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Adult Attachment and Sleep Disturbance in Cancer Patients

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Sleep disturbance is an area of functioning that is a prominent concern for cancer patients and has implications for their disease progression, poor prognosis, and mortality. Sleep disturbance can be operationalized by individual differences in difficulty initiating sleep (sleep onset latency, SOL), difficulty maintaining sleep due to extended wakening after sleep onset (WASO), and poor sleep efficiency (SE). These individual differences in sleep disturbance can be examined through a lens of adult attachment theory. This theory posits individual differences in the activated internal working model of one's attachment system that involves different psychological and physiological restorative processes in response to perceived threat and stress. Sleep disturbance may be a marker of one's difficulty in the restorative process of stress regulation.

Testing this theoretical premise with newly diagnosed colorectal cancer patients, this study examined the extent to which adult attachment orientations are associated with sleep disturbance indices. Data were analyzed from 24 cancer patients who were a subsample of the ongoing parent study. Self-reported adult attachment orientations (security, anxiety, and avoidance) were assessed with the Measure of Attachment Qualities, and sleep disturbance was assessed with the Consensus Sleep Diary over 14 consecutive days. Generalized linear modeling was used to test study hypotheses.

Adult attachment orientations were hypothesized to be differentially associated with individuals' means and variations in SOL, WASO, and SE across days, which were partially supported for attachment security only (B = -22.19, $p < .007$). Results failed to support hypotheses regarding attachment anxiety and attachment avoidance differentially associating with means and variations of sleep disturbance indices.

The current study is an important investigation on cancer patients' sleep disturbance within an adult attachment conceptual framework. Findings should be replicated with a larger sample. Investigating intra-individual changes of adult attachment, their associations with daily changes in sleep disturbance in the individual and dyadic context, as well as concordance in sleep indices between self-report and actigraph measures is warranted in future research.

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Chapter 1. Introduction

Over 15.5 million people in the United States have a history of at least one cancer diagnosis, and over 1.5 million new cancer cases are estimated each year (Cancer Facts and Figures, 2018). Cancer mortality rates have steadily declined over the last several decades, which can be attributed to decreased unhealthy behaviors, better practices in early detection, and enhanced medical treatment (Edwards, Ward, Kohler, Eheman, Zauber, et al., 2010; Joseph, King, Miller, & Richardson, 2012; Siegel, Miller, Fedewa, Ahnen, Meester, et al., 2017). However, rigorous cancer treatment can be a double-edged sword: while it does contribute to improved survival rates, it is also accompanied by a myriad of side effects (Ancoli-Israel, Liu, Rissling, Natarajan, Neikrug, et al., 2014; Howlader, Noone, Krapcho, Garshell, Neyman, et al., 2014; Kornblith & Ligibel, 2003).

Among those, clinically significant levels of depression (Pokorney & Bates, 2017; Walker, Sawhney, Hanswer, Ahmed, Martin, et al., 2014), fatigue (Jansen, Herrmann, Stegmaier, Singer, Brenner, et al., 2011; Lawrence, Kupelnick, Miller, Devine, & Lau, 2004), pain (Bennett, Rayment, Hjermstad, Aass, Caraceni, et al., 2012), and sleep disturbance (Davidson, MacLean, Brundage, & Schulze, 2002; Sephton, Sapolsky, Kraemer, & Spiegel, 2000) are frequently reported symptoms and are clustered as "sickness behaviors." Sleep disturbance in particular, is an area of functioning that is a prominent concern for cancer patients (George, Iwuanyanwu, Anderson, Yusuf, Zinner, et al., 2016; Innominato, Spiegel, Ulusakarya, Giacchetti, Bjarnason, et al., 2015). Inadequate or disturbed sleep is associated with substantial impairment in quality of life, and may exacerbate the expression of other sickness behaviors, which has relevant implications for disease-related outcomes, including progression, prognosis, and mortality (Bower, Ganz, Irwin, Kwan, Breen, et al., 2011; Davidson et al., 2002; Savard & Morin, 2001).

Characteristics of Sleep Disturbance

Normal sleep is a fundamental yet crucial restorative process that is essential to daily life and overall functioning (NIMH, 2013; Stein, Belik, Jacobi, & Sareen, 2008). Sleep disturbance is defined as perceived or actual alterations of "normal" characteristics of nighttime sleep that result in daytime impairment (Basner, Fomberstein, Razavi, Banks, William, et al., 2007; Laposky, Van Cauter, & Diez-Roux, 2016). Indices of prevalent sleep disturbances include difficulties falling asleep (sleep onset latency), inability to maintain sleep due to frequent and prolonged nighttime awakenings (waking after sleep onset), and proportion of the total time in bed that is spent actually asleep (sleep efficiency) (Engstrom, Strohl, Rose, Lewandowski, & Stefanek, 1999; Savard & Morin 2001; Ancoli-Israel, 2009; Harris, Ross, & Sanchez-Reilly, 2014; Carvalho-Bos, Riemersma-van der Lek, Waterhouse, Reilly, & Van Someren, 2007; Witting, Kwa, Eikelenboom, Mirmiran, & Swaab, 1990). Sleep onset latency, waking after sleep onset, and sleep efficiency can all be measured with both self-report tools (e.g., sleep diaries) or objective recording devices (e.g., polysomnography, actigraphy) (Luik, Zuurbier, Hofman, Van Someren, & Tiemeier, 2013). These three indices of sleep disturbance can be as an overall *mean* level and as a *variation* of sleep disturbance across days (Bei, Wiley, Trinder, & Manber, 2016; Mercadante, Girelli, & Causccio, 2004).

Mean Sleep Disturbance in Cancer Patients

Sleep disturbances are more common among cancer patients (65%) compared with age-matched individuals who have not had cancer (55%) (Davidson et al., 2002;

Gooneratne, Dean, Rogers, Nkwuo, Coyne, et al., 2007; Otte, Carpenter, Russell, Bigatti, & Champion, 2010; Palesh, Roscoe, Mustian, Roth, Savard, et al., 2010). Listed among the top five concerns of cancer patients, sleep disturbances have been associated with their impaired quality of life, poorer prognosis, and greater mortality (Lis, Gupta, & Grutsch, 2008; Nishiura, Tamura, Nagai, & Matsushima, 2015; Ness, Kokal, Fee-Schroeder, Novotny, Satele, et al., 2013; Savard & Morin, 2001; Xiao, Arem, Pfeiffer, & Matthews, 2017).

