SLEEP PROBLEMS IN UNITED STATES MILITARY VETERANS

Jaime M. Hughes

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Approved by:

Matthew O. Howard

Sarah E. Bledsoe

Jennifer M. Gierisch

Kirsten L. Kainz

Christi S. Ulmer

ABSTRACT

Jaime M. Hughes: Sleep Problems in United States Military Veterans
(Under the direction of Matthew Howard)

Approximately two-thirds of United States military Veterans who served in Iraq or Afghanistan report sleep problems. Left untreated, sleep problems may contribute to incident mental health disorders. This three-paper dissertation aimed to fill three gaps in existing literature and clinical practice through the following contributions: the introduction of a prospective, long-term model of insomnia; examination of the relationship between poor sleep, resilience, and psychological distress; and the evaluation of single-item screeners to identify sleep disturbance.

Through the presentation of an integrated theoretical model, Paper One addressed gaps in existing theory by examining short and long-term consequences of insomnia-like symptoms and advocating for a reconceptualization of sleep problems as chronic and cyclical rather than an acute, unidirectional problem. Papers Two and Three utilized a large research registry of Veterans with at least one overseas deployment to Iraq or Afghanistan and who were free of a past-month DSM-defined mental health disorder at the time of the interview (N=1,118). Paper Two utilized hierarchical linear regression and moderation analyses to explore the relationship between poor sleep, resilience factors and psychological distress. Controlling for demographic, health, and military characteristics, poor sleep explained an additional 16% of the variance in psychological distress. The relationship between poor sleep and psychological distress was moderated by two psychological resilience factors – adaptability and self-efficacy.

Paper Three examined the utility of single-item sleep measures commonly embedded in existing psychological assessments. Three commonly used items, trouble falling asleep, awakening in the early morning, and sleep that is restless and disturbed, demonstrated moderate sensitivity and specificity in predicting poor sleep. Initial findings suggest that Veterans who report sleep problems as a little distressing (response score $\geq$ 1) may benefit from additional sleep assessment.

Together, these three dissertation papers highlighted the importance of screening and treating sleep problems in U.S. military Veterans early in their course as a potential means for reducing risk for incident mental health disorders and other negative consequences. In addition, these three papers built a foundation for future longitudinal studies which may help elucidate the mechanisms through which sleep problems become chronic and/or contribute to mental health disorders.

To my late grandparents –
Jane and Jule Ward, whose commitment to education made much of my graduate work in both
Ann Arbor and Chapel Hill possible;
and,
Gloria Hughes, whose health and spirit through her last days will continue to be an inspiration
for my work in geriatrics and my tireless pursuit to promote healthy aging.

Most importantly, to all three –
May their education around love, laughter, and family always remain
the greatest lessons of them all.

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PREFACE

The views expressed here are those of the author and do not necessarily represent the views of the Department of Veterans Affairs.

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LIST OF ABBREVIATIONS

AUC   Area Under the Curve

BDI   Beck Depression Inventory

CD-RISC Connor-Davidson Resilience Scale

CES   Combat Exposure Scale

DSM   The Diagnostic and Statistical Manual of Mental Disorders

GRECC Geriatric Research, Education, and Clinical Center

GSI   Global Severity Index

MIRECC Mental Illness Research, Education, and Clinical Center

N   Number

OEF   Operation Enduring Freedom (Afghanistan)

OIF   Operation Iraqi Freedom (Iraq)

PSQI   Pittsburgh Sleep Quality Index

PTSD   Posttraumatic Stress Disorder

SCID   Structured Clinical Interview for DSM-V Diagnostic Disorders

SCL-90 Symptom Checklist-90-Revised

SD   Standard Deviation

SE   Standard Error

U.S.   United States

VA   Veterans Affairs

VHA   Veterans Health Administration

INTRODUCTION

More than 2.5 million troops have been involved in U.S. military operations in Afghanistan (Operation Enduring Freedom, OEF) and Iraq (Operating Iraqi Freedom, OIF) (National Center for Veterans Analysis and Statistics, 2016). The travel, work, and safety demands experienced with deployment can disrupt an individual's natural sleep patterns and present multiple stressors that negatively impact sleep (Bramoweth & Germain, 2013; Troxel et al., 2015). Sleep problems, including insomnia-like symptoms, are reported by approximately two-thirds of OEF/OIF Veterans upon returning home (Amin, Parisi, Gold, & Gold, 2010; Plumb, Peachey, & Zelman, 2014; Seelig et al., 2011). Poor sleep can impair cognitive, physical, and emotional function (Killgore, Balkin, & Westensten, 2006; Killgore et al., 2008; Pilcher & Huffcutt, 1996), lead to greater healthcare utilization (Wickwire, Shaya, & Scharf, 2016), and increase risk for a number of negative physical and psychological health outcomes (Fernandez-Mendoza & Vgontzas, 2013; Taylor et al., 2007).

Much research and public media attention has been directed toward the high prevalence of mental health disorders in returning Veterans (Hoge, Auchterlonie, & Milliken, 2006; Hoge et al., 2004; Hoge et al., 2002; Riddle et al., 2007; Seal, Bertenthal, Miner, Saunak, & Marmar, 2007). Attention has also focused on the frequent co-occurrence of sleep problems with symptoms of PTSD and depression (Pigeon, Campbell, Possemato, & Ouimette, 2013; Wallace et al., 2011). However, several lines of research suggest that Veterans without a DSM-defined current (past-month) mental health disorder may represent an overlooked, high risk population

worthy of equal attention. First, research suggests the onset of mental health problems is often delayed among OEF/OIF Era Veterans returning home from deployments (Milliken, Auchterlonie, & Hoge, 2007; Vasterling et al., 2010). Second, chronic sleep problems are one factor known to increase risk for incident mental health problems (Breslau, Roth, Rosenthal, & Andreski, 1996; Ford & Kamerow, 1989; Perlis et al., 2006; Wright et al., 2011). Recent research by Ulmer et al. (2015) found that although sleep problems were more prevalent and more severe in OEF/OIF Veterans with a current mental health disorder, nearly sixty percent of Veterans without a current mental health symptoms also met criteria for clinically significant sleep disturbance.

These findings are corroborated by research suggesting that sleep (Hughes & Martin, 2015; Ryden et al., 2015) and mental health (Davison et al., 2006; Hoge et al., 2002; Jordan et al., 1991; Marmar et al., 2015) problems are frequently endorsed by Veterans of earlier service cohorts. Although a lack of longitudinal data has prevented researchers from isolating the mechanisms linking sleep problems to mental health problems in older Veterans, the notable prevalence of each suggests a potential chronicity to these problems. These findings suggest that early detection of sleep problems may serve as a viable strategy to prevent subsequent mental health problems.

Despite these trends, sleep remains overlooked as a health behavior. Sleep problems are rarely assessed as a part of biopsychosocial evaluations or chronic disease management programs. Informed by training and professional experiences in health services research, geriatric social work, and lifespan developmental psychology, this collection of dissertation papers addresses three major gaps in the sleep literature and clinical practice. These gaps were evident during my professional experience as a behavioral interventionist and research social

worker with the Geriatric Research, Education, and Clinical Center (GRECC) of the Los Angeles

Veterans Affairs (VA) Medical Center, participation in a multi-year national interdisciplinary

research network, "Lifespan Outcomes of Military Service" (NIA R24AG03943), and ongoing

collaborations with VA health services researchers focused on integrated primary care.

     Throughout these experiences, three major gaps were identified: (1) a lack of theoretical

models that conceptualize sleep problems as a chronic phenomenon and identify short- and long-

term consequences of such; (2) an absence of longitudinal studies needed to identify mechanisms

through which sleep problems contribute to incident mental health disorders; and (3) a lack of

brief measures to identify sleep problems in primary care VHA settings. Although much of the

professional work described above focused on older Veterans of earlier war cohorts, researchers

recognize the value of learning from today's aging Veterans to best treat OEF/OIF Veterans

(Marmar, 2009). Following a line of research suggesting that early or mid-life military

experience impacts Veterans' health and aging trajectories (Spiro III, Settersten, & Aldwin,

2016), there may be value in treating stress and sleep-related concerns of OEF/OIF Veterans

early as a means of preserving functional independence and optimizing healthy aging across the

lifespan. Given OEF/OIF Veterans have recently returned from overseas deployment and

continue to reintegrate into civilian society, the present time is ideal for establishing a "baseline"

understanding of physical and mental health characteristics that may be related to long-term

outcomes. Following the three paper model, this dissertation addresses the three gaps noted

above.

     Paper One offers an overview of sleep problems in U.S. military Veterans, including

prevalence rates, causes, and consequences. This paper utilizes the leading model of insomnia,

the 3P Model (Spielman & Glovinsky, 1991), as an overarching framework to explore short-

and long-term consequences of sleep problems through a new integrated theoretical model. This new model draws heavily upon the stress literature, noting that daily hassles and stressors related to reintegration may also impact sleep behaviors, adaptive capacity, and health outcomes. Overall, this paper advocates for a reconceptualization of insomnia-like sleep problems as a chronic, and frequently cyclical phenomenon, rather than acute and unidirectional in nature In so doing, this paper begins to explore potential mechanisms through which sleep problems become chronic over a Veteran's life course.

Paper Two explores the association between poor sleep and increased psychological distress in a sample of Veterans free of a past-month DSM-defined mental health disorder. In the absence of longitudinal data, this study makes use of a large VHA research registry to explore risk and protective factors associated with poor sleep, and to examine whether there is a significant relationship between poor sleep, resilience, and psychological distress. Although there is a growing interest in the relationship between sleep and resilient outcomes (Seelig et al., 2016; Troxel et al., 2015), there has been no investigation of the protective nature of resilience when defined as a psychological construct. This paper makes use of hierarchical linear regression and moderation analyses to explore these relationships.

Paper Three offers an applied perspective on sleep problems and aims to provide clinical recommendations to primary care social workers. Recognizing that sleep problems are prevalent, yet overlooked, in Veterans and in noting the absence of validated brief sleep screeners, this paper explores the utility of existing single-item sleep measures commonly embedded in psychological assessments. Paper Three utilizes standard diagnostic performance tests, calculating the sensitivity, specificity, false positive and negative rates, and positive and negative predictive values for three existing sleep items: trouble falling asleep, awakening in the early

morning, and sleep that is restless or disturbed. Findings provide initial information to primary care social workers regarding how to conduct an initial screen of sleep problems and guidance on responses that may indicate a Veteran who should be referred for further assessment.

These three papers draw attention to this high-risk, yet overlooked group of OEF/OIF Veterans (i.e., those who have returned home with clinically significant sleep problems yet no past-month mental health disorder). This dissertation presents a working theoretical model for studying short- and long-term consequences of sleep, a foundational understanding of factors that may be related to mechanisms linking poor sleep to global psychological distress, and clinical tools for identifying sleep problems in primary care settings. Such findings can support researchers and clinicians in better understanding the relationship between poor sleep and mental health and encourage the development and testing of interventions to treat both early in their development. In an age when the role of healthy sleep is gaining attention (Buysse, 2014) and when the VA is focused on promoting models of whole-person health and function (Krejci, Carter, & Gaudet, 2014), these studies are poised to make strong contributions to VA research and clinical practices.

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PAPER ONE

SLEEP PROBLEMS IN UNITED STATES MILITARY VETERANS:
AN INTEGRATED THEORETICAL MODEL

Nearly two-thirds of the 2.5 million U.S. troops who served in military operations in Iraq and Afghanistan endorse sleep problems upon returning home. Sleep problems are also prevalent among Veterans of earlier war cohorts suggesting a chronic nature to the problem in this population. Common sleep problems include insomnia-like symptoms such as difficulty falling or staying asleep, accompanied by daytime impairments that are the consequence of poor, restless nighttime sleep. Left untreated, sleep problems contribute to poor physical and psychological health, functional impairment, and increased healthcare utilization. Existing theories view insomnia as an acute, unidirectional phenomenon and do little to explore the long-term consequences of such problems. This paper explores both the short- and long-term consequences of insomnia-like symptoms in military Veterans. This paper then draws upon principles from theories in behavioral sleep medicine, health behavior, and stress and coping to offer an integrated theoretical model advocating for the reconceptualization of sleep as a chronic, cyclical problem.

Introduction

The Veterans Health Administration (VHA) has experienced significant changes in recent years. In 2014, VHA faced significant public and political criticism around long patient wait times (Kizer & Jha, 2014) . As a result, there continues to be a system-wide focus on improving access to services (Campbell, 2016; Jha, 2016). The VHA has also begun to place a greater emphasis on Veteran-centered care, including clinical services that are more focused on promoting health and optimizing function rather than solely treating disease (Krejci et al., 2014). Finally, the VHA's patient population has experienced significant bimodal growth, populated by younger Veterans from more recent conflicts in Iraq and Afghanistan and Veterans of earlier conflicts (World War II, Korea, Vietnam, Gulf War) and peace times. In the midst of these changes, sleep problems have become a growing concern for many Veterans across service eras.

Sleep is a basic biological need responsible for a range of restorative functions including emotional 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 not routinely integrated into chronic disease management programs. Between one-half and 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 sleep problems upon returning home (Amin et al., 2010; Seelig et al., 2011). Sleep complaints, including insomnia, are also prevalent among Veterans of earlier wars (Hughes & Martin, 2015; Ryden et al., 2015). Many older Veterans report that sleep problems began during or immediately following their military service. While these findings suggest sleep problems are chronic within Veteran populations, the lack of longitudinal data prevents researchers from identifying the

mechanisms which contribute to such chronicity and from understanding how sleep 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.

A range of different sleep complaints are common among OEF/OIF Veterans. More than one-half endorse self-reported poor sleep quality with more than three-quarters exceeding the threshold for clinically significant sleep disturbance (Plumb et al., 2014). Additionally, just over 70% report a short sleep duration of six hours or less (Luxton et al., 2011), and roughly 40% have sleep efficiency levels below clinical thresholds (defined as percent of time asleep / total time in bed) (Capaldi, Guerrero, & Kilgore, 2011; Peterson, Goodie, Satterfield, & Brim, 2008). In contrast, similar complaints are only endorsed by only roughly 10 to18% of the general U.S. adult population (Ford et al., 2014; Roth, 2007)

Despite the high prevalence of sleep complaints, less than one-quarter of Veterans report talking with a physician about their sleep (Ryden et al., 2016). Unpublished focused group data found that some Veterans reported primary care physicians simply do not inquire about sleep problems or do not acknowledge sleep as an important component of overall health, whereas other Veterans reported physicians are quick to offer prescription remedies rather than taking the time to uncover the cause of sleep problems (Ulmer, 2015b).

Cognitive Behavioral Therapy for Insomnia (CBT-I) (Margioles, Rybarczyk, Vrana, Leszczysyn, & Lynch, 2013) and Brief Behavioral Treatment for Insomnia (BBTI) (Germain et al., 2014), are effective in reducing insomnia-like symptoms in Veteran populations. However, these treatments are not widely available within the Veterans Health Administration (VHA), particularly at clinics located in rural areas. In addition, there are fewer than one dozen certified

behavioral sleep medicine specialists nationwide in the VHA (Ulmer, 2015a). In recent years, Veterans at one large medical center waited for as long as 10 months for an initial sleep clinic intake appointment with service demand expected to increase annually in coming years (Ulmer, 2015a). To further complicate the growing problem, sleep-related epidemiological and intervention research in Veterans of the OEF/OIF conflicts is in its infancy.

