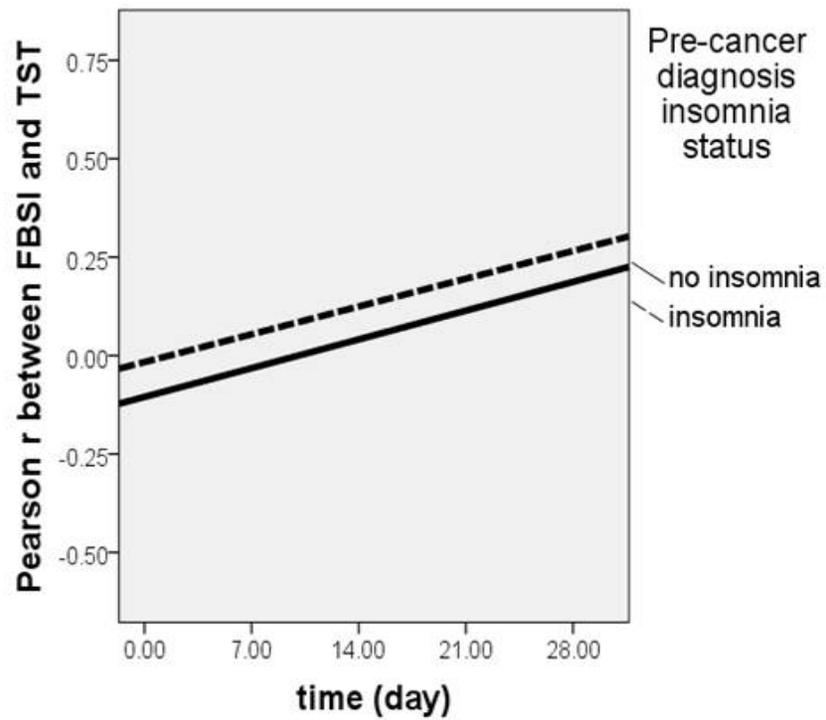
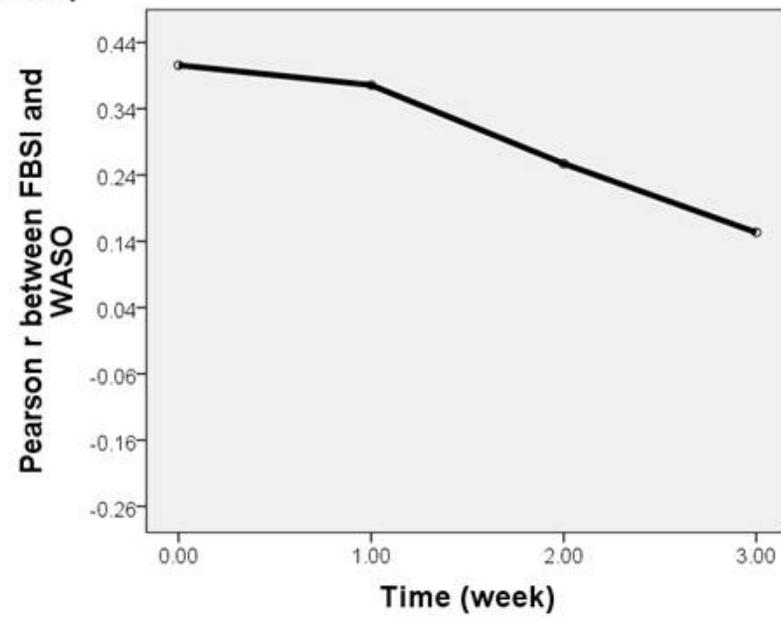
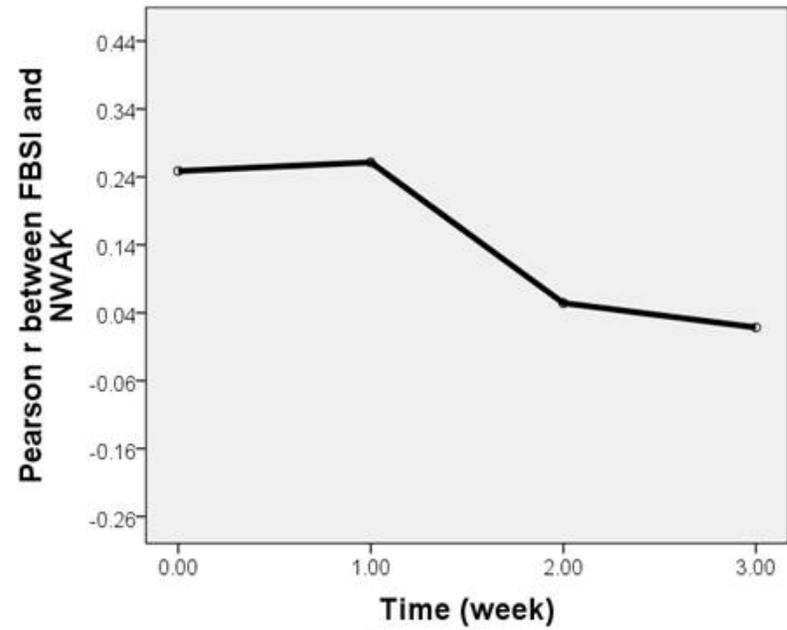
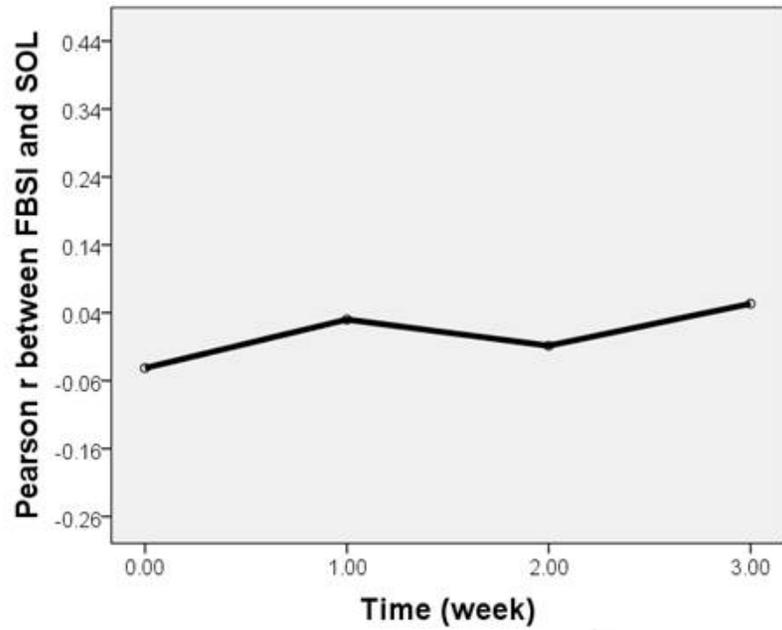