Up to 75% of newly diagnosed or recently treated cancer patients have reported sleep disturbances, most commonly difficulties falling and staying asleep (Savard, Simard, Blanchet, Ivers, & Morin, 2001; Davidson et al., 2002; Gibbins, McCoubrie, Kendrick, Senior-Smith, Davies, et al., 2009; Irwin, 2015). These sleep disturbances may be reflected in generally reduced sleep observed in those with cancer. Instead of the typical 6.7-8.9 hours of sleep per night expected in healthy adults (Basner et al., 2007; Ram, Seirawan, Kumar, & Clark, 2010; Consensus Conference Panel, Watson, Badr, Belenky, Bliwise, et al., 2015), those with cancer report sleep durations of 4.8 to 7 hours per night (Berger, Farr, Kuhn, Fischer, & Agrawal, 2007; Collins, Geller, Antoni, Donnell, Tsung, 2017; Simeit, Deck, & Conta-Marx, 2004).

Similarly, instead of the 80-100% mean sleep efficiency expected in healthy adults (Armitage, Trivedi, Hoffmann, & Rush, 1997; Mitterling, Högl, Schönwald, Hackner, Gabelia, et al., 2015; Ram et al., 2010), those with cancer report a mean sleep efficiency of 58% to 84% (Le Guen, Gagnadoux, Hureaux, Jeanfaivre, Meslier, et al., 2007; Palesh, Aldridge-Gerry, Zeitzer, Koopman, Neri, 2014; Simeit et al., 2004). A sleep efficiency score below 85% indicates generally poor sleep efficiency (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004; Williams, Karacan, & Hursch, 1974). Among advanced breast cancer patients, the mean survival for women with 85% or higher sleep efficiency was 68.9 months, whereas that for women with poor sleep efficiency (< 85%) was 33.2 months (Palesh, et al., 2014).

Cancer patients have also reported mean sleep onset latency of 28-72 minutes (Dean, Redeker, Wang, Rogers, Dickerson, et al., 2013; Palesh et al., 2014; Simeit et al., 2004; Vena, Parker, Allen, Bliwise, & Jain, et al., 2006), which is up to three times longer than the SOL reported by healthy adults that ranges 19 to 24 minutes (Mitterling et al., 2015; Ram et al., 2010). Specifically, longer mean sleep onset latency and worse mean sleep efficiency have been associated with patients' own worse physical, mental, and social functioning (Collins et al., 2017; Mitterling et al., 2015; Palesh et al., 2014; Sandadi, Frasure, Broderick, Waggoner, Miller, et al., 2011; Simeit et al., 2004; Vargas, Wohlgemuth, Antoni, Lechner, Holley, et al., 2010; Vena et al., 2006).

Finally, cancer patients have reported 60 to 96 minutes per night of waking after sleep onset (Ancoli-Israel, Liu, Marler, Parker, Jones, et al., 2006; Berger et al., 2007; Berger, Grem, Visovsky, Marunda, & Yurkovich, 2010; Dean et al., 2013; Palesh et al., 2014), whereas healthy adults have reported less than 30 minutes of waking after sleep onset (Mitterling et al., 2015; Ram et al., 2010). Such greater mean duration of waking after sleep onset among breast cancer patients has been associated with greater mortality (Palesh et al., 2014). These findings underscore compromised sleep in cancer patients compared with their healthy counterparts. They also highlight that the nature and extent of sleep disturbance have implications for poorer prognosis and greater mortality.

Variation in Sleep Disturbance Across Days in Cancer Patients

Beyond the mean levels of these sleep disturbance parameters across days, variation of sleep disturbance across days is also important to consider (Bei et al., 2016). Among cancer patients, there has been shown sizeable, intra-individual variation of sleep disturbance. For example, daily standard deviation of sleep onset latency has been on average 30 minutes, that of waking after sleep onset 40 minutes, and that of sleep efficiency 12% (Dean et al., 2013; Jim, Small, Faul, Franzen, Apte, et al., 2011). Cancer patients' greater variations in sleep onset latency, waking after sleep onset, and sleep efficiency have been notably larger compared with those of nonmedical populations: 12 minutes, 20 minutes, and 8.4%, respectively (Ankers & Jones, 2009; Knutson, Rathouz, Yan, Liu, & Lauderdale, 2007).

Although not specific to cancer patients, larger variation of sleep disturbance has also been associated with greater self-reported stress, more dysregulated neuroendocrine functioning, and higher risk for physical health conditions, such as obesity (Knutson et al., 2007; Lemola, Ledermann, & Friedman, 2013; Mezick, Matthews, Hall, Kamarck, Buysse, et al., 2009; Sigurdardottir, Valdimarsdottir, Fall, Rider, Lockley, et al., 2012; Van Lenten, & Doane, 2016). The greater variation of SOL, WASO, and SE, beyond the means, may also have implications for cancer patients' downstream poorer health and functioning. The extent to which daily variation of sleep disturbance further contributes to patients' poorer health outcomes, above and beyond that of mean sleep disturbance warrants investigation.

Medical and Psychosocial Correlates and Predictors of Sleep Disturbance in Cancer Patients

The alarming prevalence, severity, and implications of sleep disturbance among cancer patients begs the question of possible preceding factors. Sleep disturbances in cancer patients have been attributed to the physical burdens of the disease itself, as well as treatment cytotoxicity and side effects (Davidson et al., 2002; Delgado-Guay, Yennurajalingam, Parsons, Palmer, & Bruera, 2011; Fiorentino & Ancoli-Israel, 2007; Irwin, Olmstead, Ganz, & Haque, 2013; Savard, Liu, Natarajan, Rissling, Neikrug, et al., 2009).

Both prostate and breast cancer patients have reported on average more than 20 minutes of SOL during the early weeks of their radiation treatments compared with six months post treatment (Thomas, Bower, Hoyt, & Sepah, 2010). Throughout a four-week course of their chemotherapy cycle, breast cancer patients have reported an average of over 120 minutes of WASO (Liu, Mills, Rissling, Fiorentino, Natarajan, et al., 2012). Finally, lung cancer patients undergoing chemotherapy have reported longer average SOL (33.62 vs. 26.10 minutes), greater prevalence of WASO (49% vs. 38%), and poorer total average SE (82.80% vs. 85.23%) on days they were actually receiving chemotherapy drugs than during their rest period days (Chen Yu, & Yang, 2008).

Larger variation of a couple indicators of sleep disturbance has also been shown among gynecological cancer patients undergoing chemotherapy. For example, duration of WASO increased to as high as 100 minutes on the days after an infusion, compared with 60 minutes of WASO on off-treatment days, which was concurrent with their greater daily fatigue post infusion. In addition, the patients showed as much as 12% variation of

SE on post-infusion days, compared with up to 6% variation of SE on pre-infusion days (Jim et al., 2011). Together, these findings suggest that receiving a cancer treatment is physically taxing and may contribute to patients' sleep disturbance, especially during the period when chemotherapy is actually given.

