



Published in final edited form as:

Clin Psychol Rev. 2018 February ; 59: 118–125. doi:10.1016/j.cpr.2017.11.005.

Insomnia in United States Military Veterans: An Integrated Theoretical Model

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Abstract

Marked by difficulty falling or staying asleep and/or poor sleep leading to daytime dysfunction, insomnia contributes to functional impairment, poor health, and increased healthcare utilization when left untreated. As many as two-thirds of Iraq and Afghanistan military veterans complain of insomnia. Older veterans of prior conflicts report insomnia occurring since initial service, suggesting a chronic nature to insomnia in this population. Despite insomnia's high prevalence and severe consequences, there is no theoretical model to explain either the onset or chronicity of insomnia in this growing patient population. Existing theories view insomnia as an acute, unidirectional phenomenon and do little to elucidate long-term consequences of such problems. Existing theories also fail to address mechanisms by which acute insomnia becomes chronic. This paper presents an original, integrated theoretical model that draws upon constructs from several prominent behavioral medicine theories to reconceptualize insomnia as a chronic, cyclical problem

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Author Disclosure Information

The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the United States government.

Contributors

Dr. Hughes developed the first draft of the conceptual model and wrote the first draft of the manuscript. Drs. Ulmer, Gierisch, Hastings, and Howard served as theoretical consultants during the development of the conceptual model and assisted with review and editing of the final manuscript. All authors have contributed to and have approved the final manuscript.

Conflict of Interest

The authors have no conflicts of interest to disclose.

that is both a consequence and predictor of stress. Additional research examining the relationships between stress, sleep, resilience, and outcomes of interest could inform clinical and research practices. Addressing sleep problems early could potentially enhance adaptive capacity, thereby reducing the risk for subsequent negative outcomes.

Keywords

insomnia; sleep; stress; coping; resilience; veterans

Sleep is a basic biological need responsible for a range of restorative functions including emotion regulation and memory consolidation, muscle and tissue repair, and stress hormone regulation (Dement & Vaughan, 1999). Despite its necessity, sleep is often ignored as a core health behavior, rarely addressed within biopsychosocial assessments or routine primary care visits, and generally not integrated into chronic disease management programs. Sleep problems are particularly common among United States military veterans, with one-half to two-thirds of the 2.5 million U.S. military troops who served in Afghanistan (Operation Enduring Freedom, OEF) and Iraq (Operation Iraqi Freedom, OIF) complain of insomnia problems on returning home (Amin, Parisi, Gold, & Gold, 2010; Seelig et al., 2011). Insomnia complaints are also prevalent among veterans of earlier wars, including Vietnam and Korea conflicts. Additionally, many of these older veterans report that sleep problems initially began during or immediately following their military service and have persisted in the decades since separating from the military (Hughes & Martin, 2015; Ryden et al., 2015).

These findings suggest insomnia problems are chronic within veteran populations; yet, a lack of longitudinal data prohibits researchers from identifying mechanisms that contribute to such chronicity and from understanding how such problems change over a veteran's life course. Given sleep problems are tied to a number of negative physical and psychological outcomes (Fernandez-Mendoza & Vgontzas, 2013), it is critical that researchers and clinicians develop a better understanding of this growing problem. The overarching goal of this paper is to offer a theoretical model of insomnia in the veteran population. Although this model can be applied to veterans of all ages and military cohorts, a major goal of the model is to place insomnia-like sleep problems of returning OEF/OIF veterans into a larger, lifespan context as a means of advocating for additional research on the role sleep problems may play in longterm health and aging. While military-specific stressors will be addressed, we believe that elements of this integrated model can be applied to other patient populations, including those who have experienced significant stress or trauma.

Insomnia in Military Veterans

Chronic Insomnia Disorder is a common behavioral sleep disorder clinically defined as dissatisfaction with sleep quantity or quality marked by complaints of difficulty falling or staying asleep, waking up earlier than desired, or sleep that is non-restorative and the cause of significant daytime impairment. Such problems are not related to other medical or sleep disorders, exist despite adequate opportunity and environment for sleep, and are endorsed three or more nights per week for three months or longer (American Psychiatric Association, 2013). Insomnia and/or insomnia-like symptoms are present in 27–54% of military

personnel and veterans (Hoge, W. et al., 2008; Mysliwec, McGraw, Smith, Trapp, & Roth, 2013), rates that are two to three times higher than in the general U.S. adult population (Ford, Cunningham, Giles, & Croft, 2015; Roth, 2007). The rate of incident insomnia cases in military personnel saw a 19-fold increase from 2000 to 2009 (Mysliwec et al., 2013). The prevalence of insomnia among Veterans Health Administration (VHA) users is expected to continue to rise as many troops who served after September 11, 2001 continue to retire from military service and begin accessing VHA healthcare in the coming years (Campbell, Shattuck, Germain, & Mysliwec, 2015).