Figure 6: Comparison of change trajectories divided by premorbid sleep status for strength of the relationship between FBSI and sleep parameters.



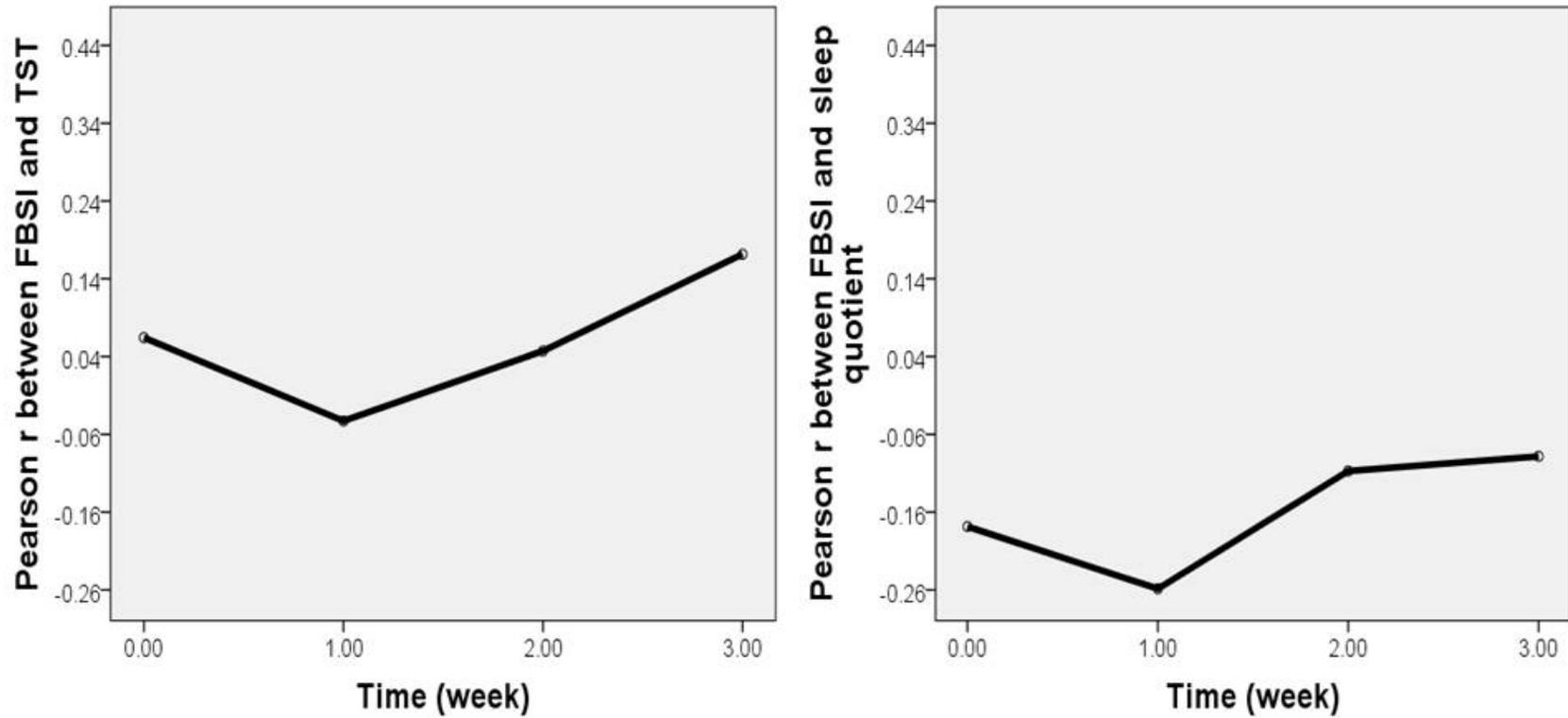


Figure 7: Comparison of change trajectories for the 4 weekly averages of the relationship between FBSI and sleep parameters.

Multilevel Modeling of Symptom Change.

A multilevel modeling approach was also used to examine change over time. The individual participant was treated as the level-2 unit of analysis and the daily measures of different sleep parameters (SOL, NWAK, WASO, TST, sleep quotient) and breast cancer symptom severity (FBSI) were treated as the level-1 factors. Initially, models using both 28 individual days and 4 weekly averages for the level-1 data points were examined. The results were similar so it was decided to present the data corresponding to the 28 individual days because it better represents nuanced changes over time. The following results are reported using this 28 day model.

Multilevel modeling on the level of the individual is an emerging statistical method (Kwok et al., 2008), and research on the topic of statistical power within multilevel modeling continues to evolve (Fan, 2003; Scherbaum & Ferreter, 2009). In this instance, determining statistical power is particularly difficult because repeated measures are being introduced into a statistical method originally developed for organizational research. This has an impact on the intra-class correlation coefficient, which measures the magnitude of dependency between observations. Because the level-1 observations are repeated measures nested within the same individual, the intra-class correlations are expected to be higher than if the level 1 observations were separate individuals nested in an organization. Higher intra-class correlations impact statistical power by increasing the standard error (Spybook, Raudenbush, Liu, Congdon, & Martinez, 2008). In organizational research, the intra-class correlations usually range from .05 to .20 (Snijders & Bosker, 1999). However, other studies using multilevel modeling with repeated measures at level-1 have shown higher intra-class correlations around .4 to .5 (Kwok et al., 2008). One published study on multilevel modeling in sleep found intra-class correlations

ranging between .2 and .5 for their dependent sleep and affect measures (McCrae et al., 2007).

Another study found intra-class correlations ranging from .2 to .68 for their dependent sleep and daytime functioning measures (Rumble et al., 2010).