In addition to cancer treatment, patients' sleep disturbances have been attributed to psychological distress that accompanies the adjustment to diagnosis and treatment (Ancoli-Israel et al., 2014; Butow, Price, Shaw, Turner, Clayton, et al., 2015; Collins et al., 2017; Pokorney & Bates, 2017). Existential concerns, as well as considerations of one's life goals and existing relationships with close others, result in a psychological toll that encumbers patients' ability to achieve and maintain arousal reduction that is crucial for restful sleep (Butow et al., 2015; Burwell, Bracker, & Shields, 2006; Hopman & Rijken, 2015; McGinty, Goldenberg, & Jacobsen, 2012; Pokorney & Bates, 2017; Posluszny, Edwards, Dew, & Baum, 2011). For example, lung cancer patients have reported greater global sleep disturbance consisting of longer SOL and poorer SE prior to initiating chemotherapy than during their first chemotherapy cycle, suggesting greater impact of psychological distress on sleep disturbance than that of cancer treatment per se (Chen et al., 2008). In addition, increased *depression* during one year, compared with increased pain, was associated with greater negative changes in sleep patterns, such as shortened sleep duration and increased WASO, among breast cancer patients (Palesh, Collie, Batiuchok, Tilston, Koopman, et al., 2007).

Elevated *anxiety* following diagnosis has also been associated with greater sleep disturbance. Among a sample of colorectal cancer patients, greater increases in anxiety were associated with worse sleep disturbance, above and beyond contributions of chemotherapy (Coles, Tan, Bennett, Sanoff, Basch, et al., 2018). However, findings from that study should be considered with caution, as the specific sleep disturbance indicators were not disclosed. In lung cancer patients, anxiety has been associated with prolonged SOL, which suggests difficulty reaching an optimal state of reduced arousal for sleep (Nishiura et al., 2015). Among a heterogeneous sample of advanced stage cancer patients, increased level of psychological distress was the only prospective predictor of developing sleep disturbance (measured by a single item), whereas pain, fatigue, and other symptoms were not (Akechi, Okuyama, Akizuki, Shimizu, & Inagaki, et al., 2007). Considered together, results suggest the psychological toll of cancer on patients that encumbers their ability to achieve and maintain arousal reduction that is crucial for restful, rejuvenating sleep.

Biobehavioral stress models posit that emotional and psychological stress regulation contributes to physiological regulatory processes and downstream health outcomes (Lutgendorf & Andersen, 2015; Monat & Lazarus, 1991; Thoits, 2010). Furthermore, individual differences in threat perception and stress regulation guide differential downstream health outcomes (Bonanno & Burton, 2013; Cohen & Hamrick, 2003). The individual differences in perceived threat and stress regulation that may predispose cancer patients to developing sleep disturbance, which has implications for downstream morbidity and mortality, can be examined within the conceptual framework of adult attachment theory (Benham, 2010; Hazan & Shaver, 1987; Maunder & Hunter, 2001; Pietromonaco & Powers, 2015; Pietromonaco, Uchino, & Dunkel Schetter, 2013; Robles & Carroll, 2011).

A Psychosocial Theoretical Framework of Sleep Disturbance: Attachment Theory

Bowlby (1979) posited that the activated biopsychosocial attachment system serves to protect infants from threat or danger by keeping them close to the mother or primary caregiver. This system is not limited to infancy: it remains with individuals "from the cradle to the grave." Attachment theory posits that individuals develop enduring cognitive schemas, or internal working models, based on the quality of their experiences during early development with an attachment figure, such as a parent or caregiver (Bowlby, 1969; 1973; 1982). These working models include specific content about interpersonal experiences and associated affects that make up expectations about the self, significant others, and the relationship between the two (Bowlby 1973; Bretherton, 1985; Collins & Read, 1994). These internal working model processes are automatic and defensive, stress mitigating systems (Bowlby 1980; Bretherton, 1985; Pietromonaco & Barrett, 2000).

Adult attachment theory extends this notion that one's disposition towards perceptions of self and others continue to have implications for interpersonal interactions throughout adulthood (Hazan & Shaver, 1987; Mikulincer & Shaver, 2003). Adult attachment predicts how individuals perceive partners, seek or provide support in times of need, and self-regulate emotions and physiological response to threatening or stressful stimuli (Mikulincer & Shaver, 2007; Pietromonaco & Beck, 2015; Troxel, Robles, Hall, & Buysse, 2007). Adult attachment theory serves as a useful lens for understanding how cancer patients' self-regulatory emotional and physiological response to the stress that surrounds diagnosis influences their sleep – a behavior that entails relatively reduced arousal and vigilance (Troxel, Cyranowski, Hall, Frank, & Buysse, 2007; Troxel, 2010).

Adult attachment has been conceptualized as a dimensional construct (Bartholomew, 1990; Collins & Read, 1990; Griffin & Bartholomew, 1994). A unidimensional approach entails a continuum of secure attachment. One multidimensional approach involves four prototypic dimensions of secure, preoccupied, fearful, and dismissive attachment, which are based on positive versus negative views of the self and other (Bartholomew, 1990). A common consensus is that two dimensions – anxiety and avoidance – tap into the individual differences in adult attachment most parsimoniously (Brennan, Shaver, & Tobey, 1991).

Carver (1997) put forth a modified four-factor structure of attachment, which described security, avoidance, and two distinct factors of anxiety-ambivalence. High attachment anxiety-ambivalence is indicated by intense self-focus and clinginess to a partner, and is associated with high distress (Kim, Kashy, & Evans, 2007; Mikulincer & Shaver, 2003). Attachment anxiety-ambivalence differentiates between the Anxious-Ambivalence Merger property and the Anxious-Ambivalence Worry property. Anxious-Ambivalence Merger is indicated by a strong desire to reunite with, cling to, and "merge" with an attachment figure, while Anxious-Ambivalence Worry describes a focus on worrying about future abandonment (Carver, 1997).

Despite numerous conceptualizations of adult attachment, most conceptions have considered attachment as three-pronged: secure, anxious-ambivalent, and avoidant styles (Ainsworth et al., 1978; Hazan & Shaver, 1987). Overall, the anxiety attachment dimension reflects one's hyper-vigilance to cues of abandonment or rejection from a partner. Individuals with greater attachment anxiety tend to over-seek affection from their partners while simultaneously distrusting their partner's love (Collins, 1996).

Attachment anxiety is also characterized by difficulties with emotion regulation, hyperactivation of physiological arousal, and hypervigilance to threatening cues (Collins & Feeney, 2000; Mikulincer & Shaver, 2008).

In contrast to all of this, the avoidance dimension is typified by a lack of comfort with intimacy and closeness with a partner, as well as dependence on a partner (Hazan & Shaver, 1994). Individuals with greater attachment avoidance tend to rely on hypoactivating strategies by dismissing, downplaying, or denying their needs or potential threats, despite evidence of their heightened physiological response (Collins & Feeney, 2004; Diamond, & Fagundes, 2010; Mikulincer & Shaver, 2008; Pietromonaco & Powers, 2015).

