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SLEEP DISTUBRANCES AMONG COMBAT MILITARY VETERANS:

A COMPARATIVE STUDY

by

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B.A. The College of William and Mary, 2012

A thesis submitted in partial fulfillment of the requirements
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ABSTRACT

The sleep characteristics of 37 military combat veterans (17 with PTSD and 20 without PTSD) of recent wars were analyzed to determine if combat deployment, with its resultant wartime sleep restriction, may be an alternative explanation for the sleep duration complaints found among combat veterans with PTSD (as determined by PCL-M scores). Participants completed sleep actigraphy and a self-report measure of sleep duration over a 1-week period. Although strongly correlated, a comparison of subjective (e.g., self-report) and objective (e.g., actigraphy) sleep duration revealed a significant difference in sleep duration based on method of assessment. With respect to group differences, actigraphy data did not reveal a significant difference in sleep duration based on the presence of PTSD, whereas there was a significant difference based on self-report. Veterans without PTSD self- reported a significantly longer sleep duration than what was recorded by actigraphy; a difference of one hour and 11 minutes ($p = 0.000$); the difference was one hour and nine minutes. In an effort to determine why veterans without PTSD perceived that they slept longer than they actually did, factors related to sleep quality were examined. The results indicated that measures of hyper arousal (anger, anxiety, nightmares) were significantly correlated with sleep duration, suggesting a pattern of autonomic arousal that is known to interfere with restful sleep. Further research is necessary to determine if the sleep of veteran with PTSD is actually different from that of combat veterans without PTSD, and if such differences are actually amenable to treatment for PTSD.

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LIST OF ACRONYMS

CAPS	Clinician Administered PTSD Scale
CAR	Combat Action Ribbon
DSM	Diagnostic and Statistical Manual of Mental Disorders
MOS	Military Occupancy Specialty
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OND	Operation New Dawn
OSA	Obstructive Sleep Apnea
PCL-M	Post-Traumatic Stress Disorder Check List Military Version
PSQI	Pittsburgh Sleep Quality Index
PSQIA	Pittsburgh Sleep Quality Index Addendum
PTSD	Post-Traumatic Stress Disorder
QOLI	The Quality of Life Inventory
RESTORES	RESearch and Treatment On Response to Extreme Stressors
TBI	Traumatic Brain Injury
WASO	Wake After Sleep Onset

CHAPTER ONE: INTRODUCTION

The inability to achieve restful sleep may result from a number of sources including sleep disorders such as obstructive sleep apnea (OSA), insomnia, snoring, and behaviorally induced insufficient sleep syndrome (Banks & Dinges, 2007). In other instances, environmental causes, such as deliberate sleep restriction, may result in complete or partial sleep deprivation (Banks & Dinges, 2007). Typically, sleep restriction is conceptualized as a reduction in sleep from an average of 8 hours per night to an average of 4 hours per night (Banks & Dinges, 2007; Belenky et al., 2003; Dinges et al., 1997). Chronic sleep restriction is associated with decreased alertness, impaired judgment on one's performance readiness, and increased risk for errors and accidents (Banks & Dinges, 2007; Belenky et al., 2003; Dinges et al., 1997). Almost anyone may encounter situations that result in sleep restriction, but certain populations, such as military personnel, are at higher risk due to demanding working environments and conditions.

Sleep restriction is common during military training and it is an inevitable component of war (Miller, Matsangas, & Shattuck, 2007)). Part of the issue is the "Prevailing culture that depriving oneself of sleep is a means of demonstrating mental and physical toughness" (Mysliwiec et al., 2013, p. 171). In addition to deliberate sleep restriction, factors such as unfamiliar environment, fear of attack, hazardous working conditions, inconsistent work hours, and insufficient numbers of personnel may also contribute to complications with sleep (Miller, Matsangas, & Shattuck, 2007; Seelig et al., 2010). A recent study suggests that combat veterans of Operation Enduring Freedom (OEF), Operation Iraqi Freedom (OIF), and Operation New Dawn (OND) reported disrupted sleep as compared to veterans who did not deploy (Seelig et al., 2010). Unfortunately, deployed veterans are not only at risk for chronic sleep restriction during

deployments, but their sleep difficulties may persist even after their deployments have ended. Veterans deemed “combat deployers” reported less average sleep duration and were more likely to report trouble sleeping even after returning state-side (Seelig et al., 2010). Given the high number of military deployed, there is reason to be concerned about sleep complaints in these personnel. Data from VA health care records reveal a sharp rise in the number of veterans receiving disability benefits for a sleeping disorder; in fact, sleep disorders alone cost taxpayers more than $500 million per year (Bagalman, 2013).