To determine the effect size needed to achieve adequate power for the current sample of 29 subjects with 28 observations each, a power analysis was conducted using *Optimal Design* software v1.76 (Spybook et al., 2008). Results indicate that for small intra-class correlations (0.2), the current study would have sufficient power (0.8) to find a moderate effect size ($\delta = 0.5$). If intra-class correlations are moderate (0.5) to large (0.8), we would have sufficient power to find an effect size of $\delta = 0.75$ and $\delta = 0.95$ respectively.

Along with establishing intra-class correlations, which represents between-subjects variability, it is important to determine if there is significant within-subjects variability to warrant further investigation using multilevel models. Specifically, having a significant amount of between-subjects variability in the dependent measures warrants the addition of level-2 predictors in future models and a significant amount of within-subjects variability warrants the addition of level-1 predictors in future models. For the current study, the level-1 predictor is time and the level-2 predictors are premorbid insomnia status, physical and cognitive presleep arousal, and time since diagnosis. To determine if there is a significant amount of variability and to establish intra-class correlations, an unconditional means model was run for each dependent measure. Table 8 presents the within- and between-subjects variance components, their significance, and their contribution to the overall variance of the dependent measures. For the set of outcome sleep variables, intra-class correlations ranged from .21 to .40. These are in a similar range to previous studies using multilevel modeling techniques in sleep and cancer research. The intra-class correlation for FBSI was .82, which is very high and suggests that a

Table 8

Component variance for daily dependent measures

Daily dependent measures	Between subjects variability/ Intra-class correlation (ICC)		Within subjects variability	
	Variance component	% of total variance	Variance component	% of total variance
FBSI	37.81*	82.0%	8.32*	18.0%
SOL	1063.10*	32.8%	2178.24*	67.2%
NWAK	.76 *	39.2%	1.18*	60.8%
WASO	561.44 *	20.7%	2149.28 *	79.3%
TST	5938.34*	32.0%	12637.15*	68.0%
Sleep quotient	336.34 *	39.9%	506.72*	60.1%

* $p < .01$

large effect would be needed to find significant results using this dependent measure. The examination of the between- and within-subjects variance components revealed that there is a significant amount of variability to warrant further multilevel modeling analysis for both level-1 and level-2 predictors.