This paper has two major goals. First, this paper will provide an overview of sleep problems, including common causes and consequences. Second, this paper advocates for conceptualizing sleep problems in military Veterans not as an acute issue of reintegration, but rather a common chronic issue that can deleteriously impact the health and well-being of Veterans over the life course. An integrated theoretical model is presented that combines principles from social work, health psychology, and lifespan developmental psychology to reconceptualize sleep as a cyclical phenomenon whereby sleep problems are both a consequence *and* predictor of stress. This paper also proposes that sleep and resilience are overlooked mechanisms linking military stress to poor physical and psychological health outcomes. Throughout the discussion, the paper notes limitations of existing theories and interventions in addressing the growing problem of sleep problems in Veterans. A major focus of this paper is on Veterans who served during OEF/OIF conflicts with the ultimate goal of advocating for ongoing, longitudinal data collection with this population.

Definition of Sleep Problems

The American Academy of Sleep Medicine's *International Classification of Sleep Disorders* (American Academy of Sleep Medicine, 2014) outlines nearly 80 diagnosable sleep disorders. Sleep disorders range from those with a more physiological etiology, such as sleep apnea and restless leg syndrome, to those with a more behavioral etiology, including insomnia.

Sleep apnea, also referred to as sleep-disordered breathing and characterized by brief cessations in breathing while sleeping (American Academy of Sleep Medicine, 2014), is the most common physiological sleep disorder and is present in approximately 13% of U.S. men (Peppard et al., 2013) and approximately 24% of U.S. Veterans (Alexander et al., 2016; Mysliwiec, McGraw, Smith, Trapp, & Roth, 2013).

Chronic Insomnia Disorder is a common behavioral sleep disorder and defined clinically 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 et al., 2008; Mysliwiec et al., 2013), rates that are two to three times that of insomnia 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 (Mysliwiec et al., 2013). Given the end of military involvement in Iraq and Afghanistan and the large number of troops retiring, the prevalence of insomnia is expected to increase significantly among VHA users in the coming years (Campbell, Shattuck, Germain, & Mysliwiec, 2015).

Insomnia, as a construct or formal diagnosis, is rarely addressed in the literature. While incorrect, broad references to "sleep problems" in both scientific literature and the popular media may refer to insomnia-like symptoms. For the purposes of this paper, the phrase "sleep problems" is intentionally left broad. However, from this point forward, the phrase "sleep

problems" is assumed to refer to insomnia-like symptoms. These symptoms are often present on a continuum, ranging from mildly impairing to more severe complaints associated with a formal diagnosis of insomnia disorder.

Insomnia-like symptoms can be easily assessed by self-report measures and outpatient sleep monitoring, including wrist actigraphy. However, few largescale epidemiological studies conducted with Veteran samples include a validated sleep measure as part of their routine assessment. Where such measures do exist, there is variability in how sleep problems and sleep disturbance are defined, making it difficult for researchers to accurately assess prevalence rates. A shortage of objective, or laboratory-based tests, used to confirm diagnoses further limits researchers. It should be noted that in clinical practice, individuals presenting with significant nighttime complaints (e.g., difficulty falling or staying asleep) combined with daytime impairment (e.g., excessive daytime sleepiness or impaired physical, cognitive, or psychological function) would be advised to undergo an overnight sleep evaluation to rule the presence of any comorbid, organic or physiological sleep disorders such as obstructive sleep apnea (Schutte-Rodin, Broch, Buysse, Dorsey, & Sateia, 2008).

Risk Factors

Both modifiable and non-modifiable risk factors contribute to sleep problems. Much of this paper focuses on 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).

In addition to modifiable factors such as stress reactivity, a number of non-modifiable risk factors are also associated with insomnia-like sleep problems including gender, race, and socioeconomic status. Women are at 1.4 times higher risk for insomnia compared to men (Zhang & Wing, 2006), likely due to both sex and gender-related factors (Krystal, 2003, 2004). Minority groups in the United States, including African American and Hispanic adults, exhibit shorter sleep duration compared to Whites (Adenekan et al., 2013; Hale & Do, 2007; Stamatakis, Kaplan, & Roberts, 2007). Individuals without a college education have 1.78 greater odds of endorsing sleep complaints (Grandner et al., 2010), whereas the odds of endorsing either poor sleep quality or multiple sleep complaints is 2.30 to 3.86 higher, respectively, for unemployed individuals compared to those who are employed (Grandner et al., 2010; Patel, Grandner, Xie, Branas, & Gooneratne, 2010). It is likely that some of these non-modifiable risk factors would have been present before military service. In general, poor linking of Department of Defense (DoD) and VHA medical records makes it difficult to ascertain the number of Veterans who experienced pre-service sleep problems and to understand the factors that may have caused such problems.

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 et al., 2008). Deployment to a war region typically requires several days of laborious travel and crossing of multiple time zones which 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. Compared to other military conflicts, warfare in Iraq and Afghanistan often blurred the lines between combat and non-combat zones. The frequent use of improvised explosive devices (IEDs) and roadside bombs made combat exposure likely for many service members, not just those technically serving in a combat zone or employed in a combat role. While no research has formally documented the cause of sleep problems in military personnel, it is likely that any one or more of the aforementioned factors served as the initial trigger of sleep problems.

A body of recent research has focused on sleep problems among active duty military personnel, including increasing rates of both incident insomnia and sleep apnea diagnoses (Mysliwiec et al., 2013), heightened mental health risks associated with insomnia symptoms (Gehrman et al., 2013), and the impact of sleep on operational readiness and 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 sleep problems (Bramoweth & Germain, 2013). 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 various 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 either prior to or during deployment. While sleep problems are initially acute, such problems can become chronic as a result of an individual's inability to positively cope with subsequent stressors and the unhealthy and maladaptive sleep behaviors employed to help manage stress-induced sleep problems and related symptoms. Given that sleep plays a major role in physical, emotional, and cognitive health and performance, it is critical that sleep in military Veterans be studied in addition to studies of sleep in active duty service members.

Consequences of Sleep Problems

Chronic sleep problems 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).

Sleep Problems, Performance, and Health Management. Chronic sleep problems impair function and performance across cognitive, emotional, social, and physical domains (Killgore et al., 2006; Killgore et al., 2008; Pilcher & Huffcutt, 1996). Adequate functioning in these areas enables Veterans to adapt to and cope with the daily hassles and reintegration stressors noted earlier. However, impairments in one or more domains can reduce a Veteran's 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 same impairments can reduce a Veteran's capacity to cope with health-related stressors, a concept of particular interest within VHA health services research departments. Medically complex patients, defined as those individuals with two or more chronic conditions and 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).

In the past ten years, the VHA has continued to focus research and clinical efforts to better meet the needs of complex patients, including understanding the individual, social, and community characteristics that contribute to the rate and direction an individual moves and/or cycles through periods of health-related stress (Weiss, 2007). A particular emphasis is placed on the fact that successful management of stressors is bolstered by high physical and psychological reserve and capacity (Zullig et al., 2016). These new models of complexity make an important contribution to the literature by supporting the idea that capacity is malleable and can be impacted by resources, behaviors, and events on individual and community levels. Although sleep problems are gaining more attention within the VHA, sleep patterns and behaviors are not explicitly addressed in these models.

Sleep Problems and Mental Health. Sleep problems are common among Veterans with mental health diagnoses. In one research sample, 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 particular 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 et al., 1996; 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, & Khawkaja, 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 both depression and PTSD at 12 months post-deployment. However, depression and PTSD at four months post-deployment did not predict changes in insomnia at 12 months (Wright et al., 2011).

While it is too early to examine the long-term effects of military service on health in OEF/OIF service members, a great deal can be learned from studying the aging trajectories of

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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 both

recent and earlier war conflicts (Hoge, Austin, & Pollack, 2007; Schnurr, Spiro IIII, & 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 the

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 and are common among Veterans with PTSD

(American Psychiatric Association, 2013; McLay, Klam, & Volkert, 2010; Pigeon, Campbell, et

al., 2013).

Sleep and Resilience: The Missing Links between Military Service and Poor Outcomes.
Sleep problems contribute to a number of negative health outcomes and can become chronic,

surfacing repeatedly over one's life course. However, the mechanisms contributing to this

chronicity have not yet been identified. The mechanisms linking sleep problems to new mental

health diagnoses also 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 outcome, such as PTSD.

Researchers studying active duty military and Veteran populations have a growing interest in resilience and its role in everything from operational readiness during the 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 is 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, such as loss, abuse, or illness, and the traits and processes employed in adapting to such an event or challenge. This early approach 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 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.

More contemporary approaches recognize resilience as a dynamic, multilevel, and multicomponent capacity for adapting to stress (Masten, 2001, 2007). This capacity draws upon 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 in 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 the pertinent mechanisms, such as modifiable health behaviors, that can enhance or degrade resilience.

Within psychology and behavioral medicine, resilience is sometimes defined as positive-stress coping ability (Connor & Davidson, 2003), or the capacity to adapt to stress. However, resilience is rarely integrated into discussions of the stress process and infrequently addressed as either a target or outcome of behavioral interventions. When confronted with a stressor such as

securing employment, making a major financial purchase, or resolving family conflicts, an individual activates a response that incorporates coping skills and processes across psychological (cognitive and emotional) and physiological systems. The goal of this response is to return to a state of balance, or homeostasis. While research has shown resilience plays a buffering role between stress and negative psychological outcomes (Green, Calhoun, Dennis, Mid-Atlantic Mental Illness Research Education and Clinical Center Workgroup, & Beckham, 2010; Hoge et al., 2007; Pietrzak et al., 2010; Pietrzak, Johnson, Goldstein, Malley, & Southwick, 2009), resilience is rarely studied in the context of repeat stressors and accompanying stress responses such as those associated with daily hassles. To our knowledge, the role of resilience in adapting to, or coping with, sleep problems has not been studied.

Theoretical Explanation of Sleep Problems

The discussions above suggest that the causes and consequences of sleep problems in U.S. military Veterans are complex. The remainder of the paper presents an innovative integrated theoretical model that could be used to better understand the growing problem of sleep problems in this population. The theoretical model builds on constructs from health psychology, behavioral sleep medicine, health services research, and lifespan developmental psychology. This model is not intended to be tested in its entirety, rather the model is intended to guide researchers and clinicians in thinking about the long-term health of OEF/OIF Veterans.

3P Model of Insomnia

The 3P Model of Insomnia (Spielman & Glovinsky, 1991) is the leading explanatory model detailing the processes through which insomnia develops. 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.

These factors encompass genetic, constitutional, environmental, experiential, and behavioral contributors to sleep problems, respectively. The interaction between and progression across the three factors transform acute sleep problems into chronic problems.

The 3P model could be further strengthened with several additions. First, the model could benefit from greater clarification of the mechanisms operating within each of the three factors and with an extension of the model that addresses long-term consequences of insomnia. Second, the 3P model and other existing frameworks of sleep problems conceptualize insomnia and sleep problems as a consequence of a stressful event. Future models should recognize sleep problems as both a stress response (consequence) as well an independent stressor (predictor) that may trigger additional, negative reactions. Third, future models of sleep problems, specifically insomnia-like symptoms, should address the effects of sleep on multiple levels including physiological, psychosocial, and cognitive levels. Finally, future theoretical and conceptual models could be strengthened by include the dimension of time. Including a dimension of time would encourage the study of long-term consequences of sleep while also encouraging the consideration of stress proliferation and the cyclical pattern of increased stress, poor sleep, and negative outcomes that some individuals experience, including Veterans of earlier wars.

Integrated Theoretical Model

In light of the empirical evidence suggesting a high prevalence of sleep problems among Veterans, and evidence for sleep problems and impairment in functioning across numerous domains, it is clear that a new theoretical model addressing the frequently chronic nature of sleep problems is warranted. The primary aim of the integrated theoretical model presented here is to propose a broader conceptualization of sleep problems. This new model posits that sleep problems are often chronic and cyclical rather than an acute, linear phenomenon. The proposed

model integrates the three major components of the 3P Model: predisposing (Boxes 1 and 2), precipitating (Box 3), and perpetuating (Box 10) factors. Utilizing constructs from several major health behavior theories (Figure 1), the model offers a conceptualization of potential mechanisms by which stress (Box 3) contributes to sleep problems (Box 11), impaired function (Box 12), reduced resilience (Box 13), and poor health outcomes (Box 14). Unlike many existing theories that suggest only a unidirectional relationship between stressful events and sleep problems, this model proposes that sleep problems are cyclical in nature. Here, sleep problems are a consequence of stress *and* a predictor of additional stress. Sleep problems impair function, which reduces adaptive capacity, thereby increasing one's risk for subsequent stressful events. Thus, the cycle beings anew (Pathways U and V).

Predisposing factors. Predisposing factors of sleep problems refer to both modifiable 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 characteristics, 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. When confronted with a stressful event or environment, these characteristics may increase an individual's risk for a negative outcome. 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 sleep problems (Box 2) (Drake, Pillai, & Roth, 2014). High sleep-related stress reactivity is positively related to stress susceptibility and heightened responses across physiological and psychological domains. Stress

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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 challenge (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 sleep problems. As addressed above, it is the interaction between the 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 either sequentially or simultaneously. For some Veterans, deployment-related stressors may trigger sleep problems, while for others, stressors related to military retirement and civilian reintegration may initiate sleep problems. In addition to this interaction, Lazarus and Folkman's Transactional Model of Stress and Coping (Glanz & Schwartz, 2008) builds upon 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, a Veteran who perceives re-integration to be stressful and a trigger for

additional family or occupational stress but who does not have strong self-efficacy, social

support or coping skills might not seek help for stress-induced sleep problems (Box 9), and, as a

result, experience significant sleep problems and related consequences.

Perpetuating factors. Acute sleep 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 increased alcohol or caffeine intake to either induce sleep or wakefulness,

respectively (Morin et al., 2006; Morin, 1993) (Box 10). In line with the constructs of the

Transactional Model of Stress and Coping (Glanz & Schwartz, 2008), positive coping efforts

reduce sleep problems 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 that are 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 the cognitions of 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 the 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 more positive, healthier coping strategies.

Consequences and 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 designed to address consequences of unresolved or residual sleep problems. The model assumes insomnia is experienced in a unidirectional, linear fashion and is fully resolved through treatment. The lack of attention to long-term consequences and/or trajectories of sleep problems is paralleled by the infrequent attention to long-term outcomes of treatment. Cognitive Behavioral Therapy for Insomnia (CBT-I) is the recommended first-line treatment for sleep problems and insomnia (National Institutes of Health, 2005). CBT-I targets perpetuating factors of insomnia and is effective in the short term (12-18 months) (Morin et al., 2006). However, a review of Veterans who have completed a standard treatment of CBT-I found that while CBT-I did contribute to a clinically significant reduction in insomnia symptoms, many Veterans continued to report insomnia symptoms above clinical thresholds at the end of treatment or in subsequent follow-ups (Hughes, in preparation, 2016). It is unclear whether these residual problems resulted from lack of sufficient follow-up (i.e. treatment effects do not take effect until a longer timeframe) or whether existing interventions are not adequately addressing all causes of sleep problems.

One possible explanation for the chronicity of sleep problems is impaired and/or reduced coping. As addressed in the first portion of this paper, poor sleep contributes to impaired cognitive and functional performance. In line with these findings and laboratory studies demonstrating reduced performance following sleep deprivation, it is hypothesized that chronic sleep problems also negatively impact an individual's reserve or adaptive capacity to respond to subsequent stressors. 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 & Karatsoreso, 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 & Karatsoreso, 2015). Allostatic load is inversely related to resilience and successful aging (Gruenewald, Seeman, Karlamangla, & Sarkisian, 2009; Seeman et al., 1997).

A second explanation for residual sleep problems and potential relapse of insomnia is unaddressed stress reactivity, including increased levels of psychological and physiological hyperarousal. While it is the gold-standard, first-line treatment for insomnia (National Institutes of Health, 2005), CBT-I does not address modifiable predisposing factors such as sleep-related stress reactivity. This suggests that perhaps innovative hybrid interventions informed by principles of CBT-I and Mindfulness Based Stress Reduction (MBSR) might be effective in targeting precipitating and predisposing factors. 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).