As with sleep difficulties, posttraumatic stress disorder (PTSD) is a common complaint among OIF and OEF combatants. It constitutes the third most common reason for filing a disability claim (McNally & Frueh, 2013). Problems with anger management, impairment of occupational and social areas of living, numbing, hyper vigilance, flashbacks, avoidance of previously enjoyable and/or important life events, and significant clinical distress are all commonly associated with PTSD (Beidel et al., 2011). Insomnia and other sleep related disorders are also primary complaints among veterans with PTSD and in turn, these sleep difficulties, can further exacerbate other symptoms (Lamarche, 2007). Thus, inadequate or deficient sleep may not just be a symptom of PTSD, but may actually play a role in the maintenance of the disorder.

Without sufficient sleep, memories are not efficiently consolidated, and overall restoration of the body, including the central nervous system, does not occur (Lee, & Douglass, 2010)). One hypothesis is that sleep may function to remove the emotional valence of a memory. Particularly in light of the emotional memories associated with traumatic events, sleep may be an important factor in diminishing the emotional aspect of a memory, while leaving the

factual information intact (Lee, & Douglass, 2010). Additionally, many PTSD symptoms such as hyperarousal tend to disrupt normal sleep patterns, setting up a vicious and self-perpetuating cycle. Recent data suggest that the largest and second largest mediation effect in the relationship between combat stressors and PTSD and depression symptoms are insomnia and nightmares (Picchioni et al., 2010). Based on those data, the authors concluded that inadequate or disrupted sleep contributes to the development and/or maintenance of serious psychiatric disorders and that early intervention could mitigate other mental health consequences. However, most interventions for PTSD do not address sleep directly (Spoormaker & Montgomery, 2008), perhaps one reason why sleep is one of the symptoms least likely to improve with even the best treatments for PTSD.

However, an alternative hypothesis is that complaints of sleep deprivation (lack of adequate sleep) may not be a symptom of combat-related PTSD but may simply be a result of the sleep restriction as a result of deployment. For example, combat veterans with and without posttraumatic stress disorder (PTSD) report sleep disturbances due to sleep restriction (Miller et al., 2008; Mysliwiec et al., 2013; Peterson, Goodie, Satterfield, & Brim, 2008)). In one study, 100% of Australian Vietnam war veterans with PTSD and 90% of veterans without PTSD self-reported clinically significant sleep disturbances using the Pittsburgh Sleep Quality Index (PSQI; which does not include reports of flashbacks and nightmares) (Lewis, Creamer, & Failla, 2009)), and these findings have been corroborated by other investigators using a United States sample (Capaldi, Guerrero, & Kilgore, 2011). Thus, sleep disturbances may be common among veterans with PTSD but they also appear common among veterans without PTSD but who have been deployed to combat areas.

An additional concern is that self-report of hours of sleep or sleep quality may not accurately reflect reality because people, especially insomniacs, have difficulty assessing their own sleep (Lockley, Skene, & Arendt, 1999). Specifically, insomniacs have been known to consistently underestimate their sleep duration and overestimate their sleep latency (Carskadon et al., 1976). Other limitations of sleep self-report include inaccurate and possibly confusing framing, format or context of the question, issues with how people quantitatively report their sleep, and cognitive processing errors such as heuristic short cuts that people are naturally prone to make (Gehrman, Turingan, Dinh, & Ancoli-Israel, 2002). These limitations may explain why the correlation between self-reports of sleep and actigraphy was r=0.47 (Gehrman, Turingan, Dinh, & Ancoli-Israel, 2002). In fact, self-report of sleep actually overestimated sleep when compared to actigraphy, and over reporting was greater when the actual amount of sleep was less (e.g., persons sleeping 5 hours reported that they slept 6.3 hours, whereas persons sleeping 7 hours reported that they slept 7.4 hours (Lauderdale, Knutson & Rathouz, 2008). Thus, an accurate understanding of sleep difficulties in combat deployed veterans with or without PTSD hinges on accurate assessment. Polysomnography is considered the gold standard but its clinical utility is questionable given the invasive nature, novel sleep laboratory environment, and expensive cost (Ancoli-Israel et al., 2003; Sivertsen et al., 2006; Souza et al., 2003; Toussaint et al., 1995). Actigraphy offers a cheaper, alternative method of objectively measuring sleep. It is less intrusive, making it potentially more appropriate for every-day clinical use.