Next, unconditional linear, quadratic, and cubic growth curve models were examined for our level-1 factor of time for each dependent variable across the entire sample. These models aimed to address the question of how these dependent measures change over time. Each of these models fit the error term to an autoregressive model (AR1) to account for covariance. The AR1 model assumes that residual variances are correlated within each individual but that they are independent across individuals. This method is appropriate for the use of repeated measures data in multilevel modeling (Heck, Thomas, & Tabata, 2010).

Table 9 presents the coefficients for the intercept and linear growth rate for each of these analyses. For NWAK, TST, and the sleep quotient, the coefficient for linear growth was significant, suggesting that there is significant linear change over time for these variables. The coefficients for NWAK suggest that there is an initial value of 2.53 awakenings per night, with a decrease of .20 awakenings per night across the 28 nights. For TST, the coefficients suggest that individuals have on average an initial value of 390.29 minutes of sleep per night that increases on average of 9.59 minutes per night across the 28 nights. Finally, for the sleep quotient, the coefficients suggest an initial value of 83.24 and an average increase of 2.10 each night over the course of 28 days. There was also a significant coefficient for quadratic and cubic growth rates for NWAK and the sleep coefficient, suggesting that the growth rate over time for these variables cannot be completely accounted for by a linear trend.

Table 9

Parameters for intercepts and for linear growth over time (28 days) for FBSI, SOL, NWAK, WASO, TST, and sleep quotient.

Growth rate parameters over time (28 days)				
Dependent measure	Source	b	t	Sig.
FBSI	Intercept	9.12	7.463	<.001
	Linear	-.045	-.374	.708
SOL	Intercept	39.24	4.397	<.001
	Linear	-1.37	-.671	.502
NWAK	Intercept	2.53	10.849	<.001
	Linear	-.199	-4.239	<.001
WASO	Intercept	31.98	4.072	<.001
	Linear	-.839	-.412	.680
TST	Intercept	390.29	17.975	<.001
	Linear	9.59	1.98	<.05
Sleep quotient	Intercept	83.24	17.884	<.001
	Linear	2.096	2.131	<.05

Lastly, differences in growth patterns for the level-1 factors were examined across our level-2 predictors of premorbid sleep status, physical presleep arousal, cognitive presleep arousal, and time since cancer diagnosis. We planned to also use post-data collection sleep status as another predictor but there were only 5 individuals who could be categorized as not having sleep problems, which created problems for comparing groups. Therefore, this factor was not examined. This model was only completed for the variables that showed significant linear growth over time, namely NWAK, TST, and the sleep quotient. The other outcome variables did not show a significant amount of interindividual differences in growth rates to warrant examination of level-2 predictors.

When these level-2 predictors were entered into the mixed model, there were no significant results to report regarding the interaction between time and the four level-2 predictors, suggesting no significant differences in change over time when comparing premorbid sleep status, levels of physical presleep arousal, levels of cognitive presleep arousal, and time since cancer diagnosis. There was one significant difference in the initial value of cognitive presleep arousal for the sleep quotient ($b = -22.12$, $t(20.82) = -2.50$, $p < .05$), which indicates that individuals with low cognitive presleep arousal had an initial sleep quotient 22.12 points higher than individuals high in cognitive presleep arousal.

CHAPTER 4

DISCUSSION

The first goal of this study was to establish an association between the severity of sleep disturbance and severity of the stress caused by the primary medical condition of breast cancer. Insomnia severity and breast cancer symptom severity were positively correlated for individuals within 6 weeks following their diagnosis. This suggests some level of association between sleep and breast cancer stress. Though no causal relationship can be inferred, these data are consistent with insomnia symptoms that are secondary or comorbid to the breast cancer experience.

Changes in correlations were also observed that support the hypothesis that the relation between these two symptom sets weakens as time passes. The correlation between insomnia severity and breast cancer stress was smaller and no longer significant after the 2 month data collection period, suggesting a potential weakening of the connection between sleep and cancer stress. Also, when comparing individuals who were first assessed within 3 weeks following diagnosis to those between 3 and 6 weeks following diagnosis, those individuals closer to the onset of their cancer-related stress (their diagnosis date) showed a trend toward a stronger association between insomnia and breast cancer stress compared to individuals first assessed further away from their diagnosis date. This provides initial evidence of the potential weakening of the relationship between insomnia and its comorbid stressor over time.

One drawback of previous research on secondary insomnia was the inability to observe secondary insomnia as it occurs. The second goal of the study was to establish evidence for secondary insomnia in action through examining differences in the association between insomnia

and breast cancer stress across different levels of factors known to perpetuate chronic insomnia. We believe the current results clearly point toward the presence of both primary and secondary insomnia in the current sample. The results of these comparisons also provide evidence supporting our hypotheses that secondary insomnia symptoms are more greatly tied to the co-occurring condition compared to primary insomnia symptoms.