Risk Factors

Both modifiable and non-modifiable risk factors contribute to insomnia. This paper addresses the role of stress regulation and coping in sleep problems with a behavioral etiology. Insomnia-like sleep problems may be a function of an individual's stress response whereby poor sleep is a function of inadequate coping and/or poor regulation of stress across physiological, cognitive, and/or emotional processes. In this context, stress refers to any event or stimulus that causes a disruption in balance, or homeostasis. Laboratory studies indicate that higher baseline levels of stress reactivity are associated with insomnia and predict future cases of the disorder (Drake, Friedman, Wright, & Roth, 2011; Drake, Richardson, Roerhs, Scofield, & Roth, 2004). In addition, individuals with insomnia have been shown to report experiencing more daily stressors and negatively evaluating such stressors (Morin & Ivers, 2003).

Initial military involvement, including enlistment and basic training, present a range of different stressors and often trigger sleep disturbance due to irregular schedules and ongoing physical, social, and emotional demands (Peterson, Goodie, Satterfield, & Brim, 2008). Deployment to a war region typically requires several days of laborious travel and crossing of multiple time zones that can disrupt one's natural circadian rhythm, or sleep schedule, and trigger sleep difficulties (Troxel et al., 2015). Deployment typically involves irregular work schedules, overnight watch demands, exposure to warzone and combat-related stressors, and risk of physical and psychological injury, including traumatic brain injury. While no research has formally documented the cause, or trajectory, of insomnia in military personnel, it is likely that one or more of the aforementioned factors served as an initial trigger of insomnia symptoms.

Recent research has focused on sleep problems among active duty military personnel, including increasing rates of incident insomnia and sleep apnea diagnoses (Mysliwec et al., 2013), heightened mental health risks associated with insomnia symptoms (Gehrman et al., 2013), and the link between sleep and impaired work performance (Seelig et al., 2016; Troxel et al., 2015). Less research has focused on sleep after military retirement. Stressors related to military separation, or retirement, and reintegration into civilian life can also trigger insomnia (Bramoweth & Germain, 2013). Additionally, many service members experience an inability to return to a "normal" sleep schedule after experiencing short sleep duration or irregular schedules while deployed (Castro, Kintzle, & Hassan, 2015; Haynes, Parthasarathy, Bootzin, & Krakow, 2013). Additional reintegration-related stressors include readjustment to family and social circles, securing civilian employment, maintaining

financial stability, and living with the physical and psychiatric comorbidities caused by deployment or combat-related stressors. These stressors can cause difficulty falling or staying asleep, or sleep that is restless and disturbed, thereby creating new sleep problems or exacerbating existing problems that began prior to or during deployment.

Consequences of Insomnia

Persistent insomnia can lead to poor health outcomes and chronic conditions (Fernandez-Mendoza & Vgontzas, 2013; Taylor et al., 2007), exacerbate symptoms of traumatic brain injury (Macera, Aralis, Rauch, & MacGregor, 2013), reduce overall quality-of-life (Katz & McHorney, 2002), and increase risk for morbidity and premature mortality (Dew et al., 2003; Kripke, Garfinkel, Wingard, Klauber, & Marler, 2002). Chronic sleep problems can also negatively impact day-to-day outcomes including task performance (Pilcher & Huffcutt, 1996), stress coping (Hamilton, Delwyn, & Karlson, 2007), and management of chronic health conditions (Ahn, Jiang, Smith, & Ory, 2014).

Function, Performance and Health Management—Chronic insomnia impairs function and performance across cognitive, emotional, social, and physical domains (Killgore, Balkin, & Westenstein, 2006; Killgore et al., 2008; Pilcher & Huffcutt, 1996). Adequate functioning in these areas enables veterans to adapt to and cope with daily hassles and reintegration stressors noted earlier. However, impairments in one or more domains can reduce ability to cope with acute and ongoing stressors. As a result, functional performance and independence decline, thereby decreasing the likelihood of successful reintegration into civilian life (Institute of Medicine, 2013; Pilcher & Huffcutt, 1996).

Many of these aforementioned impairments can also reduce a veteran's capacity to cope with health-related stressors, a concept of particular interest to clinicians and health services researchers within the VHA. Medically complex patients, defined as individuals with two or more chronic conditions, who are challenged by managing such conditions (Shippee, Shah, May, Mair, & Montori, 2012), represent a growing subgroup of veterans utilizing VHA healthcare (Yoon, Schott, Phibbs, & Wagner, 2011; Yu et al., 2003). Medical complexity is often marked by a cycle of ongoing acute and chronic health-related stressors. Patients cycle through these stressors and strive to achieve and maintain a balance between workload demands (i.e. management of chronic diseases) and physical and psychological resources (Zullig et al., 2016). Successful balance and management of stressors is bolstered by high physical and psychological reserve and capacity (Zullig et al., 2016). These new models of complexity support the idea that capacity is malleable and can be impacted by resources, behaviors, and events on individual and community levels. Although sleep problems, including insomnia, are gaining more attention within the VHA, sleep patterns and behaviors are not explicitly addressed in these models.

Mental Health—Insomnia symptoms are common among veterans with mental health disorders. In one study, more than three-quarters reported difficulty falling or staying asleep and just over one-half reported being at least moderately distressed about sleep that was restless or disturbed (Ulmer et al., 2015). Although this research sample was designed to over-recruit veterans with mental health symptoms, this same study drew attention to the

notably high prevalence of sleep difficulties in veterans without a mental health diagnosis, including approximately seventy percent who met clinical criteria for poor sleep quality, defined as a score of five or greater on the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989).