Few studies have actually compared self-report and actigraphy to assess sleep in veterans with combat-related PTSD. In perhaps the only controlled study to our knowledge (Westermeyer et al., 2007) study participants reported 51 minutes less sleep than observed via

actigraphy and when compared to actigraphy, “patients suffering from PTSD and insomnia failed to note many of their awakenings…” (p. 973-974). However, Westermeyer et. al.’s (2007) study had several limitations that restrict the study’s conclusions, particularly as it affects the sleep problems of younger combat veterans, such as those returning from OIF/OEF/OND. First, the sample consisted of older veteran with a mean age of 54.76 (range of 34-80). The age of the sample is important because sleep complaints are a common problem among older people, whether or not they served in the military or had a diagnosis of PTSD. Therefore, it is unclear if these sleep problems represent the presence of PTSD or reflect advancing age. Second, not all of the veterans in that study served under combat conditions, thus, it is not clear that sleep complaints are the result of PTSD or some other psychological condition. Third, not all veterans were diagnosed with current PTSD at the time of the study; some had a lifetime diagnosis but not a current diagnosis. Therefore, it remains unclear if those without current PTSD may have confounded the study findings, and making the utility of these data, as it affects current combatants, unclear.

In summary, sleep complaints are common among armed services personnel returning from OIF/OEF/OND who have been diagnosed with combat-related PTSD, but it is unclear if their complaints are significantly different from other returning personnel who have been subject to sleep restriction but who do not suffer from PTSD. The present study focuses on comparing actigraphy to self-report of sleep in military combat veterans with and without PTSD. Specifically, the purpose of this comparative study is to test the utility of self-report measures of sleep compared to actigraphy for OIF/OEF/OND combat veterans with and without current PTSD. The primary hypothesis of this investigation is that sleep self-report measures will be

correlated with actigraphy data but that self-report measures will over-report sleep duration and sleep quality when compared to objective measurements of sleep (e.g., actigraphy). The second hypothesis is that, regardless of current PTSD diagnosis, all combat veterans will endorse sleep difficulties; however, veterans with combat PTSD will report significantly less sleep duration and sleep quality on both measures.

CHAPTER TWO: METHOD

Participants

Forty-eight military personnel who had returned from deployment in either the OIF/OEF/OND operations (20 per group; see Power and Sample Size Calculations) participated in the study. Half of the participants met DSM criteria for current PTSD and the other 50% did not meet criteria for PTSD in their lifetime. Participants with PTSD were drawn from an ongoing clinical trial of Trauma Management Therapy for PTSD conducted at the UCF RESearch and Treatment On Response to Extreme Stressors (RESTORES) clinic.

Participants with PTSD met all inclusion/exclusion criteria for the treatment study. Specifically, participants with comorbid Axis I psychotic disorders or acute substance abuse disorders were excluded. Since PTSD typically is accompanied by high rates of comorbid psychiatric disorders (Keane & Wolfe, 1990), patients with comorbid depressive disorders, anxiety disorders, and personality disorders other than Antisocial Personality Disorder were included. Also, veterans who have a diagnosis of mild Traumatic Brain Injury were included and other psychotropic medications were allowed; however, participants were excluded if they were not off of benzodiazepines for at least two weeks prior to the study. Finally, participants taking medications specifically to promote sleep (Ambien, Prazosin) were excluded from this sleep study.