Perhaps the strongest evidence for the presence of secondary insomnia comes from examining the differences between individuals with prior history of insomnia and those without prior history of insomnia symptoms. The initial connection between breast cancer stress and insomnia severity was significant for individuals with newly developed insomnia symptoms. This suggests an association exists between the severity of the sleep disturbance and the severity of the primary stressor which fits with theory regarding the relationship between secondary insomnia and the comorbid precipitating condition. After the onset of a significant stressor such as a diagnosis of cancer, it is expected that the severity of sleep disturbance be closely linked to severity of symptoms resulting from that stressor for individuals who have newly developed sleep disturbance. For individuals with previous insomnia history, their insomnia severity was not significantly related to their breast cancer stress. This also fits with theory regarding the tendency for long standing sleep problems to become self sustaining. Individuals with prior insomnia history experience sleep disturbance that appears to function independent from their cancer symptoms.

The association between breast cancer stress and presleep arousal strengthens the conclusion that participants who first developed sleep disturbance after their cancer diagnosis were experiencing secondary insomnia, and those who have prior history of insomnia symptoms are experiencing primary insomnia. For individuals with secondary insomnia, their physical and

cognitive arousal was significantly related to the severity of their breast cancer stress when they were first assessed. This shows that the nature of both their physical and cognitive arousal at night is more strongly linked to their breast cancer experience. Again, this would be expected for individuals with insomnia that functions secondary to a medical stressor. For individuals with primary insomnia, their cognitive presleep arousal was not related to breast cancer stress, which suggests perpetuating factors other than cancer related stress may be more strongly related to their insomnia severity.

Evidence for the presence of secondary insomnia is also found through examining differences in levels of cognitive and physical presleep arousal. Presleep arousal is a highly indicated construct for perpetuating chronic insomnia in general and in women with breast cancer (Bastien, St-Jean, Morin, Turcotte, & Carrier, 2008; Stepanski, Zorick, & Roehrs, 1988; Taylor, Espie, & White, 2003). Individuals with high levels of presleep arousal can therefore be considered to be experiencing more perpetuating factors associated with a primary insomnia process than those with low levels of presleep arousal. As was true when comparing premorbid sleep groups, individuals low in physical and cognitive presleep arousal (secondary insomnia characteristic) showed significant associations between breast cancer symptom severity and insomnia severity at baseline, and those high in physical and cognitive presleep arousal (primary insomnia characteristic) did not.

For differences between primary and secondary insomnia, the overall tendencies are clear. When either defined by newly developed insomnia symptoms or by low levels of factors (presleep arousal) typically associated with primary insomnia, individuals with secondary insomnia characteristics show a significant connection between sleep and stress, and those with

primary insomnia characteristics do not. This fits with Spielman's theory of how insomnia related to co-occurring stressors across the diagnostic spectrum.

Another interesting set of findings related to the differences between people with primary insomnia characteristics and those with secondary insomnia characteristics was observed. In general, people with premorbid insomnia tended to have higher levels of insomnia severity and breast cancer symptom severity. The same was true for people with high levels of presleep arousal when compared to those with low levels of presleep arousal. This may be evidence for the additive effects of stress on sleep disturbance. Furthermore, the significant correlation between physical presleep arousal and breast cancer stress for individuals with a history of insomnia suggests that their cancer experience may affect their sleep beyond whatever sleep disturbing factors are already in place. These results may also suggest that secondary insomnia is potentially a milder form of insomnia compared to primary insomnia, as those with primary insomnia characteristics appear to have consistently higher levels of sleep disturbance compared to individuals with secondary insomnia characteristics. However, this was not the case in a previous study where the severity of secondary insomnia was shown to be similar to that of primary insomnia (Lichstein et al., 2001).

The third goal of the study was to begin filling a longitudinal void surrounding the diagnosis and subsequent experience of breast cancer. This was accomplished through the use of descriptive techniques and by using a multilevel modeling framework.

A number of observations stood out through the examination of growth trajectories for sleep and breast cancer stress over time. Though the intra-class correlations calculated through the multilevel modeling analysis were generally in line with other research using multilevel modeling with repeated measures for the level-1 predictors (Kwok et al., 2008; McCrae et al.,

2007; Rumble et al., 2010), there was a high level of heterogeneity in change trajectories over time across individuals when the data set was examined using descriptive analyses. This suggests a rather variable experience of sleep and cancer symptoms across individuals. High degrees of variability are further reflected in the number of significant parameters for linear, quadratic, and cubic growth rates over time for NWAK, TST, and the sleep quotient in the multilevel modeling analysis, and the relatively few significant linear slope parameters found when examining each individual's growth trajectory using weekly averages. Overall, this shows that individuals in this sample experienced a wide variety of fluctuations in symptoms over the two-month period in which they were observed. This makes sense in the light of the varied experiences that the participants went through during the time that they were being monitored, including differences in treatment (surgery, chemotherapy, radiation therapy, or a combination), and the onset, dosage, and frequency of treatment, which was not measured in this current study. Though research suggests that these cancer treatment-specific factors all impair sleep and functioning to a similar degree (Bardwell et al., 2008; Given et al., 2001), the timing and intensity of treatment may have an impact on the exact timing of their sleep-disturbing influence. It will be important to account for and control these factors in future research.