The high rate of sleep problems among veterans without mental health diagnoses is alarming given that research with veteran and non-veteran populations has found that chronic sleep problems predict incident mental health diagnoses (Baglioni et al., 2011; Breslau, Roth, Rosenthal, & Andreski, 1996; D. Ford & Kamerow, 1989; Perlis et al., 2006) and suicidal ideation (Pigeon, Britton, Ilgen, Chapman, & Conner, 2013; Pigeon, Pinquart, & Connor, 2012) as well as persistence of existing mental health problems, including depression (Pigeon, Unutzer, & Perlis, 2008), and increased risk for readmission to a partial hospitalization psychiatry program (Koffel, Thuras, Chakravorty, Germain, & Khawakaja, 2015). In a large study of OEF/OIF service members, researchers found that military personnel with predeployment insomnia symptoms had greater odds of developing depression, anxiety, and PTSD at follow-up (Gehrman et al., 2013). Another longitudinal study found that insomnia measured at four months post-deployment was a significant predictor of depression and PTSD at 12-months post-deployment (Wright et al., 2011).

While it is too early to examine the long-term effects of military service on OEF/OIF service members' health, a great deal can be learned from studying the aging trajectories of veterans from earlier conflicts, including the Vietnam War. By better understanding how early or mid-life military service contributed to long-term outcomes in these cohorts, researchers and clinicians can develop new practices that can be translated into more effective and preventive-oriented care for veterans of more recent conflicts (Marmar, 2009). For example, nearly 40 years after the conclusion of the Vietnam War, Marmar and colleagues (2015) noted that lifetime and current diagnoses of PTSD and major depression were prevalent among veterans.

PTSD has been linked to increased healthcare utilization and costs in veterans of recent and earlier war conflicts (E. Hoge, Austin, & Pollack, 2007; Schnurr, Spiro III, & Paris, 2000). A growing line of research suggests that some veterans involved in earlier war conflicts experience premature functional decline and accelerated aging (Lohr et al., 2015; Wolf et al., 2016) as a result of service-related experiences and injuries, including PTSD. Much of this research points to the detrimental effects of PTSD, yet little research has isolated mechanisms that link early or mid-life military experiences to PTSD and subsequent decline. While sleep problems were not measured directly in the aforementioned studies, sleep problems are a core component of PTSD diagnostic criteria (American Psychiatric Association, 2013). Given this common symptom pattern, it is possible that untreated sleep problems of Vietnam Era veterans partially contributed to mid- or late-life PTSD. However, the lack of longitudinal data and absence of sleep questionnaires in this data prevent this hypothesis from being confirmed. The model presented here illustrates one potential pathway through which early life trauma and insomnia problems may impact mid- or late-life physical and mental health.

Insomnia and Resilience as Missing Links between Military Service and Poor Outcomes

Insomnia problems contribute to negative health outcomes and can become chronic, surfacing repeatedly over one's life course. However, mechanisms contributing to this chronicity have not been identified. The mechanisms linking sleep problems, including insomnia, to new mental health diagnoses remain unclear. However, one hypothesized explanation is that chronic poor sleep reduces one's coping abilities. As a result, when subsequent stressors do arise, individuals with sleep problems respond with reduced coping abilities (Gehrman et al., 2013). A reduced capacity to positively cope with stress may lead to a more negative stress outcome, such as PTSD (Benight & Bandura, 2004).

Researchers studying active duty military and veteran populations have a growing interest in resilience and its role in everything from operational readiness during deployment period to mental health and readjustment in the post-deployment period (Seelig et al., 2016; Stanley, Schaldach, Kiyonga, & Jha, 2011; Troxel et al., 2015; Young-McCaughan, Peterson, & Bingham, 2011). A recent RAND report suggested that healthy sleep is critical to resilience, operationalized as service members' performance and operational readiness, during deployment (Troxel et al., 2015). Despite this growing interest, no consensus definition of resilience has been established nor have any theories describing the relationship between sleep, resilience, and health outcomes been proposed or tested. Further, most research has focused on active duty service members with a paucity of research on the role resilience, particularly when defined as a psychological construct rather than mere outcome, might play in sleep problems among veterans.

Much of the early resilience research was rooted in developmental psychology where researchers largely focused on resilience as a positive outcome in children who had experienced early-life stress or adversity (Garmezy, 1971; Werner, 1995). However, much of this early research only examined major life events or stressors and failed to recognize how daily stressors or hassles, such as strains related to social, occupational, or financial hardships, impact resilience. Much of the stress and coping literature suggests that the cumulative impact of daily hassles is more stressful and more detrimental to an individual's overall psychological and physical health (Charles, Piazza, Mogle, Sliwinski, & Almeida, 2013; DeLongis, Coyne, Dakof, Folkman, & Lazarus, 1982) compared to major life events. Additionally, early resilience research ignored the concept of stress proliferation, or the idea that "stress begets stress," meaning that individuals who experience major life stressors are more susceptible to experiencing the effects of subsequent stressors (Pearlin, Schieman, Fazio, & Meersman, 2005; Pearlin & Skaff, 1996). As suggested earlier, veterans may face a series of stressors during the re-integration period. While not empirically tested to date, it is likely that daily hassles outnumber major life events and that many of these hassles contribute to stress-induced sleep problems, including insomnia. Furthermore, bouts of insomnia may also act as daily hassles in which the cumulative effects of these repeated bouts trigger additional stress and resulting sleep problems.