Future directions

The proposed theoretical model highlights the complexity and interdisciplinary nature of understanding and treating behavioral sleep problems, specifically insomnia-like symptoms. Severe sleep problems might occur at one point in time, typically triggered by a major life or environmental stressor, but its antecedents start early in life and its consequences can extend for years or decades beyond the triggering stressful event(s). This may be particularly evident for those Veterans with a history of early-life adversity who experience a military-related stressor during deployment and/or reintegration, followed by chronic sleep problems and stressors persisting for decades. The model presented here is meant to encourage researchers and clinicians to apply lifespan models to the problems of stress, sleep, 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 mediating mechanisms between stressful events, sleep problems, and negative outcomes.

As alluded to above, sleep and resilience are likely important yet under-studied mechanisms in Veterans' long-term health. Additional research focusing on the multicomponent nature of resilience, including how physiological and psychological adaptive capacities contribute to an individual's stress response, is warranted. Additional research examining these relationships and mechanisms could prove fruitful in both clinical and research settings. As the theoretical model suggests, addressing sleep problems early could potentially enhance a

Veteran's coping capacity, thereby reducing the risk for negative physical and psychological outcomes in the future.

Figure 1.1. 3P Model of Insomnia: Original Framework and Integrated Theories *
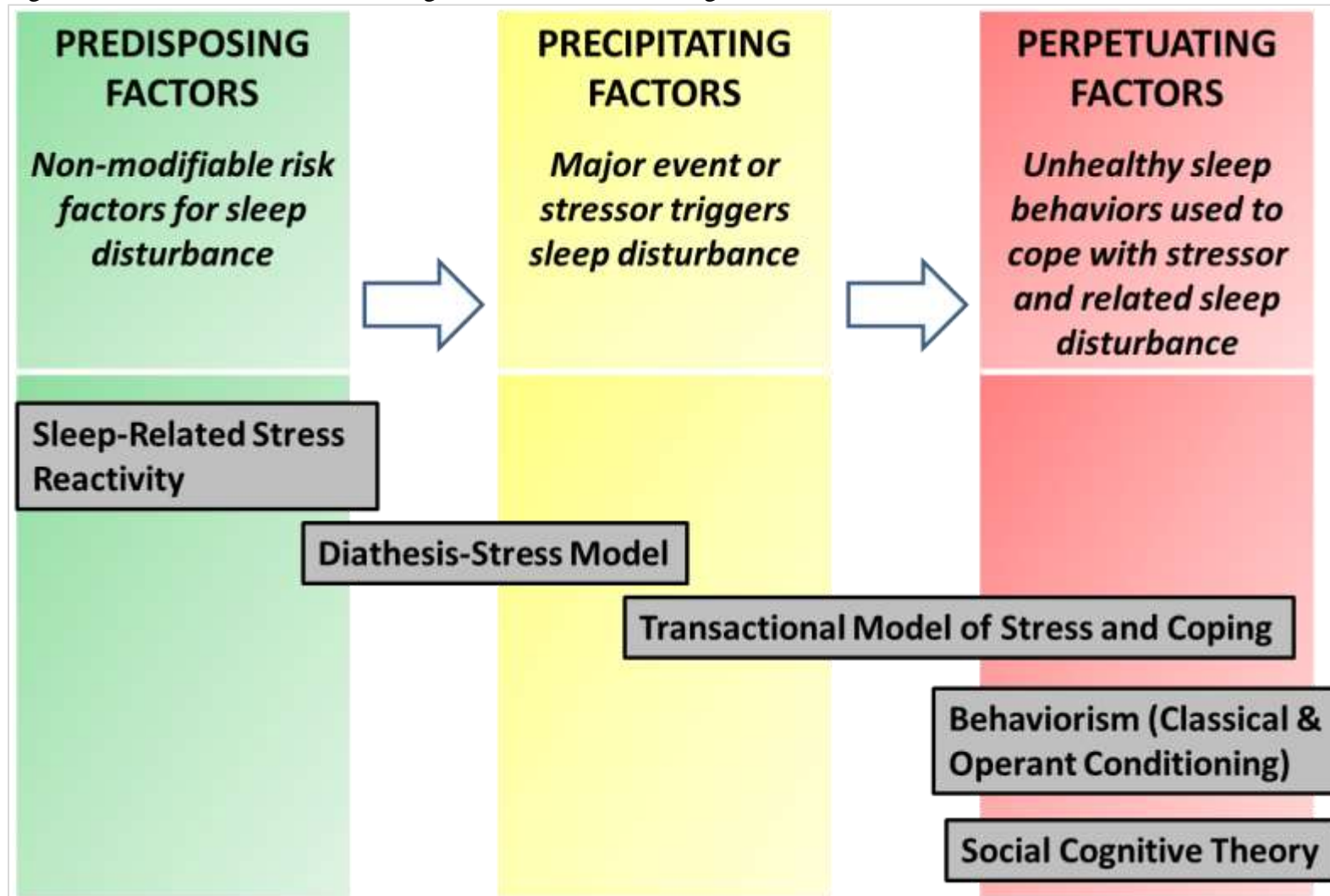
NOTE: Original elements of 3P model shown in green, yellow, and red. Author's original integration shown in gray.The additions to this model are meant to highlight the mechanisms responsible for each of the three factors and to demonstrate the overalp between and transition from one factor to the next.

Figure 1.2. Integrated Theoretical Model of Sleep in U.S. Military Veterans
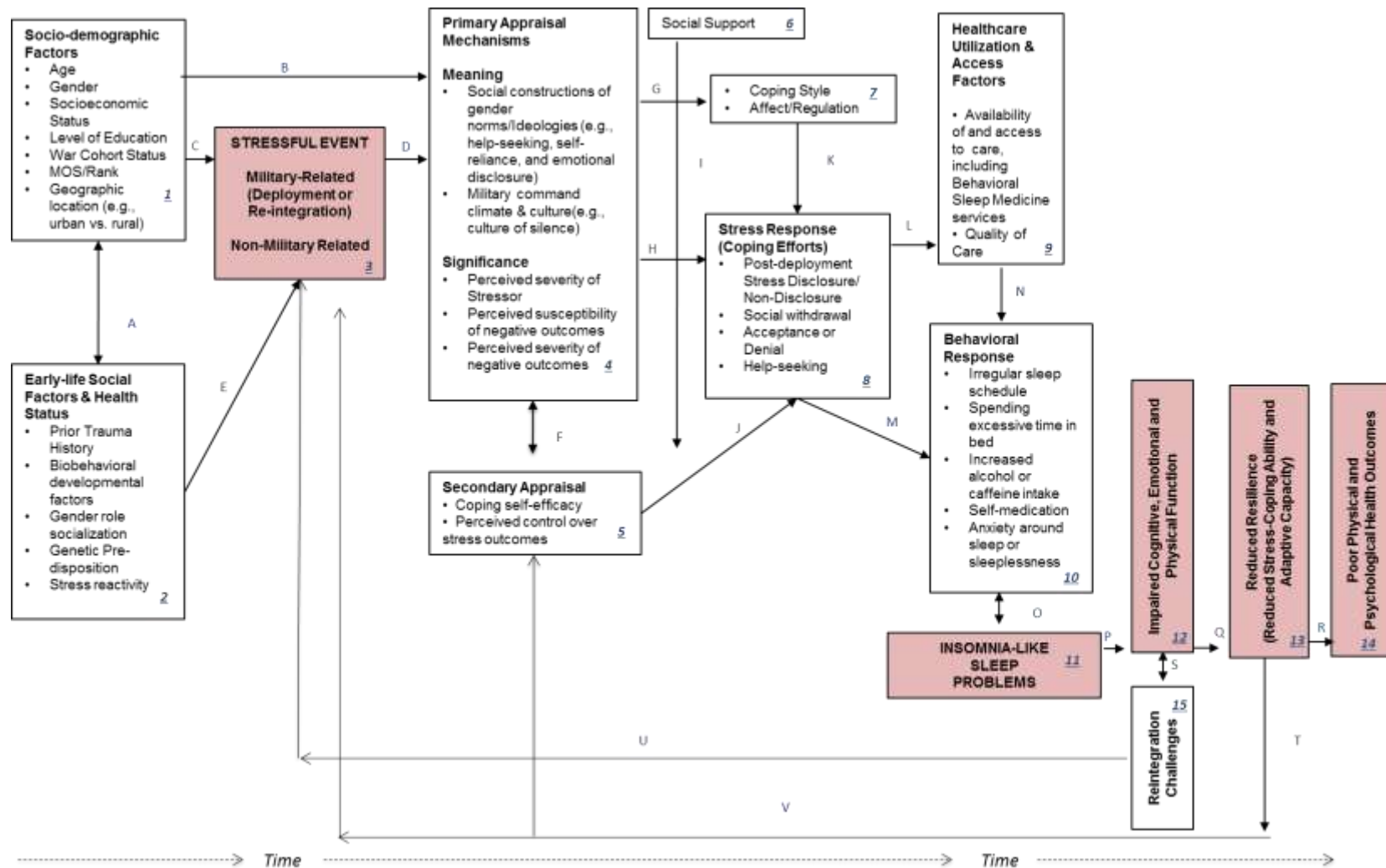
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PAPER TWO

SLEEP, RESILIENCE AND PSYCHOLOGICAL DISTRESS IN
UNITED STATES MILITARY VETERANS

Sleep problems are prevalent among Veterans with mental health conditions. However, few studies have examined the clinical correlates of sleep problems in Veterans without current mental health disorders. Left untreated, sleep problems may contribute to incident mental health disorders. Identifying risk and protective factors related to poor sleep and impaired mental health could strengthen pertinent prevention efforts. Research suggests psychological resilience, defined as positive stress-coping ability, protects against poor mental health outcomes in Veterans exposed to stress or trauma. However, the relationship between sleep and resilience has not been previously studied. The objective of this study was to examine the demographic, health, sleep, and resilience characteristics of Veterans without a current mental health disorder. Participants were Veterans who had served in the U.S. military since September 11, 2001 and had one more overseas deployments (N=1,118). Multiple linear regression was used to examine the association between poor sleep (defined by the Pittsburgh Sleep Quality Index total score) and psychological distress (defined by the Global Symptom Index score of the Symptom Checklist-90-R), controlling for demographic and health characteristics. Moderation analyses were conducted to test for a potential buffering effect of resilience (Connor-Davidson Resilience Scale). Results indicated that worse sleep was associated with greater psychological distress. Both component factors of resilience – adaptability and self-efficacy – were found to have a significant moderating effect between poor sleep and psychological distress. Additional research

is needed to understand the relationship between sleep and resilience in Veterans, and how interventions targeting each may help to reduce psychological distress.

Introduction

Approximately one-third of United States military Veterans who served in Afghanistan (Operation Enduring Freedom, OEF) or Iraq (Operating Iraqi Freedom, OIF) received at least one mental health diagnosis upon returning home, the most common conditions being posttraumatic stress disorder (PTSD) and major depressive disorder (Seal et al., 2009). Sleep problems are a core presenting symptom of many mental health disorders (American Psychiatric Association, 2013). In fact, Veterans with comorbid insomnia and PTSD were responsible for a sharp increase in sleep disorders among Veterans Health Administration (VHA) users since 2000 (Alexander et al., 2016; Luxton et al., 2011). Sleep problems and mental health problems are associated with impaired function (Killgore et al., 2006; Killgore et al., 2008; Magruder et al., 2004; Pilcher & Huffcutt, 1996), increased healthcare costs and utilization (Calhoun, Bosworth, Grambow, Dudly, & Beckham, 2002; Cohen et al., 2009; Wickwire et al., 2016), and reduced quality of life (Dobie et al., 2004; Katz & McHorney, 2002). Additionally, chronic PTSD has been linked to premature aging in Veterans of earlier war cohorts, suggesting that prevention and treatment of such may be key to successful aging (Lohr et al., 2015; Wolf et al., 2016).

Although sleep problems commonly co-occur with mental health disorders, Ulmer et al. (2015) found that more than two-thirds of OEF/OIF Veterans who returned home without a current mental health disorder also endorsed insomnia-like sleep complaints including trouble falling or staying asleep. While it is difficult to tease apart symptoms of mental health disorders and poor sleep, including the causal and directional pathways between the two, research has found that in the absence of a current mental health diagnosis, chronic sleep problems predict incident mental health diagnoses, including PTSD, depression, and anxiety (Baglioni et al.,

2011; Breslau et al., 1996; Ford & Kamerow, 1989; Gehrman et al., 2013; Szklo-Coxe, Young, Peppard, Finn, & Benca, 2010; Wright et al., 2011).

Mechanisms linking sleep disturbance to incident mental health diagnoses have not been identified (Taylor, Lichstein, Durrence, Reidel, & Bush, 2005). One proposed theory is that sleep problems reduce one's ability to cope with stressors, thereby reducing the likelihood of a positive stress response following the experience of subsequent stressors or trauma (Gehrman et al., 2013). Before examining how sleep impacts coping abilities over time, it is important to understand whether stress resilience, or positive coping, plays a significant role in protecting against negative outcomes, including increased psychological distress, when sleep problems are present.

The concept of resilience as a psychological construct has been invoked to explain positive health outcomes in the face of stress (Garmezy, 1971; Hoge et al., 2007; Werner, 1995), including the absence of a mental health diagnosis such as PTSD (Hoge et al., 2007). Military researchers have focused on the buffering nature of resilience in protecting against PTSD in Veterans who have experienced early-life trauma and/or combat exposure (Green et al., 2014; Pietrzak et al., 2010; Pietrzak et al., 2009; Pietrzak, Russo, Ling, & Southwick, 2011). Our preliminary work suggested that poor sleep is associated with reduced resilience (Hughes, Swinkels, Beckham, Mid-Atlantic Mental Illness Research Education and Clinical Center Workgroup, & Ulmer, 2015). However, to date, no research has examined whether greater resilience protects against psychological distress in the presence of sleep problems. For the purpose of this study, resilience is defined as positive stress-coping ability, a modifiable characteristic that is part of a dynamic process contributing to the maintenance of psychosocial homeostasis (Connor & Davidson, 2003).

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Two components of resilience, adaptability and self-efficacy (Green et al., 2014), may be key to successfully coping with sleep disturbance and maintaining healthy sleep behaviors. As discussed in Paper One, sleep problems often are triggered by a stressful life event which can contribute to difficulty falling or staying asleep. An inability to cope with an initial stressor or adapt to the consequences of such stressors, including difficulty falling or staying sleeping, can lead to unhealthy sleep behaviors, including irregular sleep schedules and poor sleep hygiene. The ability to maintain healthy sleep habits in the presence of ongoing physical, psychological, or environmental stressors may be associated with an individual's health-related self-efficacy, or the "confidence in one's ability to take action" (Champion & Sugg Skinner, 2008). Together, higher levels of adaptability and/or self-efficacy increase the likelihood of positively coping with stress(ors) and maintaining healthy sleep habits, thereby reducing the risk of developing chronic sleep problems which may contribute to subsequent psychological distress (see Figure 1).Together, these observations stress the importance of conceptualizing sleep and resilience as potentially modifiable targets in preventing new mental health disorders. However, individuals with comorbid sleep problems and a current mental health disorder are often prioritized in clinical and research settings, leaving little knowledge of the health, demographic, and sleep characteristics of Veterans without a current mental health disorder. Better characterizing this high-risk group may help to inform future assessment and intervention initiatives.