Despite the high levels of heterogeneity in sleep and cancer experiences, the current study was able to show some changes in insomnia symptoms over time through the descriptive analysis. For individuals who developed sleep difficulties following their cancer diagnosis, there was a significant increase in WASO over time that was not present in individuals with a prior history of insomnia. This may indicate a greater propensity for changes in severity of wake time after sleep onset for individuals with newly developed insomnia symptoms compared to those with a history of disturbed sleep. The same pattern was noted when comparing individuals with

differing levels of cognitive and physical presleep arousal on change trajectories for WASO. Individuals low in both cognitive and physical presleep arousal showed significant increases in WASO severity over time, and those high in both types of arousal did not show significant changes. This again may indicate a greater tendency toward increases in WASO for individuals who have lower levels of these common perpetuating factors.

The results of the multilevel modeling analysis showed little agreement with the descriptive analyses when considering which sleep variables showed significant change over time. The unconditional growth curve analysis yielded significant changes in NWAK, TST, and the sleep quotient over time. Furthermore, all three significant growth trajectories were in the direction of improvement in sleep, with NWAK decreasing, TST increasing, and the sleep quotient moving closer to the normative mean.

When these growth trajectories are examined as a whole, the evidence for change in symptom trajectories over time is muddled and often contradictory. However, the results are promising in that they suggest that sleep does change during the breast cancer experience. Further research is needed to unearth the exact nature of this change.

The results of this study provide preliminary evidence for the evolution of secondary insomnia over time. The examination of the association between insomnia severity and breast cancer stress at baseline and follow up shows a consistent pattern of decreasing magnitude over time. When defined by either the onset of insomnia symptoms following the cancer diagnosis or by low levels of presleep arousal, individuals with secondary insomnia characteristics showed a consistent pattern of significant correlations between stress and sleep at baseline and non-significant correlations between cancer stress and sleep at post-assessment. This pattern was

distinctly different from individuals with primary insomnia characteristics, who generally showed no association between sleep and cancer stress at either baseline or post-assessment.

Perhaps the most intriguing evidence in favor of the evolution of secondary insomnia comes from the examination of changes in the daily correlations between sleep and cancer stress over time. For both WASO and NWAK, there was a significant linear decrease in the strength and direction of the association between sleep and cancer stress over time; a change moving away from the strong positive correlation expected for secondary insomnia. It is unclear if these changes reflect an actual shift from secondary insomnia to primary insomnia or if they reflect a less drastic adjustment in the relationship that could be accounted for by different subtypes of secondary insomnia (i.e. a shift from absolute secondary insomnia to partial secondary insomnia).

A note regarding a potential causal link between cancer severity and insomnia severity is warranted. The descriptive results in this study are based on correlations, which describe the strength of an association, but do not identify a causal link. However, for the examination of the changes in daily correlations over time, the daily correlations were calculated between daytime cancer symptoms and the sleep symptoms during the ensuing night. Said another way, each correlation reflects a temporal directionality where the measure of cancer stress always precipitates the measures of sleep disturbance. This bolsters the argument for the presence of secondary insomnia (insomnia that is influenced by the co-occurring stressor) in this sample as well as the change in that directional relationship over time.

We were also interested in gaining a better understanding of the feasibility of collecting longitudinal data in a sample of newly diagnosed breast cancer patients. Regarding participant recruitment, it took more than a year to develop a strong working relationship with the DCH

cancer center to where participant recruitment was possible. The demands of practitioners at the center result in little time to devote to outside research. The breakthrough for this current study came when the researchers were allowed to collaborate with the cancer center's research coordinator, who was able to help the researchers connect with the practitioners and gain access to a steady flow of participant referrals. For individuals who agreed to meet with a researcher, 69% were enrolled in the study. This number is higher than a study that used a similar, 28-day sleep diary research methodology (Rumble et al., 2010). However, Rumble and colleagues used more stringent inclusion criteria (e.g. patients were screened for other mental health problems and were excluded for other uncontrolled medical conditions) that resulted in more disqualifications. Out of the 38 women who enrolled in the study, roughly three fourths completed the pre and post data collection measures as well as a majority of the daily measures over the 2 month data collection period.

Roughly half of the participants chose to complete their data using paper and pencil versions of the questionnaires rather than the online option. Many cited a lack of consistent internet access or did not have email, which was necessary to complete the online diaries. Overall, women in this population were generally willing to participate once the study was explained to them. Many cited the possibility that the research may help someone else with breast cancer in the future as motivation to participate. Ultimately, this research methodology showed significant promise as a viable way to study insomnia following the onset of a significant health-related stressor.