Greater secure attachment, by this approach, represents being low in both attachment anxiety and avoidance, resulting in being comfortable with closeness and interdependence. Individuals with greater attachment security are readily able to emotionally and physiologically regulate and are comforted by support (Collins & Read, 1990; Mikulincer & Shaver, 2008).

Adult Attachment as Index of Interpersonal Variation of Sleep Disturbance

One of the regulatory functions of the attachment system is the physiological restorative process, which includes sleep, in response to perceived threats (Robles & Carroll, 2011; Robles & Kane, 2014; Mikulincer & Shaver, 2007; Pietromonaco & Beck, 2015; Adams & McWilliams, 2015; Carmichael & Reis, 2005; Diamond, Hicks, & Otter-Henderson, 2008; Laposky et al., 2016; Maunder et al., 2011; McNamara, Pace-Schott, Johnson, Harris, & Auerbach, 2011). Sleep is achieved with down-regulated vigilance, which is optimized when the individual feels physically and emotionally safe (Adams, Stoops, & Skomro, 2014; Troxel et al., 2007; Voss, Kolling, & Heidenreich, 2006).

Different emotional and physiological stress regulatory processes involved in different attachment orientations (Ditzen, Schmidt, Strauss, Nater, Ehlert, et al., 2008; Maunder, Lancee, Nolan, Hunter, & Tannenbaum, 2006; Shaver & Mukulincer, 2007; Simpson & Rholes, 2017) have also been associated with various sleep disturbances (Carmichael & Reis, 2005; Hsiao, Chang, Kuo, Huang, Liu, et al., 2013; Troxel et al., 2007; Verdecias, Jean-Louis, Zizi, Casimir, & Browne, 2009). Attachment security, characterized by appropriate onset of stress response in the presence of threat and attenuation of stress response in its absence, has been associated with shorter SOL (Adams & McWilliams, 2015; Verdecias et al., 2009), although findings have been mixed (McNamara et al., 2011). However, attachment security has been consistently associated with less WASO, and inconsistently associated with greater SE (Adams & McWilliams, 2015; Scharfe & Eldredge, 2001; Troxel et al., 2007). Findings suggest that upon achieving arousal reduction to initiate sleep, individuals with greater attachment security are able to maintain this reduced arousal, and therefore maintain sleep, throughout the night.

Attachment anxiety, characterized by *hyper*vigilance to potential threat, has been inconsistently associated with longer SOL, distinctly associated with amplified reports of greater WASO, and inconsistently associated with poorer SE (Adams & McWilliams, 2015; Carmichael & Reis, 2005; McNamara et al., 2011). Consistent with attachment theory, the difficulty in downregulating vigilance that is associated with attachment anxiety manifests as volatile sleep-wake transitions throughout the night. Attachment avoidance, characterized by *hypo*vigilance to threat (Mikulincer & Florian, 1998), has been uniquely associated with longer SOL, although less consistently associated with greater WASO and poorer SE (Carmichael & Reis, 2005; Adams & McWilliams, 2015; McNamara et al., 2011; Scharfe & Eldredge, 2001). Results regarding attachment avoidance suggest that difficulty falling asleep is evidence of a heightened physiological response, despite the denial or dismissal of threat. These findings attest to the potential utility of applying an important theoretical model of adult attachment to understand how specific dimensions of relationship functioning relate to key health outcomes, such as sleep disturbance (Troxel, 2010).

To our knowledge, the literature has not yet examined the associations between adult attachment and intra-individual variations of sleep disturbance. Despite limited empirical evaluation, attachment theory reasonably suggests that the appropriate onset and offset of the physiological stress response characteristic of attachment security, which is reflected in less mean level sleep disturbance, may also be reflected in less variation of sleep disturbance. The enhanced or exaggerated arousal unique to attachment anxiety may also manifest as greater variation of sleep disturbance. Finally, the downplayed or minimized arousal stress response characteristic of attachment avoidance would reasonably be manifested as less variation of sleep disturbance, comparable to that of attachment security.

In summary, existing literatures show that the primary goal of the innate attachment system is to regulate arousal and alleviate distress during threat (Bowlby, 1969; Brennan & Shaver, 1995; Hazan & Shaver, 1987). The regulation of arousal and distress is guided by expectations regarding the responsiveness of a significant other during times of need that are embedded within the internal working model of attachment (Hazan & Shaver, 1987). Thus, individual differences in stress reactivity and regulation by different attachment orientations are likely to be reflected in the mean and variation of sleep disturbance indices, such as SOL, WASO, and SE.

Current Study: Aims and Hypotheses

The present study tested the extent to which adult attachment orientations were associated with sleep disturbance indices across 14 days among patients who were newly diagnosed with a cancer.

Aim 1. To examine the degree to which adult attachment orientations were associated with mean sleep onset latency (SOL), wakening after sleep onset (WASO), and sleep efficiency (SE).

Hypothesis 1a. Attachment security would not be associated with mean SOL, would be associated with less mean WASO, and would not be associated with mean SE.

Hypothesis 1b. Attachment anxiety would not be associated with mean SOL, would be associated with greater mean WASO, and would not be associated with mean SE.

Hypothesis 1c. Attachment avoidance would be associated with longer mean SOL, would not be associated with mean WASO, and would not be associated with mean SE.

Aim 2. To explore the extent to which adult attachment orientations were associated with individual variation of SOL, WASO, and SE across 14 days.

Hypothesis 2a. Greater attachment security would be associated with less variation in SOL, WASO, and SE.

Hypothesis 2b. Greater attachment anxiety would be associated with greater variation in SOL, WASO, and SE.

Hypothesis 2c. Greater attachment avoidance would be associated with less variation in SOL, WASO, and SE.

Chapter 2. Methods

Participants

Newly diagnosed colorectal cancer patients were enrolled in an ongoing, NIH-funded R01 study that examines the effects of stress regulation within cancer patient and their family caregiver dyads on their health outcomes (R01NR016838). The current sample was a subset of this parent study. Patients were recruited at oncology clinics in Miami, FL. Eligibility criteria were: (a) 18 years or older, (b) newly diagnosed with stage I to IV colon or rectal cancer within the past 6 months, (c) able to read and speak English or Spanish at the 5th grade level, and (d) having a heterosexual partner involved in daily life activities.

Patients were excluded if they reported having active and untreated substance dependence, psychosis, and/or suicidal ideation within the past year, have untreated, diagnosed narcolepsy or restless leg syndrome, or (if female) intend to be pregnant during the study. Patients were also excluded if they have poor physical functioning (defined as Eastern Cooperative Oncology Group scores ≥ 3 or Karnofsky Performance Status scores < 50; Oken, Creech, Tormey, Horton, Davis, et al., 1982; Karnofsky, 1949) or cognitive functioning (Mini Mental State Examination < 24; Folstein, Robins, & Helzer, 1983), were unable to see or hear, or were under end-of-life care (< 6 months life expectancy). Patients who provided complete or partial data for the variables under study, to date, were subject to statistical analysis and included in this report.