Participants without PTSD had to have served in OEF/OIF/OND and provided (a) their combat Military Occupancy Specialty (MOS) and evidence that they served in combat operations (e.g., qualification for a Combat Action Ribbon (CAR) or similar evidence). All exclusionary

criteria that applied to the combat veterans with PTSD applied to combat veterans without PTSD. Other exclusionary criteria included homelessness, severe substance abuse, and major sleep disorder. Any veteran suspected of suffering from a major sleep disorder such as sleep apnea or restless leg disorder was excluded from the study, and they were referred to a sleep specialist.

Measures

Clinician-Administered PTSD Scale (CAPS)

Assessment for the presence of PTSD was determined by the Clinician-Administered PTSD Scale for DSM-IV (CAPS; Blake et al., 1995). The CAPS evaluates the frequency and intensity of the 17 DSM IV PTSD symptoms on a 0 to 4 Likert-scale. Specifically, it scores the symptoms derived from the three DSM-IV subscales: re-experiencing (Criterion B), avoidance and numbing (Criterion C), and hyper arousal (Criterion D) by summing the frequency and intensity scores for relevant individual items. The CAPS was administered either in person or via telephone by licensed clinical psychologists, post-doctoral fellows, or by supervised senior doctoral students. It is a popular and widely used measure with excellent psychometric properties (Weathers, Keane, & Davidson, 2001).

PTSD Check List Military Version (PCL-M)

The severity of symptoms associated with PTSD was additionally obtained through the PTSD Check List Military Version (PCL-M; Weathers, Litz, Herman, Huska, & Keane, 1993). It is a 17-item self-report measure that obtains how much the combat veteran was bothered by each symptom. For this investigation, the time frame was adjusted to a one week timeframe to

better fit with the treatment trial parameters. A five-point Likert-scale allows the participant to rate the symptom severity on a scale from 1 (not at all) to 5 (extremely). The PCL-M is highly correlated with the CAPS (0.93; Blanchard, Jones-Alexander, Buckley, & Forneris, 1996), and researchers found it to have good reliability and validity (Wilkins, Lang, & Norman, 2011).

Pittsburgh Sleep Quality Index Addendum (PSQIA)

The Pittsburgh Sleep Quality Index Addendum (PSQIA; Germain, Hall, Krakow, Shear, & Buysse, 2005) is a self-report instrument that assesses sleep quality and disturbances over a one-month time interval. It allows the rater to describe the disruptive nocturnal behaviors that are associated with PTSD to include: hot flashes, general nervousness, trauma and non-trauma related nightmares, anxiety unrelated to trauma, awakening in terror, and acting out a dream. In addition, if memories or nightmares of a trauma were endorsed, additional questions ask the rater to report when a nightmare occurred and how severe the anxiety and anger associated with the nightmare was for the veteran (Germain, Hall, Krakow, Shear, & Buysse, 2005). Overall, higher PSQIA ratings are highly correlated with greater PTSD severity, and, when attempting to identify male military veterans with current PTSD, one study reported a 71% sensitivity rate and a 76% specificity rate (Insana, Hall, Buysse, & Germain, 2013).

Sleep Watch Actigraph

Actigraphs, manufactured by Ambulatory Monitoring, Inc, were used to objectively measure (a) total sleep time compared to wake time and (b) sleep quality in a non-invasive manner. The device measures gross motor activity of the wrist and continually records movement. The data are downloaded and analyzed by using computer generated algorithms. Actigraphy boasts high correlation (0.97) with polysomnography in several studies assessing

sleep and wakefulness (Jean-Louis, VonGizycki, & Zizi, 1996). Specific variables analyzed in this investigation included (a) sleep minutes (amount of actual sleep time in a sleep period calculated as total sleep period less movement and awake time), (b) WASO (wake after sleep onset – defined as the sum of wake times determined from movement in an epoch (period of sleep) from sleep onset to the final awakening), (c) sleep efficiency (proportion of sleep in the period potentially filled by sleep-ratio of total sleep time to time in bed), (d) sleep latency (time period measured from "lights out," or bedtime, to the beginning of sleep), and (e) sleep duration (which includes WASO and sleep latency).

Self-Report Sleep Log

A Self-Report Sleep Log and overall activity log was given to the participants to fill out daily for seven days in order to determine their subjective assessment of sleep duration and any interfering events during the sleep period. Other self-report variables on the overall activity log included frequency of nightmares, flashbacks, social activities, exercise, and amount of caffeine used, as well as ratings of anger and anxiety.