As the current study was exploratory in nature, there are limitations to be noted, many of which have already been touched upon. Principally, there are limitations to the scope of results as well as the statistical robustness of the study. The exploratory methods used in this study

aimed to achieve a balance between Type I and Type II error by not correcting for multiple comparisons. Though in line with exploratory research in sleep and cancer (Ancoli-Israel et al., 2006), this approach does create the opportunity for increased alpha error. Furthermore, the intra-class correlations were mostly similar to what was expected for repeated measures data, but some, particularly for FBSI, were larger than expected. This meant that in order to find significant results through the multilevel modeling approach, a moderate to large effect size would be required.

The results of the present study showed many promising directions for future study. Further research related to this field of study should focus on a few key areas. First, a more comprehensive assessment battery is needed that capture the presence of secondary insomnia as it occurs. This should include a more comprehensive assessment of premorbid insomnia history as well as a more complete consideration of factors other presleep arousal that perpetuate chronic primary insomnia. This could have important implications for the focus of intervention. Second, though we were able to begin monitoring symptoms with 6 weeks of diagnosis, for many participants, a significant period of time passed between their diagnosis date and the time we began their assessment. Catching participants closer to their diagnosis would be ideal. Third, a larger sample should be used to allow for a more nuanced evaluation of group differences. Finally, more stringent attentions should be paid to creating a sample free of the influence of other mental and physical health concerns that may impact sleep, and cancer specific variables such as treatment type, dose, and frequency should be measured and included in the statistical analyses.

Despite the limitations, the primary goals of the study were met, which were to describe the association between insomnia severity and breast cancer stress, explore a research

methodology to study sleep and cancer using longitudinal data techniques at a sensitive time for the participants, explore changes in sleep and stress over time, and unearth evidence for secondary insomnia, both its existence and its evolution over time. This study provided some of the first evidence of secondary insomnia in action and identified characteristics, namely a strong connection between sleep and cancer stress, which can be used to identify it. This may have important implications for how women with sleep disturbance and breast cancer are approached for treatment and may lead to research that helps practitioners better understand when to intervene and what symptoms on which to focus their interventions.

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APPENDICES

Appendix A

Insomnia diagnostic interview and demographic form

Last Name _____ First Name _____

Date _____ Treatment _____

Sleep Problems

1. Are you currently experiencing difficulty with your sleep at night? Yes No

Describe

How many nights per week? _____

How long have you had this problem? _____

If before diagnosis, has the problem worsened since diagnosis _____

2. Have you been given a sleep related diagnosis?(apnea, insomnia, RLS, etc.) Yes No

If yes, what diagnosis? _____

Excessive snoring or gasping for breath (has bed partner noticed)? Yes No

If yes, explain. _____

Do your legs jerk during the night or do they feel restless before sleep onset? Yes No

If yes, explain. _____

Do you have sleep attacks during the day or paralysis at sleep onset? Yes No

If yes, explain. _____

3. Have you received sleep medication or any other treatment for a sleeping problem?

If yes, when did you receive treatment and what type of treatment was involved (have individual be specific regarding the type of treatment received, including over-the-counter medications).

Daytime Functioning

4. Do you often feel sleepy during the day? Yes No

If yes, describe. _____

5. Do you have any impaired daytime functioning related to poor sleep? Yes No

Explain _____

6. Does your job require you to work shift work? Yes No

Contact information

Address _____

Home Phone _____

Cell Phone _____

Email _____

Interviewer _____

Age _____

Do you have any difficulty reading? yes no

Appendix B

The Pittsburgh Sleep Quality Index

Pittsburgh Sleep Quality Index (PSQI)

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

During the past month,

1. When have you usually gone to bed? _____
2. How long (in minutes) has it taken you to fall asleep each night? _____
3. When have you usually gotten up in the morning? _____
4. How many hours of actual sleep did you get that night? (This may be different than the number of hours you spend in bed) _____

5. During the past month, how often have you had trouble sleeping because you...	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times a week (3)
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s):				
6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?				
	Very good (0)	Fairly good (1)	Fairly bad (2)	Very bad (3)
9. During the past month, how would you rate your sleep quality overall?				

Appendix C

The Insomnia Severity Index

Insomnia Severity Index (ISI)

ID: _____ **Date:** _____

1. Please rate the current (i.e., last 2 weeks) **SEVERITY** of your insomnia problem(s).

	None	Mild	Moderate	Severe	Very
a) Difficulty falling asleep:	0	1	2	3	4
b) Difficulty staying asleep:	0	1	2	3	4
c) Problem waking up too early:	0	1	2	3	4

2. How satisfied/dissatisfied are you with your current sleep pattern?

Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
0	1	2	3	4

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

Not at all Interfering	A Little Interfering	Somewhat Interfering	Much	Very Much
0	1	2	3	4