Procedures

This study was conducted in compliance with the Institutional Review Boards of University of Miami, Sylvester Comprehensive Cancer Center (SCCC) Protocol Review Committee, and the Jackson Health System (JHS) Institutional Review Board. Eligible patients were identified by colorectal cancer diagnosis and date of diagnosis from their electronic medical records from a study site (SCCC and JHS). Patients were recruited in person at the oncology clinics or through telephone if in-person recruit is not feasible. Written informed consent was obtained individually prior to collecting any study data. Patients completed a questionnaire and daily sleep diaries on 14 consecutive days, regarding their sleep information from the previous night and morning of. Patients were reimbursed with $90 upon completion of assessment.

Measures

Attachment. Patients' qualities of their relationship to their primary caregivers were assessed using the 14-item Measurement of Attachment Quality (MAQ: Carver 1997), on a 4-point Likert format (1=*Strongly Disagree*, 4= *Strongly Agree*). The MAQ assesses four attachment orientations: security, which is comfort in seeking closeness with the caregiver (3 items: e.g., "I find it easy to be close to him/her"); avoidance, which is discomfort with the caregiver's closeness (5 items: "I get uncomfortable when he/she wants to be very close"); anxious-ambivalence worry, which is fear of being abandoned by the caregiver (3 items: e.g., "I often worry he/she will not want to stay with me"); and anxious-ambivalence merger, which is desire to merge with the caregiver (3 items: e.g., "My desire to become one with this person scares him/her away"). Each subscale was scored by averaging responses (after appropriate reversals). The anxious-ambivalence worry and anxious-ambivalence merger subscales (r = .28) were combined to represent attachment anxiety. Psychometric properties of the measure with current sample were tested (see Results).

Sleep Disturbance Indices. Sleep was assessed using the Consensus Sleep Diary (Carney, Buysse, Ancoli-Israel, Edinger, Krystal, et al., 2012). Patients reported the time at which they got into the bed, the time at which they tried to fall asleep, their estimated amount of time to fall asleep, their total amount of time of nocturnal awakenings, the time of their final awakening in the morning, and the time they got out of the bed for the day.

Three indices served as measures of sleep disturbance. First, the duration for falling asleep (sleep onset latency: SOL) was assessed by the total number of minutes reported for the item, "How long did it take you to fall asleep?" Second, the total amount of time spent awake after falling asleep but before the final awakening (waking after sleep onset: WASO) was assessed by the total number of minutes reported for the item, "If [woke up] more than once, in total, how long did these awakenings last?" Finally, the percentage of amount of time spent in the bed that was reportedly spent actually asleep (sleep efficiency; SE) was derived from the equation (Reed & Sacco, 2016):

$$\text{SE} = \frac{\text{Total Sleep Time}}{\text{Total Time Spent in Bed}} \text{X } 100$$

where Total Time Spend in Bed = SOL + Total Sleep Time + WASO. The total time spent in bed refers to the number of minutes between when the participant physically enters the bed and physically exits the bed. The total sleep time refers to the number of minutes between when the participant falls asleep and when the participant has a final awakening before exiting the bed.

For each sleep disturbance index, a mean index was derived as an average value across 14 days, and a variation index was operationalized as each person's standard deviation per sleep index (Dillon, Lichstein, Dautovich, Taylor, Riedel, et al., 2014).

Covariates. Greater sleep disturbance has been associated with greater age (Crowley, 2011; Kryger, Monjan, Bliwise, & Ancoli-Israel, 2004; Vitiello, Larsen, & Moe, 2004) and female gender (Jaussent, Dauvilliers, Ancelin, Dartigues, Tavernier, et al., 2011; Smagula, Stone, Fabio, & Cauley, 2016). Advanced cancer stage and depression have also been linked to greater sleep disturbance (Koopman, Nouriani, Erickson, Anupindi, Butler, et al., 2002; Jim et al., 2011; Palesh, et al., 2007; Savard et al., 2001). Thus, patients' self-reported age, gender, and depressive symptoms, as well as cancer stage obtained from medical records served as covariates.

Patients' depressive symptoms were assessed using the 20-item Center for Epidemiological Studies – Depression (CES-D; Radloff, 1977). Participants reported how often since their diagnosis they felt a certain way (e.g. "I felt depressed) on a 4-point Likert format (0=*Rarely or None of the Time*, 3= *Most or All of the Time*). After appropriate reverse coding, the sum of scores indicates an overall level of depressive symptomatology (Radloff, 1977).

Statistical Analyses

Descriptive Data Analysis

Means, standard deviations, and ranges of study variables were computed. Psychometric properties of the MAQ (Carver, 1997) in proposed three-factor structure with adult cancer patients, were examined. Reliability tests were conducted to examine inter-item correlation within each factor, from which Cronbach's alpha reliability coefficients were derived and assessed. For unacceptable internal consistency ($\alpha < .70$: Nunnally, 1978; Streiner, 2003), the inter-item correlations per subscale were examined.

Normality of variables – skewness and kurtosis – were assessed. Extreme outliers (set at > 3 SDs) were subjected to winsorizing to the value of 3 standard deviations of the variable (Tabachnic & Fidell, 2007). All analyses were performed using SPSS software Version 24 (IBM Corp., 2016).

Testing Study Aims

The preliminary associations among study variables (attachment and sleep disturbance indices) were estimated using Pearson correlation coefficients for continuous and normally distributed variables and using Spearman's correlation coefficients for dichotomous and non-normally distributed variables. Hypotheses were tested using a generalized linear modeling framework. Means and variations of the sleep disturbance indices (SOL, WASO, and SE) were each predicted in a separate model. Inflated Type-I error rate by multiple comparisons was adjusted by setting the critical p value to 0.05 / 6 = 0.008. Each model included age, female gender (female=1; male=0), advanced cancer stage (advanced stage III/IV = 1; early stage I/II = 0), and depression in the first block as covariates. Adult attachment orientations (security, anxiety, and avoidance) were added to the model in the second block in order to test adult attachment's effects on sleep disturbance beyond the contributions of covariates.

Chapter 3. Results

Descriptives of the Sample

A total of 24 patients provided the study data, which were subject to subsequent statistical analyses. As shown in Table 1, the sample was middle-aged, primarily male and Hispanic, diagnosed with advanced stage (III or IV) colon cancer. All patients reported having begun treatment for their cancer prior to participating in the study. The current sample also reported a moderate level of depressive symptoms, which was elevated compared to that of a mixed sample of cancer patients who had initiated treatment ($M = 10.80$; Kurtz, Kurtz, Given, & Given, 2004; $M = 11.53$; Otte et al., 2010).