More contemporary approaches recognize resilience as a dynamic, multilevel, and multicomponent capacity for adapting to stress (Masten, 2001, 2007). This capacity draws on adaptive processes and abilities across behavioral, physiological and psychological systems. Modern conceptualizations of resilience also emphasize the role of health behaviors

including sleep, diet, and physical activity as important contributors to enhancing one's resilience (Southwick, Bonnano, Masten, Panter-Brick, & Yehuda, 2014). By focusing on health behaviors, contemporary research emphasizes the importance of going "upstream" of resilience and working to identify pertinent mechanisms, such as modifiable health behaviors, that can enhance or degrade resilience.

Integrated Theoretical Model

The discussions above suggest that the causes and consequences of insomnia in U.S. military veterans are complex and that sleep may play an important role in longterm mental and physical health. Below, we present an innovative integrated theoretical model that could be used to better understand the growing problem of insomnia among military veterans. This model builds on the 3P Model of Insomnia (Spielman & Glovinsky, 1991). Widely used in clinical assessment and interventions, the 3P Model provides a framework for understanding insomnia through three interrelated, sequential factors – predisposing, precipitating, and perpetuating (see Figure 1). These factors encompass genetic, constitutional, environmental, experiential, and behavioral contributors to sleep problems, respectively. The interaction between and progression across the three factors ("3Ps") transform acute insomnia symptoms into a chronic insomnia disorder.

Although widely regarded as the leading explanatory model of insomnia, the 3P Model could benefit from several additions which are addressed in the remainder of the paper. Our integrated model offers a more thorough understanding of insomnia by exploring the following additions. First, the model provides greater clarification of the mechanisms operating within each of the three factors. Second, unlike the 3P Model that conceptualizes insomnia and sleep problems as a consequence of a stressful event, this model recognizes sleep problems as both a stress response (consequence) and an independent stressor (predictor) that may trigger additional, negative reactions. Third, this model explores both short- and long-term consequences of insomnia, acknowledging its potential effects of insomnia on physiological, psychosocial, and cognitive domains. Finally, this model includes a dimension of time which may encourage additional studying of long-term consequences of sleep, including consideration of stress proliferation and cyclical patterns of increased stress, poor sleep, and negative outcomes that some veterans experience, including those of earlier wars.

The primary aim of the integrated theoretical model presented here (Figure 2) is to encourage a broader conceptualization of insomnia problems in U.S. military veterans. The proposed model integrates and expands upon the three major components of the 3P Model: predisposing (Boxes 1 and 2), precipitating (Box 3), and perpetuating (Box 10) factors. Drawing on constructs from several key behavioral medicine theories (see Figure 1), the model depicts potential mechanisms by which a stressful event (Box 3) contributes to insomnia problems (Box 11), impaired function (Box 12), reduced resilience (Box 13), and poor health outcomes (Box 14). Unlike existing theories that assume only a unidirectional relationship between stressful events and insomnia, our model proposes that insomnia is cyclical in nature. Here, insomnia is a consequence of stress *and* a predictor of additional stress. Insomnia impairs function, which reduces adaptive capacity, thereby increasing one's

risk for subsequent stressful events. Thus, the cycle begins anew, potentially triggering what will become a chronic problem (Pathways U and V). As shown, this model places a particular emphasis on the consequences of chronic, untreated insomnia.

Predisposing factors

Predisposing factors of insomnia refer to modifiable and non-modifiable factors such as a genetic, biological, or psychological vulnerability to stress and/or chronic health problems. The diathesis-stress model suggests individuals possess a diathesis, or predisposing characteristic(s), that increase vulnerability to a negative stress response or outcome (Monroe & Simons, 1991). Such characteristics include genetic risk factors, sociodemographic factors, early trauma, personality traits, and biobehavioral developmental factors including neurological and cognitive functioning. Of note, adverse childhood experiences, including exposure to domestic violence, parental separation or divorce, and emotional or physical abuse, are more common among military servicemembers compared to non-servicemembers (Blosnich, Dichter, Cerulli, Batten, & Bossarte, 2014). Not only are early life events associated with poor physical and mental health outcomes in adulthood (Cabrera, Hoge, Bliese, Castro, & Messer, 2007), they may increase susceptibility to additional stressors, as described in above explanations of stress proliferation. When confronted with subsequent military or non-military stressors (Box 3), both early life events and personal characteristics may increase an individual's risk for negative outcomes.