This study tested the following aims (1) To compare the demographic, sleep, physical, and psychological characteristics of individuals with and without clinically significant poor sleep among Veterans with no current mental health disorder; (2a) To examine the degree to which poor sleep contributed to increased psychological distress controlling for health and demographic characteristics; and, (2b) To examine whether resilience factors (i.e., self-efficacy and

adaptability) moderated the relationship between poor sleep and psychological distress. We hypothesized that poor sleep would be significantly positively associated with older age and higher levels of combat exposure, negatively associated with physical and psychological health, and would independently predict levels of psychological distress controlling for health and demographic characteristics. We further hypothesized that greater resiliency (i.e., adaptability and self-efficacy) would be negatively associated with levels of psychological distress and would buffer against greater psychological distress in the presence of poor sleep.

Methods

Participants and Procedures

Data presented here were drawn from a multi-site volunteer research registry sponsored by the Veterans Affairs (VA) Mid-Atlantic Mental Illness Research, Education, and Clinical Center (MIRECC). The overarching goal of the Study of Post-Deployment Mental Health (the "Registry") was to examine post-deployment health and adjustment in post-9/11 Veterans. Volunteers were widely recruited throughout four VA Medical Centers in the Mid-Atlantic United States (Durham and Salisbury, NC; Hampton and Richmond, VA) via flyers, mailings, and provider referrals. Recruitment efforts did not target particular demographic or clinic groups and, instead described the study as looking at "the effects of recent military deployments on the mood, emotions, and mental, and physical health of military personnel" or "the effects of recent deployments on the physical and mental health of service members, especially as they transition from deployment back to civilian life."

Individuals were eligible to participate if they served in the United States military after September 11, 2001, spoke English and demonstrated an 8th grade or higher reading comprehension level. Institutional review board approval was obtained at each of the four

enrollment sites and all participants provided written informed consent. All participants underwent a day-long computer-administered assessment of demographics, trauma history, sleep patterns, and physical and psychological health. Participants also completed an in-person structured clinical interview with a trained clinical psychologist. All participants were compensated $175 for their participation and were provided with a summary of their results if desired.

Data presented here represents a subset of the larger study (total N=3,247) and was collected between 2005 and 2015. In order to examine the relationship between poor sleep and psychological distress, individuals with a current mental health disorder, defined as symptoms occurring the past month, were excluded. Of the 3,042 Veterans who complete the Structured Clinical Interview for DSM-IV Disorders (SCID) (First, Spitzer, & Gibbon, 1994), those respondents who met criteria for any Axis I mental health (major depressive, posttraumatic stress, anxiety, panic, bipolar, mood, or psychotic disorder) or substance dependence disorder were excluded (N=1531). Participants who did not report one or more overseas deployments were excluded (N=197). Prior to analyses, the sample was examined and statistical outliers on the Pittsburgh Sleep Quality Index were removed if any one or more of the following conditions was met: sleep onset latency > 180 minutes, total sleep time > 12 hours, and/or total sleep time greater than total time in bed (N=380). The final sample represents cases with complete data on all measures of interest (N=1,118). There were no significant differences in age, gender, health status or level of psychological distress between participants who were removed from and retained in the sample.

Measures

Outcome Variable

     Psychological Distress. The goal of this study was to better understand Veterans who may be at greater risk for developing an incident mental health disorder. This included exploring factors related to elevated psychological distress in the absence of a current mental health disorder. As a result, global psychological distress, as measured by the Global Severity Index (GSI) of the Symptom Checklist-90-Revised (SCL) (Derogatis & Savitz, 1999) was selected as the outcome. The SCL is a 90-item self-report measure that assesses how much a problem has distressed or bothered the respondent during the past 7 days. Responses are recorded on a 5-point Likert scale ranging from not at all to extremely distressed. The Global Symptom Index (GSI) is a derived score, calculated by summing the response to all items and dividing by the number of items answered. Total GSI scores range from 0 to 4 where higher scores indicate greater overall distress. The SCL has been used with Veteran samples to link higher psychological distress with PTSD (Holmes, Tariot, & Cox, 1998) and to demonstrate improvements in distress following treatment for PTSD (Perconte & Griger, 1991). For the purposes of this study, the three SCL sleep items were removed when calculating the total GSI score (Items 44, 64, and 66). Cronbach's alpha in this sample was 0.98.

Predictor Variables

     Demographic, Health and Military Characteristics. All participants reported demographics including age, race (White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, Other), marital status (married, domestic partner, remarried, widowed, separated, divorced, never married), total years of education completed, current working status (not working, part-time, full-time), and number of

military tours served. Overall health status was computed based on the number of physical chronic health conditions listed on the National Vietnam Readjustment Study's Self-Reported Medical Questionnaire (Kulka et al., 1990). The total numbers of lifetime and past-year conditions were tabulated for each respondent. The questionnaire included a total of 37 chronic conditions. Common conditions included asthma, arthritis, diabetes, high blood pressure, cancer, and digestive disorders.

The Combat Exposure Scale (CES) (Keane et al., 1989) is a 7-item self-report questionnaire widely used in VA settings which asks participants to report the frequency, duration, and degree of loss for different combat-related experiences. Items ask about serving on dangerous duty, coming under enemy fire, firing at the enemy, witnessing injury or death of a fellow service member, or coming into danger of being injured or killed. Total scores are computed using weighted item scores, and range from 0 to 41. Total scores fall into one of the following categories: light to light-moderate combat (0-16), moderate combat (17-24), or, moderate-heavy to heavy combat (25-41). Cronbach's alpha in this sample was 0.85.

Psychological Characteristics. The Traumatic Life Events Questionnaire (TLEQ) (Kubany et al., 2000), a 24-item self-report scale, was used to assess number of traumatic life events experienced before, during and after military service. General categories of traumatic events included accidents, illness, attacks, and sexual assault. The TLEQ has been used frequently with Veteran populations. Cronbach's alpha in this sample was 0.70.

The 21-item Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) assesses severity of depressive symptoms over the past 14 days and has demonstrated strong reliability in psychiatric and non-psychiatric populations (Beck, Steer, & Garbin, 1988). Scores range from 0-63 where higher scores indicate greater depressive symptoms. Scores are

also translated into severity as follows: no to minimal depression (scores less than 10); mild-to-moderate depression (10 to 18); moderate-to-severe depression (19 to 29); and severe depression (30 to 63). Cronbach's alpha in this sample was 0.90.

Sleep. The Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989) is a 19-item self-report questionnaire of sleep characteristics over the past month. The PSQI includes items related to sleep duration, sleep disturbances, daytime dysfunction, sleep quality, and use of sleep medications. Total scores range from 0-21 with scores greater than five indicative of clinically significant poor sleep. The PSQI has demonstrated strong reliability in a range of medical and clinical populations (Cronbach's alpha 0.81 to 0.83) (Buysse et al., 1989; Carpenter & Andrykowski, 1988). In addition to the original 19-item scale, the PSQI-Addendum (PSQI-A) is a 10-item self-report measure that assesses the frequency and severity of sleep complaints related to trauma and/or PTSD, including nightmares. The PSQI-A has demonstrated strong internal consistency (Cronbach's alpha = 0.85) and good predictive validity with full PTSD assessments (Germain, Hall, Krakow, Shear, & Buysse, 2005).

Resilience. The Connor-Davidson Resilience Scale (CD-RISC) is a 25-item self-report questionnaire which asks about the degree to which the respondent agrees with a variety of statements about stress and pressure over the past month. Responses are on a 5-point Likert scale, ranging from not true at all to nearly true all of the time. The CD-RISC has been used frequently with Veteran populations (Green et al., 2010; Pietrzak et al., 2009; Pietrzak et al., 2011). Validation of the CD-RISC with a sample of participants from this same data registry identified a two-factor solution (i.e., self-efficacy and adaptability) as the best fit for the data (Green et al., 2014). The adaptability factor of the CD-RISC is composed of 8 items including "Able to adapt to change," "Tend to bounce back after illness or hardship," and, "Coping with

stress strengthens." The self-efficacy factor is composed of 6 items including "Best effort no matter what," "You can achieve your goals," and "When things look hopeless, I don't give up," The abbreviated 14-item scale generates a total score ranging from 0 to 56 where higher scores indicate higher levels of resilience. Internal consistency for the 14-item scale for this sample was 0.93, and 0.87 and 0.88 for the self-efficacy and adaptability subscales, respectively.

Analyses

All analyses were performed using SPSS V21 (IBM, 2012). Research Aim 1 was examined by calculating descriptive statistics for all demographic, health, and sleep variables. Chi-square tests and student t-tests were used to compare categorical and continuous variables, respectively, between good and poor sleepers where poor sleepers were those participants with a total PSQI score greater than 5 (Buysse et al., 1989). Sequential, hierarchical linear regression was used to examine the degree to which poor sleep contributes to psychological distress controlling for demographic, health, and military-related variables (Research Aim 2a). Variables were entered in following order: Block 1: demographic variables including age, gender, and physical health status; Block 2: military service (combat exposure); Block 3: sleep (PSQI total score).

Finally, to test whether resilience moderated the relationship between poor sleep and psychological distress (Research Aim 2b), the regression model described above was expanded to include two additional blocks. In Block 4, resilience factors, adaptability and self-efficacy, were entered individually to test whether such factors were inversely associated with psychological distress. In Block 5, three interaction terms were added for purpose of conducting moderation analyses. These three terms were created based on PSQI total score and resilience factors as follows: (1) sleep x adaptability; (2) sleep x self-efficacy; and, (3) sleep x adaptability

x self-efficacy. Results were examined for significant interaction terms and the change in variance, as indicated by R-squared. The simple slopes of adaptability and self-efficacy were graphed individually to examine the magnitude of the interaction effects. Regression assumptions were also tested by examining plots of the residuals.

Results

This study examined health, demographic, sleep, and resilience characteristics in 1,118 OEF/OIF Veterans who did not meet criteria for a current Axis I mental health disorder. The average age of the sample was 38.0 years (SD=10.4; Range: 19 to 69), more than three-quarters of participants were male (80.1%, n=894), and approximately one-half were Caucasian (N=565, 52%). According to standard clinical criteria (Schutte-Rodin et al., 2008), sleep problems were prevalent across this sample: one-quarter had clinically significant extended sleep onset latency (i.e. 30 minutes or more; N=289, 25.8%), one-third were clinically short sleepers (i.e. 6 hours or less; N=406, 36.3%), and just under one-half demonstrated clinically significant poor sleep efficiency (i.e. 85% or less; defined as total time asleep out of total time in bed) (N=550, 49.2%). More than one-half of all respondents met criteria for poor overall sleep quality (i.e. PSQI > 5; N=654, 58.5%; average PSQI score=7.17, SD=3.99).

Veterans with clinically significant poor sleep (PSQI total score > 5) endorsed a higher number of lifetime traumatic events and reported worse physical and psychological health. As expected, there were significant quantitative differences in sleep duration, sleep onset latency, and sleep efficiency between individuals who did and did not meet criteria for poor sleep (all p's<0.001). Demographic and sleep characteristics for the sample are shown in Tables 2.1 and 2.2, respectively. As hypothesized, worse sleep was associated with higher psychological

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distress, predicting an additional 16% of the variance over and above health and demographic characteristics. Results are shown in Table 2.3.

Resilience, defined as stress-coping ability, did significantly moderate the relationship between poor sleep and psychological distress. When examined individually, both resilience factors, self-efficacy and adaptability, were also protective against greater psychological distress in the presence of worse sleep. There was no significant 3-way interaction effect between poor sleep, adaptability, and self-efficacy vis-à-vis psychological distress. Results for all interaction effects are shown in Table 2.3. Graphical results of adaptability and self-efficacy are shown in Figures 2.2 and 2.3. There were no violations of regression assumptions.

Although our sample was comprised only of Veterans who did not meet criteria for a current mental health disorder and less than ten percent endorsed moderate or severe depressive symptoms (BDI score, sleep item removed $\geq$ 19) (N=86, 8%), we recognize that sleep problems are common symptoms of mental health disorders, particularly depression (Manber & Chambers, 2009). Research suggests that chronic sleep problems contribute to depression (Baglioni et al., 2011; Szklo-Coxe et al., 2010) and may continue as residual symptoms of a prior psychiatric episode or diagnosis (Ohayon & Roth, 2003). Depressive symptoms (BDI total score) and sleep quality (PSQI total score) were moderately correlated in our sample (rho = 0.504, p < 0.001). However, in the absence of longitudinal data, we are unable to determine causality between these symptoms. We conducted two sensitivity analyses to explore whether depressive symptoms (BDI) may confound the relationship between poor sleep (PSQI total score) and global psychological distress (GSI).

In the first analysis, the regression model described above was replicated but with past mental health diagnoses added in Block 1. Poor sleep contributed 12.8% to the variance in

psychological distress over and above demographics and physical and mental health characteristics. However, there was little change in the total amount of variance explained (46% compared to 45.2% in original model). Adaptability remained a significant buffer between poor sleep and psychological distress, but self-efficacy did not. In the second analysis, a dummy variable was created for participants whose scores on the BDI may indicate subthreshold depression (total score, sleep item removed $\geq$ 10). The regression model described above was replicated but with subthreshold depression added in Block 1. Compared to our original model, poor sleep contributed less to the variance in psychological distress (Block 3, $\Delta R^2 = 5.4\%$, p < 0.001). Poor sleep remained a significant predictor of psychological distress, and adaptability and self-efficacy both remained significant moderators of this relationship. The level of global psychological distress increased when severe depressive symptoms were added into the model.

Discussion

We believe this is the first study to examine the relationship between poor sleep, resilience, and psychological distress in a population of post-9/11 military Veterans without a current Axis I mental health disorder. This study extended the work of Ulmer et al. (2015) noting that sleep problems are common among Veterans without a current mental health disorder. This study further identified demographic and clinical factors associated with poor sleep, including race (non-white), worse physical health, prior mental health disorders, more current depressive symptoms, and more lifetime traumatic events. This study also demonstrated that worse sleep contributes to greater psychological distress independent of health and demographic characteristics in Veterans free from a current mental health disorder. These findings add to the literature by identifying potential risk factors, including worse physical and psychological health, associated with poor sleep. In light of research demonstrating that poor sleep predicts subsequent

mental health diagnoses (Ford & Kamerow, 1989; Wright et al., 2011), identification of such risk factors may inform tailored prevention programs addressing poor sleep.

This study further demonstrated that psychological resilience, defined as positive stress-coping ability, may be a significant buffer between worse sleep and greater psychological distress. Although other military focused researchers have found that poor sleep contributes to less resilient outcomes, both in the form of reduced operational readiness and poor health metrics (Seelig et al., 2016; Troxel et al., 2015), this study is the first to consider resilience as a psychological construct and predictor as opposed to an outcome. This study followed the work of Green et al. (2014) suggesting a two-factor structure of adaptability and self-efficacy was the best fitting model of resilience in this sample. Results indicated that higher levels of adaptability were inversely associated with psychological distress, suggesting adaptability may serve as a buffer between worse sleep and greater psychological distress. We believe adaptability to be important in managing sleep problems. As described earlier, adaptability may be key to adjusting both to initial stressors and the disturbed sleep resulting from such a stressor. There was also a significant buffering effect of self-efficacy. While the self-efficacy items of the CD-RISC do not touch on health-related behaviors, we believe traits related to personal competence and tenacity assessed by the scale are relevant to health-related self-efficacy, particularly as self-efficacy relates to maintaining a healthy sleep routine in the face of one or more stressors.

This study establishes a foundation for future studies that elucidate the relationship between sleep, resilience, and psychological distress over time. Longitudinal studies with repeated-measures, including daily sleep diaries and wrist actigraphy, are needed to better understand the temporal and directional relationships between sleep, resilience, and psychological health outcomes, as well as the stability and variability in these patterns over time.