4. How noticeable to others do you think your sleeping problem is in terms of impairing the quality of your life?

Not at all Noticeable	A little	Somewhat	Much	Very Much Noticeable
0	1	2	3	4

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

Not at all Worried	A Little	Somewhat	Much	Very Much Worried
0	1	2	3	4

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Appendix D

The Presleep Arousal Scale

For the list below, think about your experience during the pre-sleep period (in bed with the lights out before falling asleep for the first time). **Please rate how intensely you experience each item as you attempt to fall asleep in your bed each night.**

	Not at all	Slightly	Moderately	A Lot	Extremely
1. Heart racing, pounding, or beating irregularly	1	2	3	4	5
2. A jittery, nervous feeling in your body	1	2	3	4	5
3. Shortness of breath or labored breathing	1	2	3	4	5
4. A tight, tense feeling in your muscles	1	2	3	4	5
5. Cold feeling in your hands, feet, or body in general	1	2	3	4	5
6. Have stomach upset (knot or nervous feeling in stomach, heartburn, nausea, gas, etc)	1	2	3	4	5
7. Perspiration in palms of your hands or other parts of your body	1	2	3	4	5
8. Dry feeling in mouth or throat	1	2	3	4	5
9. Worry about falling asleep	1	2	3	4	5
10. Review or ponder events of the day	1	2	3	4	5
11. Depressing or anxious thoughts	1	2	3	4	5
12. Worry about problems other than sleep	1	2	3	4	5
13. Being mentally alert, active	1	2	3	4	5
14. Can't shut off thoughts	1	2	3	4	5
15. Thoughts keep running through your head	1	2	3	4	5
16. Being distracted by sounds, noise in the environment (e.g., ticking of clock, house noises, traffic)	1	2	3	4	5

Appendix E

The FACT/NCCN Breast Symptom Index with One Week Time Frame

FACT/NCCN BREAST SYMPTOM INDEX

Below is a list of statements that other people with your illness have said are important. **By circling one (1) number per line, please indicate how true each statement has been for you during the past 7 days.**

		Not at all	A little bit	Some- what	Quite a bit	Very much
GP1	I have lack of energy	0	1	2	3	4
GP4	I have pain	0	1	2	3	4
GP2	I have nausea	0	1	2	3	4
P2	I have certain areas of my body where I experience significant pain	0	1	2	3	4
B1	I have been short of breath	0	1	2	3	4
GE6	I worry that my condition will get worse	0	1	2	3	4
GF7	I am content with the quality of my life right now.....	0	1	2	3	4
GP3	Because of my physical condition, I have trouble meeting the needs of my family	0	1	2	3	4

Appendix F

Daily Sleep Diary with Instructions

ID _____

Please answer the following questionnaire **WHEN YOU AWAKE IN THE MORNING**. Enter yesterday's day and date and provide the information to describe your sleep the night before. Definitions explaining each line of the questionnaire are given below.

ITEM DEFINITIONS

1. If you napped yesterday, enter total time napping in **minutes**.
2. What time did you enter bed for the purpose of going to sleep (not for reading or other activities)?
3. Counting from the time you wished to fall asleep, how many **minutes** did it take you to fall asleep?
4. How many times did you awaken during the night?
5. What is the total **minutes** you were awake during the middle of the night? This does not include time to fall asleep at the beginning of the night. It also does not include awake time in bed before the final morning arising.
6. What time did you wake up for the last time this morning?
7. What time did you actually get out of bed this morning?
8. Pick one number below to indicate your overall **QUALITY RATING** or satisfaction with your sleep.
 1. very poor, 2. poor, 3. fair, 4. good, 5. excellent
9. List any sleep medication or alcohol taken at or near bedtime, and give the amount and time taken.

EXAMPLE

		TUES	day 1	day 2	day 3	day 4	day 5	day 6	day 7
yesterday's day ⇒ yesterday's date ⇒		TUES 10/14/97							
1. NAP (yesterday)	70 min.								
2. BEDTIME (last night)	0:55 pm								
3. TIME TO FALL ASLEEP	65 min.								
4. # AWAKENINGS	4								
5. WAKE TIME (middle of night)	10 min.								
6. FINAL WAKE-UP	5:05 am								
7. OUT OF BED	7:10 am								

8. QUALITY RATING	2							
9. BEDTIME MEDICATION (include amount & time)	Halcion 0.25 mg 0:40 pm							

Appendix G

Original IRB approval letter

April 26, 2010

Gregory VanderWal
Department of Psychology
College of Arts & Sciences
The University of Alabama

Re: IRB Protocol # 09-019-ME
“The Evolution of Secondary Insomnia in Cancer”

Mr. VanderWal:

The University of Alabama Medical IRB has received the revisions requested by the full board on 4/9/10. The board has reviewed the revisions and your protocol is now approved for a one year period. Please be advised that your protocol will expire one year from the date of the board’s approval, March 11, 2010.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number. Please use reproductions of the IRB approved informed consent form to obtain consent from your participants.

Good luck with your research.

Sincerely,

John C. Higginbotham, Ph.D., MPH
Medical IRB Chair
The University of Alabama