In addition, the theory of sleep-related stress reactivity posits that individuals with high levels of baseline stress reactivity (i.e., higher basal cortisol levels and more negative/ anxious psychological dispositions) have greater susceptibility to developing insomnia (Box 2) (Drake, Pillai, & Roth, 2014). High sleep-related stress reactivity is positively associated with stress susceptibility and heightened responses across physiological and psychological domains. Stress reactivity is marked by a hyperactive adrenal system (i.e., elevated levels of stress and adrenal hormones) and poor emotional and cognitive regulation, which are manifested in an inability to sleep in a high stress situation (Drake et al., 2004; Harvey, Tang, & Browning, 2005; Perlis, Giles, Mendelson, Bootzin, & Wyatt, 1997). This diathesis, or predisposition to a negative outcome (Box 2), then interacts with a personal or environmental stressor such as military deployment, retirement, or reintegration-related challenges (Box 3) to trigger a stress response, as suggested by the Diathesis-Stress Model (Monroe & Simons, 1991).

Precipitating factors

Precipitating factors represent major life or environmental stressors that trigger insomnia-like sleep problems. As addressed above, it is the interaction between predisposing factors, or diathesis, and an environmental stressor or event (precipitating factor) that triggers a stress response (Monroe & Simons, 1991). Multiple predisposing and precipitating factors can occur sequentially or simultaneously. For some veterans, deployment-related stressors (i.e. combat exposure, service-related injury) may trigger insomnia symptoms, whereas for others, stressors related to military retirement and civilian reintegration (i.e. family obligations, occupational or financial stress, injury and/or rehabilitation challenges) may initiate these symptoms. Additionally, some veterans may experience one major stressor, or

precipitating factor, while others may experience a series, of smaller, daily stressors. It is this accumulation of stressors that serves as the precipitating event for insomnia.

In addition to the interaction noted above, Lazarus and Folkman's Transactional Model of Stress and Coping (Glanz & Schwartz, 2008) builds on the diathesis-stress model to suggest that a stress response depends on a "transaction," or interaction, between the individual and environment. This model emphasizes that an individual's appraisal of a stressor (i.e., precipitating event) vis-à-vis susceptibility and severity (primary appraisal) (Box 4), and perceived ability to cope with a stressor (self-efficacy) (secondary appraisal) (Box 5), directly influence the coping efforts and behaviors he or she chooses to enact (Box 8). These processes are moderated by dispositional coping style (Box 7) and degree of social support (Box 6) and mediated by coping efforts, including the use of problem- or emotion-focused strategies (Box 7). For example, some veterans who perceive military culture as discouraging stress disclosure and/or that military status artificially protects against negative outcomes (Box 4) may be less likely to disclose having experienced a stressful event and therefore less likely to seek help (Box 8). Other veterans may perceive re-integration to be stressful and a trigger for other negative outcomes (i.e. additional family or occupational stress). However, if these individuals do not have strong self-efficacy, social support or coping skills, they may be less likely to seek help for stress-induced insomnia problems (Boxes 8 and 9), and, as a result, experience significant insomnia problems and related consequences. Additional factors may also impact an individual's decision to seek care, including the availability of and access to trained sleep specialists, prior experiences with sleep or other behavioral treatments, and personal treatment preferences.

Perpetuating factors

Acute insomnia problems become chronic through a combination of the perpetuation of unhealthy sleep behaviors and the conditioned arousal resulting from an inability to achieve and/or maintain sleep and the consequential shift in sleep patterns (Pathway O). Perpetuating factors represent unhealthy sleep behaviors used to cope with poor sleep, including following an irregular sleep schedule, spending excessive time in bed even when not sleeping, or increasing alcohol or caffeine intake to either induce sleep or wakefulness, respectively (Box 10) (Morin, 1993; Morin et al., 2006). In line with the constructs of the Transactional Model of Stress and Coping (Glanz & Schwartz, 2008), positive coping efforts reduce insomnia symptoms while negative coping efforts, including those listed above, exacerbate symptoms of poor sleep. Many of these behaviors, including spending time in bed while not sleeping or attaching negative cognitions to an inability to sleep, generate feelings of frustration, fatigue, and anxiety, each of which becomes paired, or conditioned, with the bed and bedroom. Over time, these negative thoughts and behaviors reinforce an inability to initiate and maintain quality, uninterrupted sleep. Such negative associations and reinforcement demonstrate core characteristics of classical and operant conditioning, respectively (Perlis et al., 1997).

Bandura's Social Cognitive Theory (McAlister, Perry, & Parcel, 2008) highlights several constructs central to health behavior and health promotion. When applied to sleep, these constructs aid in further explaining the mechanisms of Spielman's perpetuating factors

(Spielman & Glovinsky, 1991), particularly how cognitions co-occurring with unhealthy sleep behaviors become associated with sleep. First, reciprocal determinism suggests that unhealthy sleep behaviors and a poor sleep environment are bidirectional, constantly influencing and reinforcing one another. Second, prolonged unhealthy behaviors diminish an individual's capacity for self-regulation and self-efficacy for maintaining healthy, restorative sleep behaviors. Finally, chronic problems and frustration associated with not being able to sleep condition an individual's sleep-related outcome expectations to be negative rather than positive. Negative expectations can discourage an individual from reducing unhealthy, maladaptive behaviors in favor of healthier coping strategies.