Longitudinal studies can reveal trajectories experienced by Veterans over time and how such trajectories impact health and independence. In line with Connor and Davidson's proposed trajectories following a stressful life event (2003), Veterans in this sample may experience any one of the following sleep trajectories: (1) poor sleep that continues and/or worsens over time, thereby continuing unhealthy or maladaptive sleep behaviors; (2) poor sleep that resolves (i.e., returns to baseline); (3) poor sleep that resolves but remains above threshold levels, thereby increasing risk for relapse; or, (4) new complaints of poor sleep that are triggered by one or more stressful events in those Veterans who were free of sleep problems at the time of the initial interview. Such studies must also examine how resilience, defined as stress-coping ability, changes over time and the degree to which these changes are related to sleep trajectories.

Longitudinal studies are also well-poised to further elucidate the relationship between sleep and depression. Additional research is needed to better understand the rate at which sleep problems contribute to both prodromal depressive symptoms and clinical levels of a major depressive disorder. Although a better understanding of this relationship is warranted, research has shown that behavioral treatment for insomnia-like symptoms, including Cognitive Behavioral Therapy for Insomnia not only improves sleep, but also improves depressive symptoms (Manber et al., 2011; Manber et al., 2008; Wagley, Rybarczyk, Nay, Danish, & Lund, 2013). These findings suggest that early screening and treatment of sleep problems may also help improve symptoms of psychiatric disorders, including depression.

Second, future research should supplement findings from psychological constructs identified by the Connor-Davidson Resilience Scale with physiological measures of resilience. Given resilience is now commonly recognized as a multidimensional construct (Almedom & Glandon, 2007; Southwick et al., 2014) and that sleep problems are both psychological and

physiological in nature, a more comprehensive assessment of resilience is warranted. Finally, greater emphasis should be placed on potential links between stress and sleep. Much of the resilience literature has focused on recovery from a major stressful event with little research examining stress associated with daily stressors or chronic, prolonged stress. Veterans who return from deployment with physical or psychological service-related injuries are likely to experience repeated stressors and chronic stress due to general reintegration-related challenges. Given sleep and stress operate in a cyclical fashion where chronic sleep disturbance taxes cognitive, emotional, and physiological systems if left untreated, it will be important that future research focuses on changes in Veterans' sleep patterns over extended periods of time.

Despite the strengths of this study, several limitations must be noted. First, this study captured overall sleep quality and did not measure insomnia specifically. While insomnia-like sleep disturbances can be identified with the PSQI, poor sleep quality may be due to a variety of causes, including sleep apnea and restless leg syndrome. Second, the causes and duration of poor sleep were unknown. Use of cross-sectional data prevented us from determining the temporality and directionality between poor sleep and psychological distress. We were also unable to determine how subthreshold symptoms of depression were related to worse sleep and whether such symptoms were or were not related to prior mental health disorders. Third, self-selection by Veterans into the study was possible. Advertising the study as focused on "post-deployment health" may have recruited both Veterans with more or less post-deployment and reintegration challenges. It is unknown how health, sleep, or resilience values may or may not have differed in Veterans who did not elect to participate in this research study or how these results may or may not generalize to Veterans not utilizing VHA healthcare services. Fourth, although the PSQI and CDRISC have been frequently used with Veteran populations, each has its limitations. The

PSQI, (though reliable,) has yet to be validated in a Veteran population; thus, it is unclear whether the traditional cut point (total PSQI scores > 5 indicate poor sleep) is clinically appropriate. A lack of validated clinical cut points on the CD-RISC makes it difficult to accurately characterize individuals as high or low in resilience.

In conclusion, this study highlights several important findings. First, results suggest that poor sleep is inversely associated with psychological health in Veterans without a current mental health disorder. Additional research is needed to determine whether early screening and treatment of poor sleep reduces the risk of incident mental health diagnoses. Second, this study draws attention to the role of positive stress-coping skills (i.e., adaptability and self-efficacy), in protecting against psychological distress. However, more information is needed to understand the causal mechanisms of this relationship and how sleep problems and resilience affect one another over time. Despite many troops drawing down in Iraq and Afghanistan, the prevalence of sleep problems among service members and returning Veterans will likely remain high or even increase in coming years (Campbell et al., 2015). Further, it is unknown how many individuals who returned home free of sleep complaints will develop subsequent sleep problems given the ongoing stress associated with reintegration. It is critical VHA and community providers alike continue to address sleep problems in the coming decades and develop an understanding of the long-term effects of poor sleep on Veterans' stress resilience and overall health. A better understanding of the relationship between sleep and resilience may be critical in preventing new mental health problems among Veterans of the Iraq and Afghanistan conflicts.

Table 2.1. Demographic, Military, and Health Characteristics of Good and Poor Sleeping Veterans without a Current Mental Health Disorder

	Total Sample	Good Sleeping Veterans PSQI ≤ 5	Poor Sleeping Veterans PSQI > 5	Test Statistic [†]
	N = 1118	N = 464	N = 654	
Demographics and Military Characteristics				
Age, mean (SD)	38.0 (10.4)	37.6 (10.9)	38.2 (10.1)	-0.9
Gender, N (%) Male	913 (81.7)	392 (84.5)	521 (79.7)	4.2
Race, N (%)[a]				
White, non-Hispanic	565 (51)	271 (58)	305 (47)	17.4*
Black or African-American	495 (44)	174 (38)	321 (49)	
Other	47 (4)	19 (19)	28 (4)	
Education, Total Years, mean (SD)	13.7 (3.8)	13.9 (4.0)	13.6 (3.6)	1.3
Marital Status, N (%)[b]				
Married/Living as Married	635 (33)	260 (56)	375 (58)	1.1
Divorced or Separated	241 (22)	99 (21)	141 (22)	
Never Married	240 (21)	105 (23)	135 (21)	
Working Status, N (%)[c]				
Not working	330 (30)	106 (23)	224 (34)	17.5*
Employed Part-Time	139 (12)	67 (15)	72 (11)	
Employed Full-Time	647 (58)	290 (63)	357 (55)	
Number of Tours Served, mean (SD)	1.74 (1.4)	1.71 (1.2)	1.76 (1.5)	-0.7
Combat Exposure, Total Score, mean (SD)	9.36 (9.2)	9.89 (9.4)	13.9 (4.0)	4.1
Light to light moderate, N (%)	859 (76.8)	367 (79)	493 (75)	
Moderate	169 (15.1)	69 (15)	169 (15)	
Moderate heavy to heavy	89 (8.0)	29 (6)	89 (8)	

Physical and Psychological Health Characteristics				
Chronic Health Conditions, mean (SD)				
Lifetime	2.45 (2.3)	1.92 (2.1)	2.84 (2.1)	6.6*
Past year	1.73 (1.9)	1.26 (1.6)	2.06 (2.0)	7.5*
One or More Lifetime Mental Health Diagnoses[d], N (%)	478 (43)	148 (32)	330 (51)	38.2*
Beck Depression Inventory, mean (SD)	7.74 (8.0)	4.28 (5.3)	10.2 (8.6)	13.1*
Total Number of Lifetime Traumatic Events, mean (SD)	2.74 (2.7)	0.90 (1.2)	3.3 (3.0)	9.3*
Connor-Davidson Resilience Scale, mean (SD)				
Total Score	45.4 (8.3)	47.1 (7.0)	44.1 (8.8)	6.2*
Factor 1: Self-efficacy	20.0 (3.6)	20.6 (3.2)	19.6 (3.9)	6.7*
Factor 2: Adaptability	25.3 (5.2)	26.5 (4.5)	24.5 (5.5)	4.5*

[a, b, c] Not all categories total 100% due to rounding errors and/or missing data (race).

[d] Lifetime mental health diagnoses determined by the Structured Clinical Interview for DSM-IV Disorders (SCID).

[†] Student t-tests used for comparisons of continuous variables, Chi-square tests of association used to compare categorical variables. Significance level set at 0.002 based on Bonferroni-adjusted comparison rate: $0.05/25 = 0.002$

* $p < 0.001$

Table 2.2. Sleep Characteristics of Good and Poor Sleeping Veterans without a Current Mental Health Disorder

	Total Sample	Good Sleeping Veterans PSQI $\leq$ 5	Poor Sleeping Veterans PSQI $>$ 5	Test Statistic[†]
	N=1118	N=464	N=654	
Sleep Characteristics, mean (SD)				
Sleep Onset Latency (mins)	29.7 (26.9)	15.4 (11.2)	39.8 (30.0)	-16.7*
Total Sleep Time (hrs)	5.93 (1.4)	6.88 (1.0)	5.25 (1.3)	23.3*
Sleep Efficiency [a] (percent)	79.1% (19.7%)	90.0% (11.0%)	71.4% (20.8%)	17.6*
Sleep Complaints, N (%)				
Trouble falling asleep	322 (30)	25 (5)	297 (45)	212.0*
Waking up too early	126 (11)	34 (7)	92 (14)	12.3*
Sleep that is restless or disturbed	261 (23)	26 (6)	215 (33)	80.0*
Poor sleep quality rating	654 (59)	8 (2)	353 (54)	338.9*
Nightmares and bad dreams [b], N (%)				
Frequent trauma-related memories/nightmares	35 (3)	3 (1)	32 (5)	16.1*
Frequent non-trauma related memories/nightmares	17 (2)	3 (1)	14 (2)	4.1*

[†] Student t-tests used for comparisons of continuous variables, Chi-square tests of association used to compare categorical variables. Significance level set at 0.002 based on Bonferroni-adjusted comparison rate: $0.05/25 = 0.002$
[a] Sleep efficiency = total time asleep / total time in bed
[b] Endorsed if nightmares or bad dreams were reported 3 or more nights per week
* $p < 0.001$

Table 2.3. Hierarchical Regression of Psychological Distress on Health, Demographic, and Sleep Characteristics and the Interaction Between Poor Sleep and Resilience Factors (N=1117)

Block	Variable Entered	B	SE (B)	β	Adj R^2	ΔR^2	F	Sig
Block 1					0.125	0.128	40.5	<0.001
	Age	-0.008	0.001	-0.180*				
	Gender	-0.067	0.034	-0.056				
	Race (Reference: White)	-0.012	0.026	-0.014*				
	Health status	0.092	0.007	0.372				
Block 2					0.152	0.028	40.9	<0.001
	Age	-0.006	0.001	-0.146*				
	Gender	-0.030	0.034	-0.026				
	Race (Reference: White)	-0.042	0.026	-0.045				
	Health status	0.090	0.007	0.363*				
	Combat Exposure	0.009	0.001	0.177*				
Block 3					0.312	0.159	84.7	<0.001
	Age	-0.006	0.001	-0.131*				
	Gender	-0.044	0.031	-0.037				
	Race (Reference: White)	-0.003	0.024	-0.003				
	Health status	0.061	0.007	0.007*				
	Combat exposure	0.006	0.001	0.001*				
	PSQI total score	0.048	0.003	0.003*				
Block 4					0.431	0.120	106.0	<0.001
	Age	-0.004	0.001	-0.101*				
	Gender	-0.029	0.028	-0.024				
	Race	0.003	0.022	0.004				
	Health status	0.056	0.006	0.227*				
	Combat exposure	0.007	0.001	0.134*				
	PSQI total score	0.039	0.003	0.334*				
	Resilience: Adaptability	-0.023	0.003	-0.225*				
	Resilience: Self-Efficacy	-0.016	0.004	-0.126*				

Block	Variable Entered	B	SE (B)	β	Adj R^2	ΔR^2	F	Sig
Block 5					0.452	0.023	84.3	<0.001
	Age	-0.005	0.001	-0.104*				
	Gender	-0.026	0.028	-0.0224				
	Race	0.002	0.022	0.002				
	Health status	0.055	0.006	0.221*				
	Combat exposure	0.006	0.001	0.127*				
	PSQI total score	0.147	0.014	1.272*				
	Resilience: Adaptability	-0.005	0.006	-0.055				
	Resilience: Self-Efficacy	-0.003	0.009	-0.026				
	Sleep*Adaptability	-0.003	0.001	-0.718**				
	Sleep*Self-Efficacy	-0.004	0.001	-0.505**				
	Sleep*Adaptability*Self-Efficacy	0.00006	0.000	0.306				

** $p < 0.05$, * $p < 0.001$

Figure 2.1. Relationship between Poor Sleep, Resilience Factors, and Psychological Distress
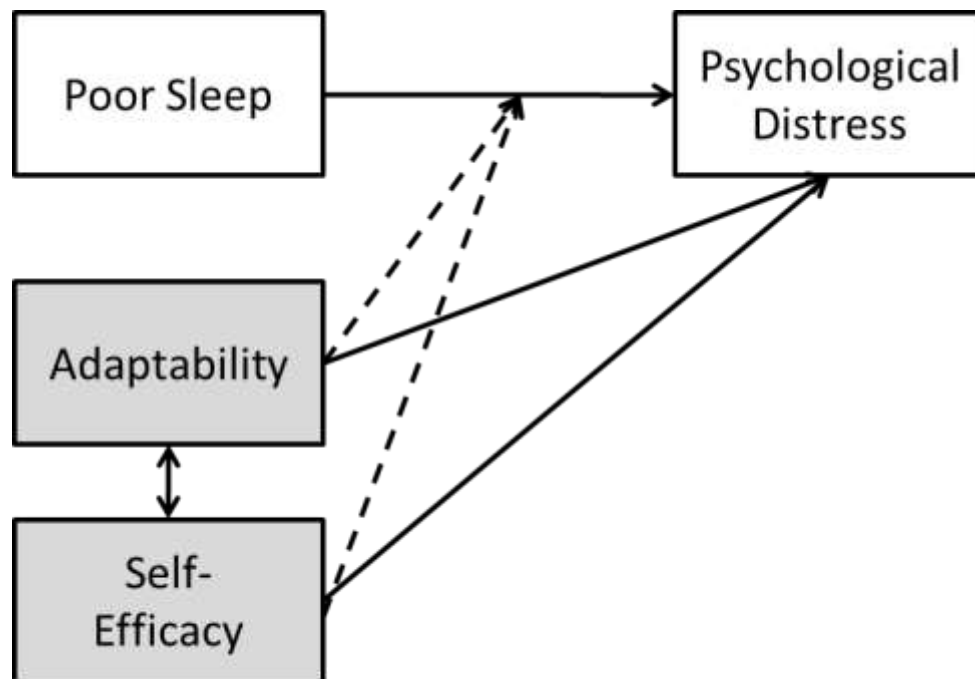
Note: solid lines indicate main effects, dashed lines indicate interaction effects.