Testing Reliability of Attachment Orientation Measures

Three attachment orientations were measured using the Measure of Attachment Quality (Carver, 1997): attachment security (three items), attachment avoidance (five items), and attachment anxiety (six items). Only attachment security subscale had acceptable internal consistency with current sample ($\alpha = .74$). Thus, the attachment avoidance ($\alpha = .66$) and attachment anxiety ($\alpha = .66$) subscales were subject to inter-item reliability analysis. Among attachment avoidance subscale items, one item ("I prefer not to be too close to him/her.") was not significantly correlated with the other items (rs < .26, ps > .23). Excluding this item resulted in acceptable internal consistency of the attachment avoidance subscale ($\alpha = .70$). Thus, this item was removed in subsequent analyses.

Among the attachment anxiety subscale items, one item ("I don't worry about him/her abandoning me.") that was reverse coded for the anxiety subscale was also not significantly correlated with the other items (rs < .24, ps > .25). Excluding this item also improved internal consistency for attachment anxiety ($\alpha = .73$). Thus, this item was also removed.

As shown in Attachment Orientations rows in Table 1, the mean attachment security (three items) score had a ceiling effect, whereas those of attachment avoidance (four items) and attachment anxiety (five items) had floor effects, respectively.

Descriptives of Sleep Disturbance Indices

Of the 24 patients, 9 (37.5%) had missing sleep diary data on at least one day. However, we considered the three sleep disturbance indices across 14 days for 24 participants; of the 1,008 total possible values, 68 (6.75%) were missing. A non-significant Little's MCAR test indicated that missing values were likely to be missing at random ($\chi^2 = 200.36$, $df = 310$, $p > .05$). Thus, with the available daily data, an average was calculated across the days for each individual's mean sleep onset latency (SOL), mean waking after sleep onset (WASO), and mean sleep efficiency (SE) values. Each subject's standard deviation per sleep index was derived for individual variation of sleep disturbance (Dillon et al., 2014).

Self-reported sleep disturbance indices were inspected. Extreme outliers (one value for mean SE and one value for variation of WASO) were winsorized by recoding them at the value of three standard deviations of the mean for the respective index (Osborne & Overbay, 2004; Tabachnick & Fidell, 2007).

After winsorizing two out of 144 possible values, all sleep disturbance indices had skewness less than 2, and all but two indices had kurtosis less than 2. The kurtosis of mean SE and variation of WASO was 2.48 and 4.45, respectively. Winsorized values of sleep disturbance indices were used in subsequent analyses.

As shown under “Sleep Disturbance Indices” in Table 1, patients took an average of about 20 minutes to fall asleep and spent around 16 minutes awake after sleep onset and before final awakening. While values below 85% indicate poor SE, the sample had an average 90% SE, which suggests they overall had good sleep. However, 21% (5 patients) of the sample had SE below 85%. Regarding variation of sleep disturbance indices across days, the derived variations in SOL, WASO, and SE of our sample are comparable to those seen in adults who do not have cancer (Buysse, Yu, Moul, Germain, Stover, et al., 2010; Dillon et al., 2014).

Correlations Among Study Variables

Spearman’s rho correlations were calculated for the six sleep disturbance indices, all of which were non-parametric; otherwise Pearson’s correlations were calculated. The zero-order correlation coefficients among study variables are shown in Table 2. Attachment security was significantly negatively correlated with attachment avoidance but was not significantly correlated with attachment anxiety ($p = .26$). Attachment anxiety and attachment avoidance were significantly positively correlated.

Among sleep disturbance indices, mean sleep onset latency was significantly positively correlated with mean waking after sleep onset and variation of all three indices sleep disturbance (i.e., standard deviations; SDs); and was significantly negatively correlated with mean sleep efficiency. Mean WASO was significantly negatively correlated with mean SE and significantly positively correlated with the SDs for all three indices of sleep disturbance. Mean SE was significantly negatively correlated with the SDs for all three indices of sleep disturbance. Finally, the SDs for all three indices of sleep disturbance were positively and significantly correlated to each other.

Attachment orientations were not significantly correlated with any mean or SD for all three indices of sleep disturbance (*p*s > .27).

Testing Study Aims: Associations of Adult Attachment Orientations with Sleep Disturbance Indices

Shapiro-Wilk tests of normality showed that all six sleep disturbance indices significantly deviated from a normal distribution (*p*s < .03). Thus, non-parametric generalized linear modeling was employed to test hypotheses involving dependent variables that were not normally distributed. Results regarding predicting the three mean and three variability indices of sleep disturbance are reported in Table 3.

Testing Associations of Adult Attachment Orientations with Mean Sleep Disturbance Indices (Aim 1). As shown in the upper section of Table 3, with an adjusted critical *p*-value of 0.008, covariates were not significantly associated with any mean of sleep disturbance indices (*p*s > .034). Above and beyond the covariate effects, greater attachment security was associated with less time taken to fall asleep (*p* = .006). Attachment avoidance was also marginally associated with less time taken to fall asleep (*p* = 0.009). The results provided partial support of Hypothesis 1a (regarding attachment security) and failed to support Hypothesis 1c (regarding attachment avoidance). Attachment anxiety was not significantly associated with any mean indices of sleep disturbance (*p*s > 0.269), failing to support Hypothesis 1b.

Testing Associations of Adult Attachment Orientations with Indices of Variability of Sleep Disturbance (Aim 2). As shown in the lower section of Table 3, older patients had significantly less variability in the amount of time to fall asleep (SOL) across days (*p* = .004). In addition, patients with greater depressive symptoms had greater variability in their sleep efficiency (SE; $p = .007$). Other covariates were not significantly associated with any variability of sleep disturbance indices studied ($ps > .070$). Above and beyond the covariate effects, no attachment orientations were significantly associated with any variation of sleep disturbance indices ($ps > .477$), which failed to support Hypotheses 2a, 2b, and 2c.

Chapter 4. Discussion

The current study examined the extent to which individual differences in adult attachment orientations are related to sleep disturbance among colorectal cancer patients who were recently diagnosed within 5 months, on average.

Sleep disturbance. Compared with other (lung, liver/pancreas) cancer patients who were receiving treatment (Collins et al., 2017; Dean et al., 2013), patients in this study reported, on average, taking less time to fall asleep, spending less total time awake after sleep onset but prior to final awakening, and having better sleep efficiency. Compared with those other cancer patient samples, our sample was younger and slightly a greater proportion of female patients, although proportions of participants with advanced cancer stages were similar. The sleep indices of our sample were comparable to those reported by adults without cancer, which suggests that our patient sample had considerably normal sleep (Mitterling et al., 2015; Ram et al., 2010). Our finding perhaps suggests that within six months after their diagnosis, cancer patients continue to have their lower baseline, pre-diagnosis levels of sleep disturbance in the meantime. However, another consideration is that within other cancer patient studies, at least 50% of each sample had significant sleep disturbance, driving the sample's overall poorer average sleep, whereas up to 25% of our sample of cancer patients had poor sleep indices comparable to those of other patients (Collins et al., 2017; Dean et al., 2013; Jim et al., 2011; Otte et al., 2010; Palesh et al., 2014).