Proliferation of Sleep Problems

While the 3P Model of Insomnia provides a larger framework for understanding risk, development, and continuation of insomnia, it was not originally designed to address consequences of unresolved or residual sleep problems. The 3P Model suggests insomnia is experienced in a unidirectional, linear fashion and assumes that insomnia is resolved by treating perpetuating factors. Future studies of insomnia, including new iterations of the 3P model, could benefit from a more longitudinal approach. Such an approach should be applied to both epidemiological studies examining trajectories of insomnia and to treatment studies.

Cognitive Behavioral Therapy for Insomnia (CBT-I) is the recommended first-line treatment for insomnia (National Institutes of Health, 2005; Qaseem et al., 2016). CBT-I targets perpetuating factors of insomnia (as shown in Box 10), including unhealthy behaviors and cognitions, and is effective in the short term (12–18 months) (Morin et al., 2006). CBT-I and other behavioral treatments have been shown to effectively reduce insomnia symptoms and severity in veterans (Germain, Shear, Hall, & Buysse, 2007; Karlin, Trockel, Spira, Taylor, & Manber, 2015; Trockel, Karlin, Taylor, & Manber, 2014). However, some veterans continue to have either subthreshold or clinically significant symptoms following treatment (Trockel et al., 2014). The lack of long-term follow-up (i.e. beyond 6 or 12 months after treatment completion) makes it difficult to gauge the longterm trajectories of these individuals and the number who experience future bouts of insomnia. It is unclear whether these residual problems resulted from lack of sufficient follow-up (i.e. participants need additional time to adjust to a new sleep schedule and experience full treatment effects) or whether existing interventions could benefit from one or more revisions (i.e. booster sessions, general coping strategies, or tips for managing high stress reactivity). Additionally, veterans may experience an additional stressor that triggers insomnia after completing a course of CBT-I treatment. Additional research is needed to examine the extent to which prior CBT-I treatment remains effective after experiencing subsequent stressors.

One possible explanation for the chronicity of sleep problems is impaired and/or reduced coping capacity. As addressed in the first portion of this paper, poor sleep contributes to impaired cognitive and functional performance (Box 12). In line with these findings and laboratory studies demonstrating impaired performance following sleep deprivation, it is hypothesized that reduced function resulting from chronic sleep problems also negatively impact an individual's reserve or adaptive capacity to respond to subsequent stressors (Box

12). This prediction is in line with health-related definitions of resilience, defined as a dynamic process of physiological and psychological adaptation to acute and chronic stress (Irwin, 2014; Lavretsky, 2014). Over time, chronic sleep problems, particularly sleep deprivation, lead to an ever-increasing allostatic load on physiological and psychological systems (McEwen, 2006; McEwen & Karatsoseso, 2015), thus contributing to excessive “wear and tear” on the body (Seeman, Singer, Rowe, Horwitz, & McEwen, 1997). Increasing allostatic load reduces the likelihood that an individual is able to successfully respond to or cope with subsequent stressors (Juster, McEwen, & Lupien, 2010; McEwen & Karatsoseso, 2015). This reduced stress capacity then contributes to poor physical and psychological health outcomes (Box 14).

There may be benefits to future research examining how impaired coping capacity may interact with high levels of stress reactivity, and what impact this combination of factors may have on future bouts, or relapses, of insomnia. If such an interaction is present, it may be that innovative hybrid interventions, such as those informed by principles of CBT-I and Mindfulness Based Stress Reduction (MBSR) may be effective in targeting both unhealthy sleep behaviors and underlying stress reactivity. MBSR has been shown to reduce physiological and psychological stress reactivity (Sharma & Rush, 2014) and an initial test of one such hybrid program, Mindfulness Based Therapy for Insomnia, which combines principles of CBT-I and MBSR, demonstrated promising results in reducing severity of insomnia symptoms (Ong et al., 2014). Although CBT-I curriculum teaches sleep-related coping strategies, it does not include more general stress and coping strategies. Integrating some of these strategies into behavioral sleep treatments may improve long-term coping and help reduce the likelihood of chronic insomnia.

Future directions

The proposed theoretical model highlights the etiological and clinical complexity of insomnia in U.S. military veterans, placing a particular emphasis on untreated insomnia problems. Severe sleep problems, such as insomnia, might occur at one point in time, typically triggered by a major life or environmental stressor, but their antecedents are found early in life and their consequences can extend for years or decades beyond the triggering stressful event(s). The model presented herein is meant to encourage researchers and clinicians to apply lifespan models to the problems of stress, insomnia, and health outcomes in veterans. While longitudinal data collection is time and resource intensive, such information would allow researchers to better understand the temporal nature and interrelationships between stressful events, sleep problems, and negative physical and psychological outcomes. Although not shown in this model, insomnia may co-occur with other sleep disorders, including sleep disordered breathing, restless leg syndrome, and chronic nightmares. Future iterations of the model should take a holistic approach to sleep and acknowledge these other common sleep disorders.