Procedure

The participants were recruited through flyers, radio advertisements, websites, and military oriented TMT outreach events. A telephone screen was used to determine eligibility. Those deemed eligible were invited to the clinic to participate in the study. Participants were administered the CAPS to confirm the presence or absence of PTSD. After completing the CAPS, the participant completed the PCLM and the PSQIA. They were also instructed on the use of the actigraph, which they wore nightly for one week, and the daily self-report sleep log.

After return of the actigraph, participants with PTSD began treatment and participants without PTSD were compensated with a $25 gift card for their participation.

CHAPTER THREE: RESULTS

Twenty-four combat veterans with PTSD and 24 combat veterans without PTSD were admitted to the study. Seven of the 24 combat veterans with PTSD (PTSD group) and 4 of the combat veterans without PTSD (no PTSD group) were not included in the final analysis because they either failed to wear the watch for at least 3 nights or they did not fill out the sleep self-reports. Thirty-seven combat veterans thus provided data that could be analyzed. Overall, the group with PTSD wore the watch for an average of 5.88 nights, whereas the group without PTSD wore the watch for an average of 6.75 nights. Demographics of the two groups are listed in Table 1. A series of *t*-tests and *chi* square analyses revealed significant group differences only age and employments status. Specifically, veterans with PTSD were older (M = 34.29 vs. M = 29.40), t (35) =-2.96, p = .006), and more likely to be unemployed (35% vs. 0%, $\chi(2)$ = -3.212, p = .003) than the without PTSD group. As expected, an independent-samples *t*-test indicated that PCLM scores were significantly higher for the PTSD group (M = 60.82, SD = 16.13) than the non- PTSD group (M = 25.45, SD = 8.01), t (23) = -8.648, p < .000, d = 2.78. Similarly, an independent-samples t-test indicated that CAPS total scores were significantly higher for the PTSD group (M = 82.59, SD = 26.57) than the non-PTSD group (M = 17.87, SD = 15.28), t (26) = -8.292, p < .000, d = 0.35.

The primary hypothesis was that despite diagnostic category, self-reported sleep duration would be correlated with actigraphy data but that self-report measures would over-report sleep duration. Across all participants, there was a significant positive correlation between the two assessment methods (r = .490, n = 37, p = .002) and a paired-samples t-test indicated that there was a significant difference in sleep duration when assessed by self-report (minutes) (μ=403.72,

SD=82.47) and actigraphy (μ =366.61, SD=52.20; t (36) =-3.10, p = .004). Across the entire sample measures participants overestimated their sleep duration by an average of 37.11 minutes.

The second hypothesis was that, regardless of PTSD diagnosis, all combat veterans will endorse shortened sleep duration as a result of sleep restriction during deployment. As indicated above, regardless of diagnosis, veterans returning from combat deployment reported sleeping an average of 6 hours and 6.6 minutes (based on actigraphy) or 6 hours and 43.7 minutes (based on self-report) per night. With respect to between group differences, actigraphy data did not reveal a significant difference in sleep duration between veterans with or without PTSD (μ =360.96, SD=65.74 vs. μ =371.42, SD=38.34); t (35) = 0.602, p = .551; see Table 3). Veterans with PTSD slept 6 hours and 1.0 minute compared to 6 hours and 11.4 minutes for veterans without PTSD, a difference of 10.4 minutes. In contrast, veterans with PTSD self-reported significantly less sleep than veterans without PTSD (μ =360.85, SD=97.03 vs.μ =440.16, SD=43.77; t (35)=3.289, p = .002); veterans with PTSD reported 6 hours and 9 minutes of sleep compared to 7 hours and 20 minutes reported by veterans without PTSD, a difference of 1 hour and 11 minutes. Examined differently, a paired sample t-test indicated that veterans without PTSD self-reported a longer sleep duration (μ =440.16, SD = 43.77) than what was recorded by actigraphy (μ =371.42, SD=38.34; t (19) = -6.591, p = 0.000); the difference was one hour and nine minutes. In contrast, for veterans with PTSD, sleep duration was not significantly different for self-report (μ =360.85, SD=97.03) vs. actigraphy (μ =360.96, SD=65.74; t (16) =0.005, p = 0.996); self-report of sleep was only 0.11 minutes less than actigraphy.