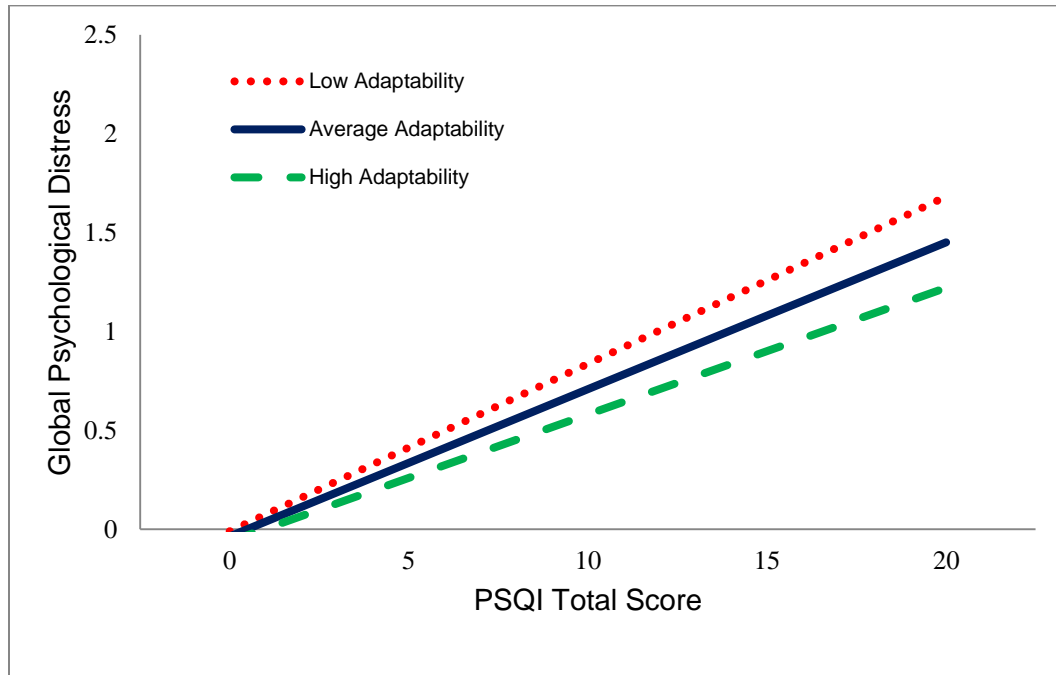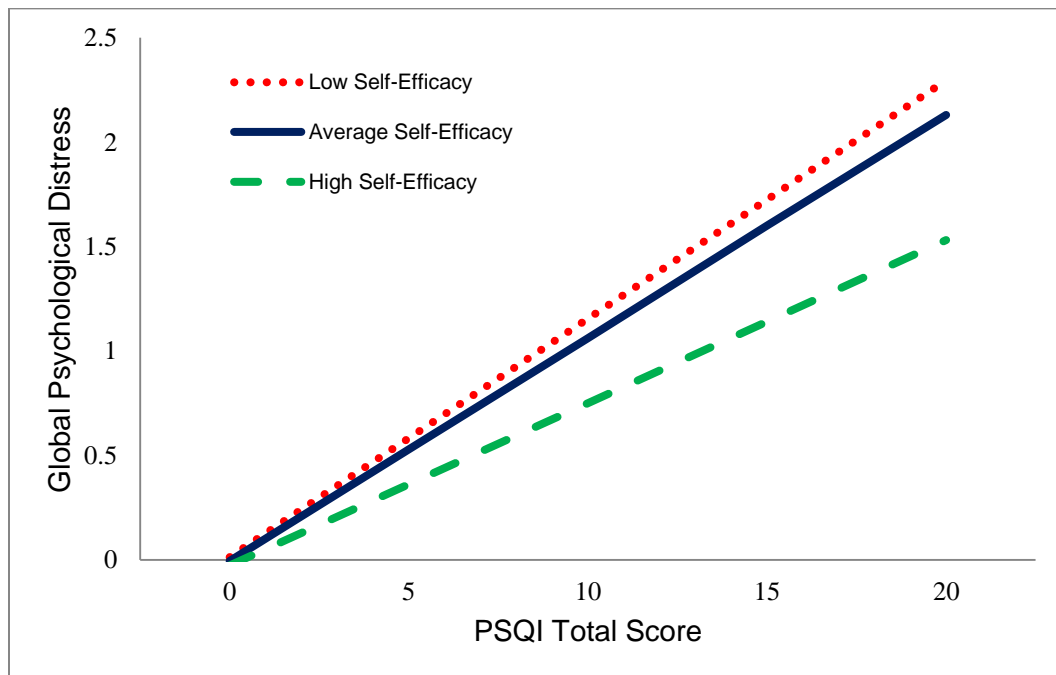Figure 2.2. Interactive Effects of Adaptability and Sleep Quality on Global Psychological Distress

Figure 2.3. Interactive Effects of Self-Efficacy and Sleep Quality on Global Psychological Distress

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PAPER THREE

**SINGLE-ITEM MEASURES FOR THE DETECTION OF SLEEP PROBLEMS
IN UNITED STATES MILITARY VETERANS**

Chronic sleep problems may contribute to increased risk of suicide, incident mental

health disorders and higher rates of healthcare utilization. Although sleep problems are reported

by as many as two-thirds of U.S. military Veterans who served in Iraq and Afghanistan, sleep

problems remain overlooked in clinical settings. To date, there are no brief sleep screeners or

clinical guidelines addressing how to best screen for sleep problems in VHA primary care

settings. The objective of this study was to examine the utility of single sleep items embedded in

existing psychological assessments. Participants were U.S military Veterans who served since

September 11, 2001 who did not meet past-month criteria for a DSM-defined Axis I psychiatric

disorder (N = 1,118). Participants completed a battery of computer-administered questionnaires

assessing demographics, health, and sleep. The performance, including sensitivity and

specificity, of three sleep items embedded in the Symptom Checklist-90 (i.e., trouble falling

asleep, awakening in the early morning, and sleep that is restless or disturbed), were evaluated in

relation to two reference outcomes: poor sleep (defined as a Pittsburgh Sleep Quality Index total

score > 5) and DSM-defined probable insomnia. Using an item response score of one, each of the

three items demonstrated moderate sensitivity and acceptable rates of false positives and

negatives in predicting poor sleep and probable insomnia. Although additional research is needed

to test the performance of these items across diverse Veteran groups, our initial findings suggest

that existing items may serve as a first step in screening for sleep problems.

Introduction

Sleep problems are a common complaint of United States military Veterans who served in Iraq and Afghanistan (Peterson et al., 2008; Seelig et al., 2011) and earlier service cohorts (Hughes & Martin, 2015; Ryden et al., 2015). Insomnia-like sleep problems, including trouble falling or staying asleep, waking up earlier than desired, and excessive daytime fatigue and impairment as a result of restless or disturbed nighttime sleep are particularly common (McLay et al., 2010; Plumb et al., 2014). Sleep problems, including insomnia, contribute to impaired performance (Pilcher & Huffcutt, 1996), reduced quality-of-life (Katz & McHorney, 2002), and increased healthcare utilization (Hunter, Yoon, Blonigen, Asch, & Zulman, 2015). Chronic insomnia has also been linked to increased risk for incident mental health disorders (Breslau et al., 1996; Ford & Kamerow, 1989; Gehrman et al., 2013; Wright et al., 2011) and suicidal ideation and attempts (Pigeon et al., 2012). Early screening and treatment of sleep problems might prevent or ameliorate many of these negative outcomes.

Beginning in 2011, the Veterans Health Administration (VHA) made an effort to increase behavioral sleep medicine services for Veterans with insomnia. This effort included the nationwide roll-out of Cognitive Behavioral Therapy for Insomnia (CBT-I) (Karlin, Trockel, Taylor, Gimeno, & Manber, 2013; Manber, Carney, & Edinger, 2012; Trockel, Karlin, Taylor, & Manber, 2014) and the introduction of a phone and tablet-based self-help application, CBT-I Coach (Khun et al., 2016), designed to be used alongside active treatment by a healthcare provider. However, despite the high prevalence of sleep problems, known consequences of such problems, and increased behavioral sleep medicine services, sleep problems remain overlooked in clinical settings. Sleep complaints are commonly reported by patients in VHA medical social work encounters (Strong et al., 2014); yet, to date, there are no clinical guidelines addressing

screening for sleep problems in primary care or specialty clinics. Medical social workers serve in a range of VHA clinics (National VA Social Work Public Relations Committee, 2013) and could help to improve early screening and treatment of sleep problems if provided with the proper tools to do so.

Full-length, multi-item sleep questionnaires, including the Pittsburgh Sleep Quality Index (Buysse et al., 1989), and Insomnia Severity Index (Bastien, Vallieres, & Morin, 2001), are considered feasible, reliable assessment tools (Smith & Wegener, 2003). However, many providers working in primary care are unfamiliar with how to deliver and score sleep questionnaires. Moreover, the limited time available for most primary care encounters may prevent providers from completing a multi-item sleep questionnaire. Brief measures are frequently used in the VHA to assess symptoms of other common conditions, including depression (e.g. Patient Health Questionnaire, 2- and 9-item versions) (Aroll, Goodyear-Smith, Crengle, Kerse, et al., 2010) and posttraumatic stress disorder (Primary Care Post Traumatic Stress Disorder Screen, PC-PTSD) (Prins et al., 2003). However, no brief sleep measures have been developed or validated to date. In the absence of full-length sleep questionnaires or validated brief measures, existing single sleep items may function as a first-line assessment tool. However, practitioners must first be informed about which response options on these items would warrant additional evaluation for sleep problems.

Items assessing insomnia-like symptoms, such as difficulty falling or staying asleep or sleep that is restless or disturbed, are embedded in commonly used psychological assessments, including the Symptom Checklist (Derogatis & Savitz, 2000), Patient Health Questionnaire-9 (PHQ-9) (Aroll, Goodyear-Smith, Crengle, Gunn, et al., 2010) and PTSD Checklist (PCL) (Blevins, Weathers, Davis, Witte, & Domino, 2015). To our knowledge, the utility of single-item

screeners in identifying Veterans with sleep problems has not been examined. Thus, this study will evaluate the sensitivity and specificity of three sleep items included in the SCL-90 in relation to two "gold standard" sleep instruments, the Pittsburgh Sleep Quality Index (Buysse et al., 1989) and a DSM-5-based probable insomnia diagnosis. This study will also identify response options (i.e., cutpoint scores) on each of the three items that optimize detection of Veterans with clinically significant sleep problems while minimizing the occurrence of false positive screens.

Methods

Participants

Participants were a subset of 3,247 Veterans enrolled in a volunteer research registry between 2005 and 2015. A full description of the research registry is presented below. The study sample was limited to Veterans who did not meet current criteria (symptoms within past-month) for a DSM-IV Axis I mental health disorder according to the Structured Clinical Interview for DSM-IV Disorders (SCID) (First et al., 1994). Within our full sample, 3,042 participants had complete SCID data. A total of 1,531 participants were excluded because they met criteria for one or more of the following mental health (major depression, posttraumatic stress, anxiety, panic, bipolar, mood, or psychotic disorder) or substance dependence disorders. Participants without one or more overseas deployments were also excluded (N = 197). Outliers on the Pittsburgh Sleep Quality Index (PSQI) were also removed if one or more of the following conditions were met: sleep onset latency ≥ 180 minutes, total sleep time ≥ 12 hours, or total sleep time > total time in bed (N = 380).The final sample was comprised of participants with complete data on all measures of interest (N=1,118).

Procedures

Data presented here were collected as a part of the Study of Post-Deployment Mental Health (research "registry"), sponsored by the Mid-Atlantic Veterans Affairs Mental Illness, Research, Education, and Clinical Center (MIRECC). Participants were recruited via flyers, mailings, and provider referrals for a study focusing on post-deployment health. Recruitment efforts were broad and not limited to particular demographic or clinical groups. As described to potential participants, this research registry examined "the effects of recent military deployments on the mood, emotions, and mental and physical health or military personnel" or "the effects of recent deployments on the physical and mental health of service members, especially as they transition from deployment back to civilian life."

Participants were recruited at four medical centers throughout the Mid-Atlantic Region (Durham and Salisbury, NC; Hampton and Richmond, VA). Institutional review board approval was obtained at each of the four participating sites. To participate in the registry, Veterans must have served in the U.S. military since September 11, 2001, spoke English, and demonstrated an 8th grade or higher reading comprehension level. After providing informed consent, all study participants completed a daylong assessment including computer-administered questionnaires and an in-person structured diagnostic interview with a doctoral-level, clinical psychologist. All participants were compensated $175 for their time and participation. If desired, participants were provided with a summary of their results upon completion of the study.

Measures

Demographics and Health Questionnaires. All participants reported basic demographic characteristics including age, race (White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian, or Other Pacific Islander), gender, marital status

(married, domestic partner, remarried, widowed, separated, divorced, never married), total years of education completed, current working status (working full-time or part-time, not working), number of military tours served, combat exposure, and military service-connected disability.

Overall health status was assessed using the National Vietnam Veterans Readjustment Survey Medical Questionnaire (Kulka et al., 1990) which asks about the presence or absence of 37 different chronic conditions over the past year and over an individual's lifetime. Common conditions included asthma, arthritis, diabetes, high blood pressure, cancer, and digestive disorders. A higher number of chronic conditions represents worse overall health.

Current depressive symptoms were assessed using the Beck Depression Inventory (BDI) (Beck et al., 1961), a 21-item self-report questionnaire that assesses severity of depression symptoms over the past 14 days and has demonstrated strong reliability in psychiatric and non-psychiatric populations (Beck et al., 1988). Total scores range from 0 to 63 where higher scores indicate more severe depressive symptoms (note: scores less than 10 indicate no to mild depression). Cronbach's alpha in this sample was 0.90.

Overall psychological distress was assessed using the Symptom Checklist-90-R (SCL-90) (Derogatis & Savitz, 1999), a 90-item self-report questionnaire frequently used in medical and research settings to assess global psychological distress. Respondents are asked to indicate the level of distress they experienced for each of 90 symptoms over the past seven days. Response options fall along a 5-point Likert scale and include the following: not at all, a little bit, moderately, quite a bit, or extremely distressing. The Global Symptom Index (GSI) is calculated by summing all items (range: 0 to 360) and dividing by the total number of items answered. GSI scores range from 0 to 4 where higher scores indicated greater psychological distress. The SCL includes three sleep items that were the focus of our analyses: trouble falling asleep (Item 44),

awakening early in the morning (Item 64), and sleep that is restless or disturbed (Item 66). These three items are related to different aspects of insomnia including difficulty with sleep initiation (Item 44), sleep maintenance (Item 64), and sleep continuity (continuous, restful sleep) (Item 66). In order to avoid inflation of the total score, the three sleep items were removed from the calculation of the GSI. Cronbach's alpha in this sample was 0.98.

Clinical Markers of Sleep Problems. For this study, two outcomes were used to categorize individuals as having clinically significant sleep problems. The Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989) is a 19-item self-report questionnaire assessing sleep patterns, disturbances, and consequences over the past month. Total scores range from 0-21 with scores greater than five indicative of clinically significant poor sleep. The PSQI has demonstrated strong reliability in a variety of settings (Carpenter & Andrykowski, 1988) and is considered a gold-standard self-reported sleep assessment. The total score from the Pittsburgh Sleep Quality Index (PSQI) was used to differentiate individuals with and without clinically significant poor sleep. Given the multidimensional nature of the PSQI, the total score may reflect poor sleep that results from a variety of causes including, but not limited to, insomnia-like symptoms, sleep disordered breathing, chronic pain, or bad dreams.

Probable insomnia was approximated based on DSM-V criteria (American Psychiatric Association, 2013). Participants were identified as having probable insomnia if all of the following criteria were endorsed: complaint of difficulty falling or staying asleep *or* waking up too early (Criterion A); daytime fatigue or disturbance as a result of poor sleep (Criterion B); and, symptoms occurring at least three times per week (Criterion C). A more detailed description of our probable insomnia approximation is included in Table 3.4.

Analyses

Data were analyzed using SPSS 21.0 (IBM, 2012). Prior to evaluating the performance of individual items, descriptive statistics were calculated for all demographic variables and sleep characteristics. The performance of each of the three sleep items (trouble falling asleep, awakening in the early morning, sleep that is restless or disturbed) was evaluated in relation to two outcome measures, PSQI-defined poor sleep and an approximated DSM-5-defined diagnosis.

The following measures were obtained for each of the three SCL "screening" items in predicting our two reference outcomes: sensitivity (the proportion of participants correctly identified by an SCL item as having sleep problems); specificity (the proportion of participants correctly identified by an SCL item as not having sleep problems); efficiency (the percentage of SCL screeners that produce correct classifications relative to total number of tests); false positive fraction (the percentage of SCL screeners that produce a false result when sleep problems are not present); false negative fraction (the percentage of SCL screening tests that fail to produce positive results when sleep problems are present); positive predictive value (the probability of significant sleep problems if an SCL item is endorsed); negative predictive value (the probability of no significant sleep problems if an SCL screening item is not endorsed). Results of these measures were used to evaluate response options scores associated with clinically significant sleep problems on each of the three SCL items.