Sleep problems, particularly insomnia, are often assumed to be an acute consequence of deployment or reintegration. However, this model highlights the potential cyclical nature of insomnia, noting that chronic problems can deleteriously impact veterans’ long-term health and function. This model also highlights the importance of studying major life events and

daily stressors as both predictors and consequences of insomnia problems. Finally, as alluded to above, sleep and resilience are likely important yet under-studied mechanisms in veterans' long-term health. Additional research focusing on the multidimensional nature of resilience, including how physiological and psychological adaptive capacities contribute to an individual's stress response, is warranted. Future research examining these relationships and mechanisms could prove fruitful in both clinical and research settings, particularly as an increasing number of OEF/OIF veterans retire from military service and begin to utilize both VA and community healthcare services. As our theoretical model suggests, addressing sleep problems early could potentially enhance a veteran's adaptive capacity, thereby reducing the risk for negative physical and psychological outcomes across the lifespan. Finally, the constructs and mechanism outlined in this particular model may have application to non-veterans, including individuals who have experienced a significant life stressor or traumatic event. Future iterations of the model should highlight the mechanisms of insomnia and comorbid mental and physical health conditions.

Acknowledgments

The authors wish to thank Wizdom Powell, PhD, MPH who provided comments on an initial version of the conceptual model and manuscript.

Role of Funding Sources

This work was supported by facilities and resources at the Center of Innovation for Health Services Research in Primary Care at the Durham VAMC (CIN 13-410); Office of Academic Affiliations, VA Health Services Research & Development (TPH 21-000), and University of North Carolina Program on Integrative Medicine (Hughes: NIH/NCCIH T32AT003378). None of the funding sources had a role in developing this material, writing the manuscript, or the decision to submit the paper for publication.

Abbreviations

VHA	Veterans Health Administration
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
PTSD	Post-traumatic Stress Disorder
CBT-I	Cognitive Behavioral Therapy for Insomnia

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Highlights

- Chronic insomnia problems are highly prevalent among US military Veterans
- Existing theoretical models view insomnia as a unidirectional phenomenon
- An integrated model is proposed that explains insomnia as a chronic, cyclical problem
- Insomnia should be viewed as a both a consequence and predictor of stress