Adult attachment and sleep disturbance. Participants reported patterns of relatively higher levels of attachment security and lower levels of attachment anxiety and avoidance, which is consistent with previous findings (Adams & McWilliams, 2015). The first set of hypotheses was that different attachment orientations would be associated with mean sleep disturbance indices to different extents. Contrary to our hypothesis that attachment security would be unrelated to the duration of falling asleep (SOL), greater attachment security was associated with less time to fall asleep. While our results are consistent with findings from a large nationally representative sample (Adams & McWilliams, 2015), they are inconsistent with findings from other smaller, non-cancer samples (McNamara et al., 2011; Verdecias et al., 2009). Similar to that of the nationally representative sample, our sample of patients' ability to appropriately downregulate stress response and arousal, which is characteristic of attachment security, is reflected in their efficient sleep initiation evidenced by their shorter mean sleep onset latency (Adams & McWilliams, 2015; Mikulincer & Shaver, 2008).

Findings regarding attachment avoidance are inconsistent with existing literature that had shown attachment avoidance to be uniquely associated with longer SOL (Adams & McWilliams, 2015; McNamara et al., 2011). The marginally significant association between attachment avoidance and shorter SOL suggests that the denial and suppression of threat, characteristics of attachment avoidance, also seemingly helps for a quicker sleep onset at a comparable degree to that of attachment security (Mikulincer & Florian, 1998).

Conceptually, both attachment security and attachment avoidance enable individuals to achieve minimization of vigilance when needed, which is optimal for sleep initiation, and possibly explains the similar associations with shorter SOL for the two attachment orientations (Adams et al., 2014; Hazan & Shaver, 1987; Robles & Carroll, 2011). To some degree, secure and avoidant attachment orientations both entail the view that feeling threatened and stressed is an undesirable state that should be deactivated

(Mikulincer & Shaver, 2007). The difference between the two orientations lies within the approach to deactivate; whereas security-based strategies (e.g. positive appraisal of the self and others) may facilitate deactivation, avoidance-based strategies rely primarily on suppression. While such defensive strategies may equip patients with a degree of short-term resilience towards sleep disturbance, long-term use of such strategies, hypo-vigilance to threat/stress in particular, may become ineffective under prolonged, intense stress (Mikulincer & Shaver, 2007). The long-term effects of attachment avoidance, which employs denial and suppression to downplay the vigilance to threat perception, on sleep health should be examined.

Attachment anxiety was not associated with any sleep indices, which was inconsistent with empirical findings that show attachment anxiety to be associated with greater sleep disturbance (Adams & McWilliams, 2015; McNamara et al., 2011; Verdecias et al., 2009). One consideration is that a goal of hypervigilance and hyper-activating strategies typified by attachment anxiety is to minimize distance from a partner (Mikulincer & Shaver, 2007). Although bed partners were not included in the current analyses, all patients of the study sample did report sleeping with a consistent bed partner. Sleeping with their bed partner, which achieves the goal of close proximity at night, may have resulted in a reduced ability to detect an association between attachment anxiety and sleep disturbance.

The second set of hypotheses was that different attachment orientations would be differentially associated with variation of sleep disturbance indices.

No attachment orientations were significantly associated with any variation of sleep disturbance indices. The null finding may be due to SDs of sleep disturbance indices having greater sensitivity to daily level factors, as opposed to the discrete differences in attachment orientations. For example, throughout the course of treatment, days on which patients receive chemotherapy infusion may drive their greater sleep disturbance on that same and following nights as a result of treatment cytotoxicity and side effects (Jim et al., 2011; Savard et al., 2009). As negative affective states are also related to sleep impairment, days on which patients have oncology appointments that elicit greater negative affect may influence their greater sleep disturbance as well (Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010; Mezick et al., 2009).

Finally, weekly routines may play a role in sleep variability, particularly for the portion of our patient sample (50%) who reported working at least part-time, as opposed to being unemployed or retired. In contrast to weekend schedules that are likely to consist of fewer obligations and more time to "catch up" on sleep, weekday routines that entail more responsibilities perhaps require a more regimented or limited sleep schedule, thus less variation. However, greater daily stressors that accompany work and obligations on weekdays may result in one's greater sleep disturbance during the limited amount of time for sleep on weeknights. The individual working model of attachment may not directly influence sleep variation to the extent that it may moderate associations between daily stressors and sleep disturbance.

Overall, our current sample of patients had good sleep, which perhaps limited us from seeing associations between adult attachment orientations and sleep disturbance. Thus, this may also have resulted in potentially false, negative findings.

Limitations and Future Directions

Limitations of this study should also be considered and addressed in future studies. First, due to small sample size, the study was underpowered; findings should be replicated with a larger sample. In addition, the sleep disturbance indices in the current study were derived from self-reported measures. Studies have found that older individuals (although without cancer) report their sleep less disturbed than what is shown in on objective measure (Buysse, Reynold, Monk, Hoch, Yeager, et al., 1991; Vitiello et al., 2004). As individuals, particularly patients, tend to over- or underestimate their sleep behaviors, objective assessment of sleep will be useful providing complementary information to subjective assessments (Ancoli-Israel et al., 2006; Carskadon, Dement, Mitler, Guilleminault, Zarcone, et al., 1976). Investigating the role of attachment orientations in the degree to which the two types of sleep assessment concord, which may differentially relate to different sleep disturbance indices is warranted in future studies.

Future studies on sleep variability should also consider the inclusion of sleep-wake rhythm patterns guided by one's circadian clock. Sleep-wake rhythm disruption, due in part to poor or disturbed nighttime sleep, has been associated with poorer physical functioning and disease prognosis (Hrushesky, Grutsch, Wood, Yang, Oh, et al., 2009; Meerlo, Sgoifo, & Suchecki, 2008; Okun, Reynolds, Buysse, Monk, Mazumdar, et al., 2011; Sephton & Spiegel, 2003). Such health implication of sleep-wake rhythm disruption has been recognized as "probably carcinogenic to humans" by the International Agency for Research on Cancer of the World Health Organization (Caruso, Lusk, & Gillespie, 2004; Sigurdardottir et al., 2012; Hrushesky et al., 2009; Straif et al., 2007; Van Lenten, & Doane, 2016). Examination of sleep-wake rhythm disruption, indicated by individuals' rest-activity patterns within a day and across days, which can be measured using a wrist-worn accelerometer (van Someren, Hagebeuk, Lijzenga, Scheltens, de Rooij, et al., 1996) is warranted for future studies.