Receiver operating characteristic (ROC) curves were then constructed for each of the three sleep items based on our two reference outcomes of interest, poor sleep (PSQI total score > 5) and probable insomnia. The area under the curve (AUC) represents the probability that the screening test result from any randomly chosen positive case will exceed the result for a

randomly chosen negative case. An area of 1.0 represents a perfectly accurate test while an area of 0.50 represents a screening test that is no more accurate or efficient than chance alone (Hanley & McNeill, 1983; Pepe, 2000).

Results

Of the 1,118 Veterans who participated in this study, most were male (80.1%, n=894). The sample had roughly equal proportions of Caucasian (52%, N=565) and African-American (44%, N= 495) participants. The average age of participants was 38.0 years (SD=10.4). Participants reported 1.74 average tours of duty (overseas deployment) (SD=1.4) with roughly eight percent (N=89) reporting moderately-heavy to heavy combat exposure. Although all participants were free of current DSM-IV mental health disorders, roughly forty percent met criteria for one or more lifetime mental health disorders. Additional demographics are shown in Table 1.

Sleep problems were common in our sample, as indicated by several different results. Three quantitative markers commonly used in sleep assessments all approached or exceeded clinical cutoffs indicative of insomnia, extended sleep onset latency ($\geq$ 30 minutes), short sleep duration (< 6 hours), and reduced sleep efficiency ($\leq$ 85%) (Buysse, Ancoli-Israel, Edinger, Lichstein, & Morin, 2006; Lichstein, Durrence, Taylor, Bush, & Riedel, 2003). Approximately 60 percent of participants met clinical criteria for poor sleep, as indicated by a score greater than 5 on the PSQI (Buysse et al., 1989) (58.5%, N=654, average PSQI total score=7.2). Just under 20 percent of the sample (N=202) met criteria for DSM-5 probable insomnia based on approximated diagnostic criteria. Neither poor sleep nor probable insomnia was significantly associated with age, race, or gender. Thirty percent of participants who met criteria for poor sleep (PSQI > 5) also met criteria for probable insomnia. This discrepancy may be explained by sleep disorders

other than insomnia (i.e. obstructive sleep apnea, restless leg syndrome, nightmares) that contribute to a higher rate of poor sleepers compared to Veterans with probable insomnia.

First, the performance of the three items in predicting overall poor sleep was examined. Results for sensitivity, specificity, false positive and false negative fractions, and predictive values for each of the possible response options on the three SCL items are displayed in Table 3.2. Sensitivity was highest for all three options at the lowest response option of 0. A response score of one resulted in the highest sensitivity (range: 0.58 to 0.74) but resulted in a false positive fraction of one-quarter or higher (range: 0.23 to 0.30). A response score of two resulted in lower sensitivity (range: 0.33 to 0.47), higher specificity (range: 0.90 to 0.97) and a false positive fraction of ten percent or less (range: 0.05 to 0.10).

ROC curves were constructed to evaluate the accuracy of each of the three SCL items in discriminating between "poor sleepers" and "good sleepers" and are displayed in Figure 3.1. The areas under the curve for each of the three items in predicting total PSQI score were: Item 44, trouble falling asleep: 0.79 (SE=0.013, p<0.001); Item 64, awakening in the early morning: 0.66 (SE=0.016, p<0.001); and, Item 66, sleep that is restless or disturbed: 0.77 (SE=0.014, p<0.001).

Second, the performance of the three items in predicting probable insomnia was examined. Results for sensitivity, specificity, false positive and negative fractions, and predictive values for each of the possible response options on the three SCL items are displayed in Table 3.3. Sensitivity and specificity were again optimized at the lowest response option of 0. A response score of one resulted in the highest sensitivity (range: 0.81 to 0.89) but was associated with more false positives (range: 0.42 to 0.48). A response score of two results in moderate sensitivity (range: 0.63 to 9.71) and specificity (0.79 for each item) while generating a false positive fraction of roughly twenty percent or less (range: 0.17 to 0.21).

ROC curves were also constructed for each of the three SCL items in discriminating between participants with and without probable insomnia and are displayed in Figure 3.2. The areas under the curve for each of the three items in predicting probable insomnia were: Item 44, trouble falling asleep: 0.76 (SE=0.020, p<0.001); Item 64, awakening in the early morning: 0.69 (SE=0.022, p<0.001); and, Item 66, sleep that is restless or disturbed, 0.80 (SE=0.017, p<0.001).

In comparing the two outcomes, poor sleep and probable insomnia, the three SCL items demonstrated higher sensitivity in predicting probable insomnia compared to poor sleep. However, the three items generated lower rates of false positives and higher positive predictive values in predicting overall poor sleep compared to probable insomnia. In examining the results from all three items, the item that was the most global in its scope, assessing sleep that is restless or disturbed (SCL, Item 66), performed well, as indicated by the highest sensitivity and greatest area under the curve for each of the two outcomes.

Discussion

This study presents results suggesting that single-item sleep measures embedded in psychological assessments may function as effective screeners for general sleep problems and probable insomnia in Veterans of the Iraq and Afghanistan conflicts who do not meet past-month criteria for DSM-defined mental health disorders. Three items evaluating trouble falling asleep, awakening early in the morning, and sleep that is restless or disturbed were moderately predictive of overall poor sleep, as measured by the Pittsburgh Sleep Quality Index, and probable insomnia, as approximated based on DSM-V diagnostic criteria. As indicated in Tables 3.2 and 3.3, a response score of 1 (indicating "a little" distress) on each of the three SCL screening items was able to detect poor sleep and probable insomnia with fair sensitivity and a low false positive rate. These findings may allow primary care social workers not otherwise

familiar with sleep questionnaires or formal diagnostic criteria to identify Veterans with clinically significant sleep problems and refer them for more extensive evaluation.

In our evaluation of the three SCL sleep items, we prioritized sensitivity over specificity for a number of reasons. First, as noted earlier, chronic sleep problems are associated with a number of negative consequences, including increased risk for poor physical and psychological health outcomes. Given these known risks, it is important to detect and treat sleep problems early in their course. Second, additional in-depth screening of potential sleep disorders possesses low burden and risk as subsequent screening can be done by additional paper-based questionnaires or overnight home sleep monitoring. Third, as noted earlier, the availability of safe and effective behavioral treatments is increasing within VHA settings (Karlin et al., 2013; Khun et al., 2016; Manber et al., 2012; Trockel et al., 2014), making treatment more accessible for Veterans identified with a sleep disorder.

In identifying and suggesting a response score indicative of poor sleep and probable insomnia, we took several factors into account. Although sensitivity was highest at a response score of one for both outcomes, this resulted in a false positive rate of 25% (poor sleep) to 45% (probable insomnia). In predicting poor sleep, there was little change in specificity between response scores of two, three, or four. In predicting probable insomnia, efficiency was highest at scores of two, three, and four, but sensitivity suffered. Although sensitivity and false negative fractions were optimized using a response score of four, we caution against using such stringent cutpoints as the goal of using these single-item sleep measures should be to identify a broad spectrum of veterans who are poor sleepers including those who sleep problems have not become severe and/or chronic. Utilizing a relatively sensitive response score will help identify Veterans with subsyndromal poor sleep and insomnia.

Sensitivity and efficiency were generally higher in predicting probable insomnia compared to poor sleep. This is unsurprising given two of the three items evaluated (Items 44 and 64) reflect common insomnia symptoms and should correlate well with an insomnia diagnosis. On the other hand, the PSQI is a multicomponent instrument whose total score is comprised of seven component scores. As a result, overall poor sleep, as indicated by the PSQI, may reflect a combination of insomnia-like symptoms, short sleep duration, and accompanying daytime consequences of poor sleep. Despite these differences, two of the three items – trouble falling asleep and sleep that is restless or disturbed – demonstrated strong performance compared to both outcomes of interest. These are notable findings given these items reflect common complaints related to the two most prevalent sleep disorders in Veterans, insomnia and sleep apnea, respectively.

The rate of false positives was higher in predicting probable insomnia compared to overall poor sleep. This may be due to the fact that the SCL-90 screening items ask about the degree of distress caused by insomnia symptoms, whereas the DSM-V probable insomnia diagnosis is based not only on distress of symptoms but also on frequency of symptoms and the impact insomnia-like symptoms have on an individual's daytime functioning. While false positives are viewed negatively in many diagnostic tests, we believe the potential harm associated with a false positive test for sleep problems is minimal. Additionally, further evaluation for sleep problems following a positive screen carries low time and cost burdens for the patient.

On a related note, the rate of false negatives was higher in predicting overall poor sleep compared to insomnia (a response score of one was associated with false negatives of 0.26 to 0.47 for poor sleep compared to 0.11 to 0.32 for probable insomnia). Although sleep problems

may not be considered as serious as other medical conditions such as hypertension or cancer, the negative consequences of sleep problems can be severe. A false negative test runs the risk of a participant further dismissing subsyndromal sleep problems as unimportant, thereby potentially increasing the risk of delaying further screening or treatment. Given poor sleep may be associated with an undetected sleep disorder such as obstructive sleep apnea, we believe as though false negatives should be taken seriously and explored through additional assessment.

Several limitations of this study should be noted. First, this study was not designed to collect an objective measure of sleep, such as outpatient wrist actigraphy or overnight polysomnography. Although the PSQI is considered a gold-standard measure, these results should be interpreted cautiously as this instrument may still be vulnerable to self-report bias. Furthermore, the PSQI has not been formally validated in a population of military service members or Veterans, thus making it unknown what cutpoint indicates clinically significant poor sleep in this population. Although readers may critique our use of a probable insomnia assessment, there is currently no medical test for insomnia and diagnosis is based purely on self-report. Second, our analytic sample included only Veterans free of past-month mental health disorders at the time of study participation, thus it is unknown how Veterans who report sleep problems <u>and</u> mental health problems, including depression and anxiety, may evaluate the three items examined in this study. However, as shared throughout both this paper and Paper Two, we believe that early detection of sleep problems in Veterans without current symptoms of a mental health disorder is critical.

Despite these limitations, several strengths should be noted. Given the increasing prevalence of both sleep apnea and insomnia in Veterans (Alexander et al., 2016), a significant strength of our study is in evaluating performance of single items in predicting overall poor

sleep and insomnia. The use of the total PSQI score allowed us to capture sleep problems due to a number of different causes, including insomnia and sleep apnea. In addition, many research studies are limited only to items assessing insomnia-like symptoms, including difficulty falling or staying asleep. An additional strength of our study is the inclusion and evaluation of a more global sleep item assessing sleep that is restless or disturbed (SCL Item 66). This item potentially captures sleep problems that may stem from causes beyond insomnia and sleep apnea.

Additional research is needed to better understand how Veterans define restless and disturbed sleep and whether such symptoms are perceived to be consequences of other sleep problems such as difficulty falling asleep, staying asleep, or awakening earlier than desired or represent unique complaints of their own. Should this item capture symptoms due to a variety of conditions such as insomnia and sleep apnea and/or reflect consequences of common sleep problems, it may be a strong candidate for a one- to two-item brief screener. Additionally, this type of global item may be particularly relevant for primary care social workers who are interested in the impact of sleep problems on health and functional status.

The goal of this study was to address a growing gap in clinical practice by providing preliminary recommendations to primary care social workers vis-à-vis using existing sleep items embedded in widely used psychological assessments to identify Veterans with sleep problems who may benefit from additional screening by a specialty clinic. As addressed in Paper Two, sleep problems were prevalent in our sample of Veterans without a current DSM-IV Axis I mental health disorder. Early screening and treatment of sleep disorders may reduce risk of suicidal ideation and subsequent mental health disorders. This study has also established a foundation for additional refinement and validation of brief sleep screeners. Future studies should include mixed methods designs with patients and practitioners that aim to better

understand how sleep problems are defined, evaluated, and prioritized among other competing chronic conditions and health symptoms. Future studies should also collect data from single-item sleep measures at repeated intervals. Longitudinal data can help researchers to assess the stability of patients' responses and identify factors that may be associated with patients evaluating their sleep problems as more or less distressing over time.

Although additional evaluation of the three SCL screening items should be conducted with a more diverse patient population, including Veterans of varying ages, races, and functional statuses, our results suggest that, particularly in the absence of validated brief screeners, existing items may be a first step in identifying Veterans with sleep problems. The three sleep items evaluated herein should not be substituted for the use of a full-length sleep questionnaire or formal evaluation by a sleep specialist. However, our findings suggest that VHA social workers could play a role in addressing the growing problem of undetected sleep problems in VHA users by utilizing existing sleep items to identify and triage Veterans with suspected poor sleep or insomnia.

Table 3.1. Participant Demographics and Sleep Characteristics (N = 1,118)

Demographic Characteristics	
Age, mean (SD)	38.0 (10.4)
Gender, male, n (%)	913 (82)
Race, n (%)[a]	
Caucasian, non-Hispanic	565 (51)
Black, non-Hispanic	495 (44)
Other	47 (4)
Education, total years, mean (SD)	13.7 (3.8)
Married or Living with a Domestic Partner, n (%)	635 (57)
Working Full-Time, n (%)	647 (58)
Number of Tours Served, mean (SD)	1.74 (1.4)
Number of chronic health conditions in past year, mean (SD)	1.73 (1.9)
Global psychological distress (SCL GSI), mean (SD)	0.40 (0.46)
Beck Depression Inventory, mean (SD)	7.74 (8.0)
Had one or more lifetime mental health disorders, n (%)[b]	478 (43)
Sleep Characteristics	
Sleep Onset Latency (mins), mean (SD)	29.7 (26.9)
Total Sleep Time (hours), mean (SD)	5.9 (1.4)
Sleep Efficiency Percent, mean (SD) (total time asleep/total time in bed)	79.1% (19.7%)
Pittsburgh Sleep Quality Index, mean (SD)	7.2 (2.5)
Clinically Significant Poor Sleep, n (%)[c]	654 (59)
Probable Insomnia, n (%)[d]	205 (18)

[a] Total N = 1108; percentages not equal to 100 due to rounding errors; [b] Axis I disorder as assessed by the SCID; [c] Defined as a PSQI total score > 5; [d] Probable insomnia based on approximation of criteria displayed in Table 3.4.