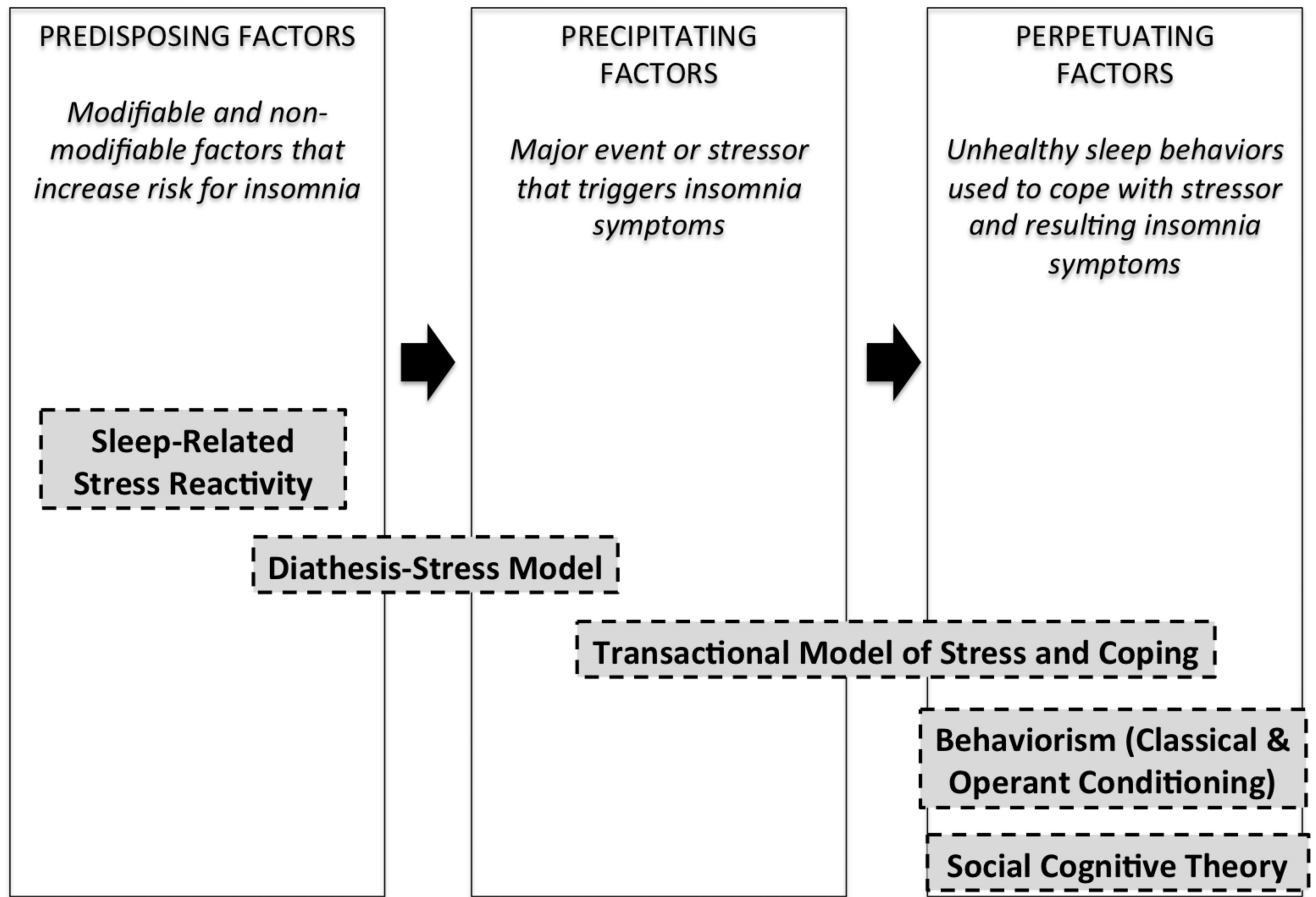


Figure 1. 3P Model of Insomnia: Original Framework and Integrated Theories

Description: This model displays the three factors of the 3P Model of Insomnia – predisposing, precipitating, and perpetuating – as well as the series of behavioral health theories that are used to further describe these three factors.

Footnote: **NOTE: Original factors of 3P model enclosed in boxes outlined in solid lines.*

Authors’ original integration are indicated by dashed lines. The additions to this model are meant to highlight mechanisms responsible for each of the three factors and to demonstrate the overlap between and transition from one factor to the next.

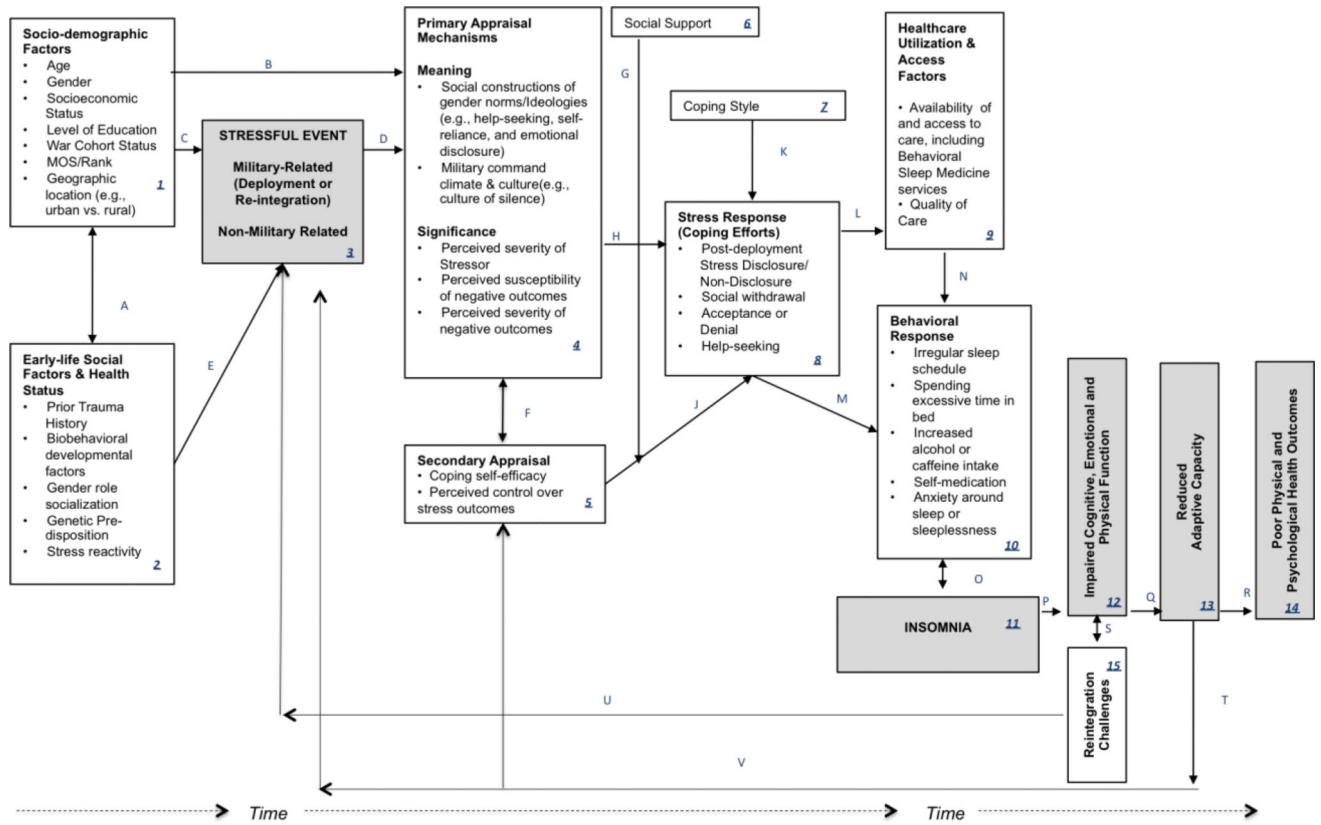


Figure 2. Integrated Theoretical Model of Insomnia Problems in US Military Veterans
 Description: This figure displays an integrated conceptual model of insomnia. This model utilizes constructs from various behavioral health theories to illustrate the cyclical nature of insomnia in United States military Veterans.