In addition, current sleep indices, although self-reported, are different from perceived *quality* of sleep. From the adult attachment perspective, differences in stress regulation have to do with the threat perception. Therefore, subjective evaluation of sleep quality may better represent individual differences in perceived threat and corresponding regulatory patterns.

Finally, the primary goal of the attachment system is to protect individuals from threat and danger by keeping them close to an attachment figure (Bowlby, 1979). In the social context, when one's internal working model of attachment is activated by threat, a common way of regulating stress is to seek out help and to connect, or not, with others. It will be fruitful to expand the scope of current work to dyadic investigation of adult attachment among patients and their caregivers, which will allow exploration of interpersonal phenomena, such as coregulation and co-agitation in sleep disturbance.

Conclusion

The current study contributes to better understanding of cancer patients' sleep disturbance grounded on the adult attachment theory framework. Attachment security was significantly associated with taking less time to fall asleep on average. None of the attachment orientations was associated with variability of sleep disturbance indices. Despite limited findings, our study suggests sleep health benefits of security-based stress regulatory strategies, which may have implications for better disease prognosis. Future investigations are encouraged to uncover the pathways linking attachment orientations to sleep disturbance that have implications for their downstream health outcomes.

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Table 1. Sample Characteristics and Descriptive Statistics of Study Variables

	Mean (SD) or frequency (%)
Demographics:	
Age (years)	55.93 (10.57): Range = 34.35-69.06
Gender (female %)	9 (37.50%)
Ethnicity	
Hispanic	17 (70.8%)
White, Non-Hispanic	6 (25.0%)
African American/Black	1 (4.2%)
Education	
High school diploma/GED or less	4 (16.7%)
Some college or college/vocational degree	15 (62.5%)
Professional or graduate degree	5 (20.8%)
Medical Characteristics:	
Colon cancer	19 (79.2%)
Rectal cancer	5 (20.8%)
Cancer stage (advanced)	17 (70.8%)
Treatment status (initiated)	24 (100.0%)
BMI	26.25 (5.08): Range = 19.00-40.00
Depressive symptoms	13.46 (9.66): Range = 0.00-30.00

Attachment Orientations:	Mean	SD	Scale Range	α
Security	3.72	0.52	0 ~ 4	.74
Avoidance	1.49	0.61	0 ~ 4	.70
Anxiety	1.48	0.61	0 ~ 4	.73
Sleep Disturbance Indices:			Actual Range	
Mean SOL (minutes)	19.75	14.36	1.29 – 61.07	
Mean WASO (minutes)	15.53	12.78	0.00 – 52.00	
Mean SE (%)	90.14	7.28	68.23 – 98.94	
Variation of SOL (minutes)	11.57	10.05	0.00 – 33.52	
Variation of WASO (minutes)	15.77	16.31	0.00 – 64.70	
Variation of SE (%)	6.27	5.13	1.33 – 20.19	

N = 24; *Note:* SOL = sleep onset latency; WASO = waking after sleep onset; SE = sleep efficiency

Table 2. Correlation Coefficients among Adult Attachment Orientations and Sleep Disturbance Indices

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	-											
2. Gender (female)	-.29	-										
3. Stage (advanced)	-.12	-.07	-									
4. CES-D	-.12	-.36	.11	-								
5. SEC	.41	-.14	.18	.38	-							
6. AVD	-.26	.07	.26	-.09	-.71**	-						
7. ANX	-.22	-.22	.04	.40	-.24	.54**	-					
8. Mean SOL	-.13	.17	.11	-.14	-.08	-.10	-.09	-				
9. Mean WASO	-.14	-.01	.03	-.06	-.23	-.02	-.06	.70***	-			
10. Mean SE	.21	-.09	-.09	-.23	.10	-.03	.01	-.75***	-.83***	-		
11. Var SOL	-.61**	.37	.13	-.05	-.15	.10	.04	.74***	.55**	-.66***	-	
12. Var WASO	-.05	.16	.29	-.06	-.11	.13	-.12	.59**	.78***	-.79***	.57**	-
13. Var SE	-.10	.08	.03	.40	.07	-.11	-.09	.45*	.50*	-.80***	.43*	.68**

$N = 24$; * $p < .05$ ** $p < .01$ *** $p < .001$

Note: Pearson correlation coefficient (r) is reported except for non-parametric variables (gender, cancer stage, all sleep disturbance indices), for which Spearman Rank Order Correlation (rho) is reported. SEC = attachment security; AVD = attachment avoidance; ANX = attachment anxiety; SOL = sleep onset latency; WASO = waking after sleep onset; SE = sleep efficiency; SD = standard deviation

Table 3. Non-parametric Generalized Linear Models Predicting the Mean and Variation Indices of Sleep Disturbance

	Mean SOL			**Mean WASO**			**Mean SE**		
	B	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*
Covariates									
Age (years)	-0.23	0.27	0.408	-0.30	0.25	0.240	0.13	0.14	0.325
Gender (female)	7.75	7.49	0.301	0.20	5.68	0.972	-3.96	3.16	0.210
Cancer Stage (advanced)	2.09	5.91	0.724	2.90	5.47	0.596	-0.55	3.01	0.855
Depressive Symptoms	-0.15	0.26	0.564	-0.13	0.29	0.663	-0.34	0.16	0.035
Attachment Orientations									
Security	-22.19	8.00	0.006	-15.13	9.53	0.113	2.70	5.37	0.616
Anxiety	13.38	12.14	0.270	3.32	5.99	0.579	0.77	3.28	0.815
Avoidance	-22.30	8.65	0.009	-15.64	8.52	0.066	3.85	4.89	0.431

	Variation SOL			**Variation WASO**			**Variation SE**		
	B	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*
Covariates									
Age (years)	-0.46	0.16	0.004	0.01	0.25	0.963	-0.01	0.09	0.863
Gender (female)	6.72	3.72	0.071	9.26	7.85	0.238	0.79	1.58	0.619
Cancer Stage (advanced)	0.31	2.04	0.878	5.22	5.26	0.321	0.03	1.43	0.986
Depressive Symptoms	-0.04	0.10	0.696	<0.01	0.23	0.993	0.22	0.08	0.007
Attachment Orientations									
Security	-1.65	6.14	0.788	-3.04	5.40	0.574	-1.59	3.16	0.614
Anxiety	-1.14	3.80	0.764	-3.95	7.42	0.594	-1.39	3.02	0.646
Avoidance	-3.46	4.88	0.478	0.98	9.20	0.915	-2.11	3.42	0.536

* adjusted $p < 0.008$ indicates alpha level .05 or less.

Note: Gender: female = 1, male = 0; Cancer stage: advanced = 1, non-advanced = 0; SOL = sleep onset latency, WASO = waking after sleep onset, SE = sleep efficiency