Table 3.2. Sensitivity and Specificity of Single-Item Sleep Screeners in Predicting Overall Poor Sleep among U.S. Military Veterans[†]

Item	N	Response (Score)[*]	Sensitivity	Specificity	Efficiency	False Positive Fraction	False Negative Fraction	Positive Predictive Value	Negative Predictive Value
SCL-44:	537	0	1.00	0.00	0.59	1.00	0.00	0.59	0.00
Trouble	259	1	0.73	0.78	0.75	0.23	0.27	0.82	0.67
falling asleep	123	2	0.45	0.95	0.66	0.05	0.55	0.92	0.55
	116	3	0.29	0.98	0.58	0.02	0.71	0.96	0.50
	83	4	0.13	0.99	0.49	0.00	0.87	0.99	0.45
SCL-64:	599	0	1.00	0.00	0.59	1.00	0.00	0.58	0.00
Awakening in	258	1	0.58	0.70	0.63	0.30	0.42	0.73	0.54
the early	126	2	0.33	0.90	0.57	0.10	0.67	0.82	0.49
morning	86	3	0.18	0.96	0.50	0.04	0.82	0.86	0.45
	49	4	0.06	0.98	0.45	0.02	0.94	0.86	0.43
SCL-66:	494	0	1.00	0.00	0.59	1.00	0.00	0.58	0.00
Sleep that is	284	1	0.74	0.70	0.73	0.30	0.26	0.78	0.66
restless or	160	2	0.47	0.93	0.66	0.07	0.53	0.91	0.56
disturbed	111	3	0.25	0.97	0.55	0.03	0.75	0.92	0.48
	69	4	0.10	0.99	0.47	0.01	0.90	0.96	0.44

[†] Overall poor sleep indicated by a PSQI total score > 5.
[*] 0 = not at all distressed; 1 = a little bit distressed; 2 = moderately distressed; 3 = quite a bit distressed; 4 = extremely distressed

Table 3.3. Sensitivity and Specificity of Single-Item Sleep Screeners in Predicting Probable Insomnia among U.S. Military Veterans[††]

Item	N	Response (Score)*	Sensitivity	Specificity	Efficiency	False Positive Fraction	False Negative Fraction	Positive Predictive Value	Negative Predictive Value
SCL-44:	537	0	1.00	0.00	0.18	1.00	0.00	0.18	0.00
Trouble	259	1	0.81	0.55	0.59	0.45	0.19	0.29	0.93
falling asleep	123	2	0.63	0.79	0.76	0.21	0.37	0.40	0.90
	116	3	0.50	0.89	0.82	0.11	0.50	0.52	0.89
	83	4	0.27	0.97	0.84	0.03	0.73	0.66	0.89
SCL-64:	599	0	1.00	0.00	0.18	1.00	0.00	0.18	0.00
Awakening in	258	1	0.81	0.55	0.60	0.42	0.32	0.29	0.93
the early	126	2	0.63	0.79	0.77	0.17	0.49	0.40	0.90
morning	86	3	0.45	0.90	0.80	0.09	0.72	0.51	0.45
	49	4	0.11	0.97	0.81	0.03	0.89	0.47	0.83
SCL-66:	494	0	1.00	0.00	0.18	1.00	0.00	0.18	0.00
Sleep that is	284	1	0.89	0.52	0.59	0.48	0.11	0.29	0.96
restless or	160	2	0.71	0.79	0.77	0.21	0.29	0.43	0.93
disturbed	111	3	0.49	0.90	0.82	0.10	0.55	0.51	0.88
	69	4	0.20	0.97	0.83	0.03	0.80	0.61	0.84

†† Probable insomnia based on approximated diagnosis using DSM-V criteria.
* 0 = not at all distressed; 1 = a little bit distressed; 2 = moderately distressed; 3 = quite a bit distressed; 4 = extremely distressed

Figure 3.1. ROC Plots for Single-Item Measures Predicting Overall Poor Sleep among U.S. Military Veterans (N = 1,118)
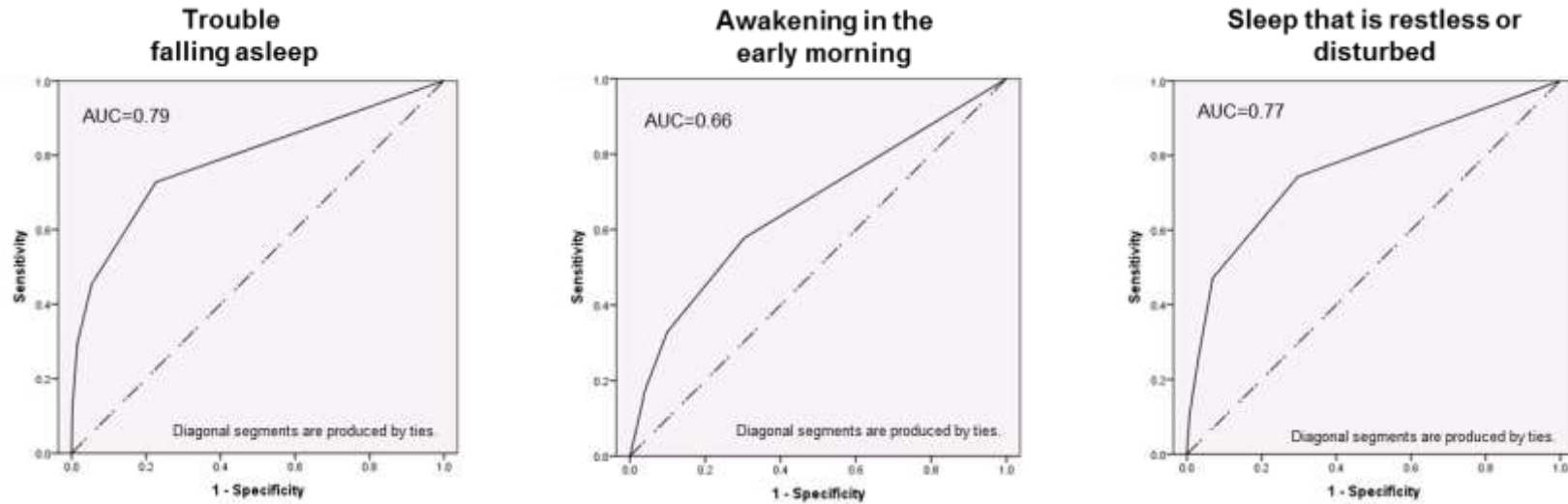
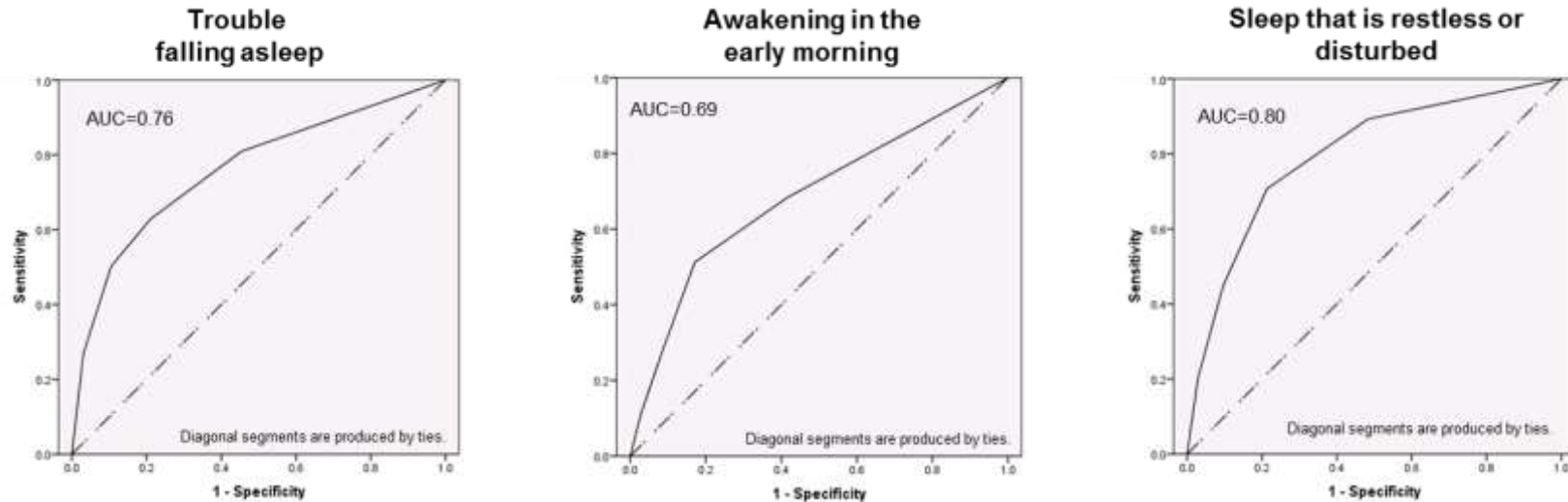Figure 3.2. ROC Plots for Single-Item Measures Predicting Probable Insomnia among U.S. Military Veterans (N = 1,118)

Table 3.4. Criteria Used to Approximate DSM-5 Probable Insomnia among U.S. Military Veterans

	DSM-V Criterion	Criterion Met if One or More of the Following was Endorsed
Criterion A	Dissatisfaction with sleep quantity or quality, with one or more symptoms: Difficulty initiating sleep; Difficulty maintaining sleep; or, Early morning awakening	Cannot get to sleep within 30 minutes (PSQI, Item 5_1); _or_, Wake up in the middle of the night or early morning (PSQI, Item 5_2); _or,_ Difficulty falling or staying asleep (DTS: Item 12_1)
Criterion B	Sleep disturbance causes significant distress or impairment in social, occupational, educational, academic, behavior, or other impaired areas of functioning	Trouble staying awake while driving, eating meals, or engaging in social activities (PSQI, Item 8, Response of three or more times/week); _or_, Problem keeping up enough enthusiasm to get things done (PSQI, Item 9, Response of somewhat of a problem or a very big problem); _or,_ Too tired or fatigued to do a lot of the things I used to do (BDI, Item 20); _or_ , Too tired or fatigued to do most of the things I used to do (BDI, Item 20)
Criterion C	3x/week for at least 3 months despite an adequate opportunity for sleep	Frequency evaluated by one or more of the complaints listed under Criterion A endorsed as occurring three or more times per week Cannot confirm duration of symptoms at this time
Criterion D	Does not co-occur with another sleep disorder	Cannot confirm at this time; no sleep history available
Criterion E	Insomnia complaints are not explained by co-existing mental disorders or medical conditions	Cannot confirm at this time; no sleep history or medical history available

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CONCLUSION

Together, these three dissertation papers examined several existing theoretical and clinical gaps pertaining to the growing prevalence of sleep problems in U.S. military Veterans. Although these papers focused primarily on OEF/OIF Veterans, one goal of this dissertation was to fuel further discussion and research regarding the long-term consequences of military service and importance of early detection and treatment of sleep problems. Establishing a better understanding of the relationship between stress, sleep problems, resilience, and psychological distress may help researchers prevent long-term consequences of military service in this most recent cohort of Veterans.

Paper One presented an original integrative theoretical model that addressed several major gaps in the literature. First, this model focused on the role of insomnia-like sleep problems as a consequence of a stressful life event *and* predictor of additional stress. By combining constructs from behavioral sleep medicine, health psychology, health services, and lifespan developmental psychology, this model advocated for a reconceptualization of insomnia-like sleep problems as often chronic and cyclical rather than acute and unidirectional in nature. Second, this paper explored long-term consequences of such problems not currently addressed in existing theoretical models. Specifically, this model proposed that sleep problems trigger a series of interrelated negative outcomes. Sleep problems impair function, which then reduces adaptive capacity. This decrease in coping ability may then increase an individual's vulnerability to stressors and lead to poor stress reactions. Over time, this cycle of impaired function, reduce

capacity, and repeated stress may contribute to negative physical and psychological health outcomes, including incident mental health disorders.

Paper One established a strong foundation for additional research in several areas. The highest priority should be the collection of longitudinal data from a variety of sources, including self-reported questionnaires on sleep, health, and stress, administrative data on healthcare utilization, and measures of physiological and psychological resilience. Such data will help researchers to better understand the prevalence and trajectories of sleep problems in Veterans while also studying how such problems impact Veterans' quality-of-life, functional status, and healthcare utilization over the life course. Findings from such studies may aid clinical and behavioral researchers in designing, evaluating, and implementing preventive interventions that can address sleep problems early in their course as a means of maintaining functional independence and promoting healthy aging.

Paper Two explored the association between poor sleep and psychological distress in a sample of military Veterans free from a past-month DSM-defined mental health disorder. Results indicated that more severe sleep problems were associated with greater psychological distress, explaining an additional 16 percent of the variance after demographic, health, and military characteristic variables were entered into the regression model. In addition, psychological resilience factors – adaptability and self-efficacy – significantly moderated the relationship between sleep problems and distress. These results are significant for two reasons. First, sleep problems were associated with greater psychological distress in Veterans without a past-month mental health disorder. Second, psychological resilience may be an important, modifiable target of behavioral interventions.

These findings highlight that sleep problems are positively associated with psychological distress in individuals free of a past-month mental health disorder, thereby supporting the need to assess and treat sleep problems early in their course. These findings also suggest that positive stress-coping may reduce risk for psychological distress in Veterans with sleep problems. As suggested by Gehrman et al. (2013), a reduction in coping ability may be one mechanism through which chronic sleep problems contribute to incident mental health disorders. Longitudinal studies are needed to better understand several issues including the: (1) temporality and directionality of the relationship between sleep problems and psychological distress; (2) stability and change in sleep problems and resilience over time, including how changes in sleep problems enhance or degrade resilience over time; and (3) rate at which sleep problems contribute to clinically significant psychological distress associated with a mental health disorder.

Paper Three extended findings of Papers One and Two and studied sleep problems though a more applied, clinical lens. Informed by principles of health services research, Paper Three addressed a current clinical gap in that sleep problems are prevalent among U.S. military Veterans but are not routinely addressed in primary care settings. Noting the high prevalence of social workers in VHA care settings (National VA Social Work Public Relations Committee, 2013) and their potential to address this growing problem (Franklin, 2009; Strong et al., 2014), Paper Three examined the utility of single-item sleep measures embedded in existing psychological assessments. Results indicated that three particular items assessing trouble falling sleep, awakening early in the morning, and sleep that is restless or disturbed, demonstrated moderate sensitivity in predicting poor sleep and DSM-defined probable insomnia. Results suggested that respondents reporting sleep problems of moderate or greater distress (i.e.,

response score ≥ 2) may exhibit clinically significant sleep problems and should be triaged for additional sleep screening.

Clinicians should integrate brief screeners into all primary care encounters as repeat assessments will allow researchers to examine the stability and change in Veterans' reports of sleep problems. For instance, it is unknown how long Veterans who respond that symptoms of poor sleep are "only a little distressing" (response score = 1) remain at this level before starting to experience more severe and/or distressing sleep problems. Given mental health symptoms tend to increase in Veterans over time (Milliken et al., 2007; Vasterling et al., 2010), repeat assessments may also aid in early detection and treatment of sleep problems as a means of preventing incident mental health disorders. Additionally, mixed method study designs, including the use of qualitative interviews, may help researchers better understand how Veterans evaluate sleep problems and how clinicians do or do not prioritize screening in primary care settings.

These dissertation papers highlight the importance of early detection of sleep problems in U.S. military Veterans and provide initial guidance vis-à-vis utilizing existing single-item sleep measures to assess for such problems. By identifying a positive association between poor sleep and psychological distress, these papers suggest that sleep problems should continue to be a high priority of VHA clinicians and health services researchers. Future research should include a variety of survey, cohort, intervention, and mixed methods studies that can further address the following topics:

- o Stability and change in symptoms of poor sleep over time;

- o Mechanisms by which sleep problems become chronic, including how sleep problems contribute to negative outcomes, including incident mental health disorders ;

- o Brief assessment methods; and,

- o Brief treatment that can be delivered by clinical social workers, especially those working in integrated primary care settings

In closing, it is clear that a multicomponent sleep research plan is needed. This research agenda is best addressed through collaborative, interdisciplinary efforts bringing together researchers and practitioners from social work, clinical health psychology, health services, and implementation science. The cultural climate of VHA provides fertile ground for acknowledging and integrating sleep problems into routine primary care. In recent years, the VHA has adopted a greater focus on Veteran-centered care and programs that focus on overall health and wellness with an eye towards optimizing and maintaining function (Krejci et al., 2014). VHA has also risen as a leader in integrated care, through primary care mental health integration (PCMHI) (Post, Metzger, Dumas, & Lehmann, 2010; Zeiss & Karlin, 2008) and the patient-centered medical home, known as the Patient-Aligned Care Team (PACT) (Kearney, Post, Pomerantz, & Zeiss, 2014; Kearney, Post, Zeiss, Goldstein, & Dundon, 2011). These models integrate behavioral health specialists into primary care, allowing Veterans to receive quick assessment and treatment for mental health-related concerns. Given known links between sleep problems and mental health outcomes, this type of delivery setting is ideal for screening and treating sleep problems. Grounded in holistic, wellness-oriented models, social workers are well-qualified to screen for sleep problems and deliver brief behavioral treatments. However, social workers must be integrated into the core provider team within PACT and PCMHI rather than serving in a more

secondary role. Future research should examine the effects of utilizing social workers in a more

active, integrated manner.

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