In an effort to understand why veterans without PTSD over-estimated their sleep duration, other factors related to sleep quality (frequency of nightmares, scores on the PSQIA)

were compared. Veterans with PTSD reported significantly more nightmares per week than veterans without PTSD (μ =4.31, SD=4.80 vs μ =0.75, SD=1.74; t (34) = -3.08, p = 0.004). Veterans with PTSD also had significantly greater scores on the PSQIA, which is indicative of poorer overall sleep quality (μ = 10.65, SD = 4.42) vs (μ = 2.70, SD= 2.64; t (35) = -6.76, p = 0.000). An examination of the individual items comprising the PSQIA revealed significant group differences for all items except for two questions: question 1-e, which was a question about how many bad dreams not related to traumatic memories did the rater have in the past month, and item 2-c, which was what time of night did most memories/nightmares occur (see Table 3).

In contrast, there were no significant group differences on objective measures of sleep quality as assessed by actigraphy. There was no group difference in terms of the WASO scores (wake time from sleep onset to final awakening) for veterans with or without PTSD, respectively (μ = 34.10, SD = 28.89 vs μ = 37.34, SD= 28.89; t (35) = .366, p = 0.386). With regards to sleep latency, there was no significant difference after removing one veteran without PTSD's sleep latency (amount of time spent in bed until person is asleep determined by a consistent reduction of movement) score of 57. One other veteran without PTSD had a sleep latency score of 7 minutes; however, all other veterans in both groups had sleep latency scores of zero. When asked why the one participant had a sleep latency score of 57, he indicated he was sleep training his infant. Therefore, that veteran's sleep latency score was not included in the analysis. When the other participant with a sleep latency score of 7 was included, the group differences were not significantly different. Finally, there was no significant difference on sleep efficiency. Veterans with PTSD and veterans without PTSD exhibited high levels of sleep efficiency (μ = 90.85, SD

= 5.73 vs μ = 91.12, SD = 6.24; t (35) = 0.135, p = 0.894). These findings suggest that subjectively veterans with PTSD are reporting overall poorer sleep quality, but the reason for this difference is not discernible by measures of actigraphy.

Exploratory analyses were conducted to determine whether general measures of emotional arousal (anxiety, anger, nightmares) or behaviors known to promote or attenuate sleep quality (caffeinated beverages, exercise, tobacco use) might explain the differences in subjective sleep quality. Veterans with PTSD endorsed more total flashbacks in a week (μ = 8.69, SD = 14.87) vs without PTSD (μ = 0.40, SD= 0.184; t (34) = -2.497, p = 0.018), higher global anger ratings on a 1-10 scale (μ = 4.79, SD = 2.65) vs without PTSD (μ = 2.19, SD= 1.57; t (34) = -3.67, p = 0.001), and higher global anxiety ratings on a 1-10 scale (μ = 5.73, SD = 3.44) vs without PTSD (μ = 2.45, SD= 1.62; t(33) = .-3.70, p = 0.001).

Correlations between these variables and both self-report and actigraphy measures of sleep duration were examined. There were significant, negative correlations between total number of nightmares and sleep duration as assessed by self-report (r = -.478, n = 36, p = .003) as well as total number of nightmares and sleep duration as assessed by actigraphy (r = -.365, n = 36, p = .029). There were significant negative correlations between ratings of global anger and self-report of sleep duration (r = -.523, n = 36, p = .001) and global anger and sleep duration as assessed by actigraphy (r = -.513, n = 36, p = .001). Similarly, global anxiety ratings were significantly and negatively correlated with self-report of sleep duration (r = -.513, n = 35, p = .002) and as assessed by actigraphy (r = -.391, n = 35, p = .020). Self-report of sleep was significantly negatively correlated with total number of flashbacks (r = -.329, n = 36, p = .05), and the actigraphy sleep duration was significantly negatively correlated with physical rage

episodes (r = -.367, n = 35, p = .030). Weekly averages of caffeine beverages, exercise, tobacco, social activities were not significantly correlated with either sleep measure methods.

Finally, correlations between individual CAPS items and both self-report and actigraphy measures of sleep duration were examined for the entire sample. The following CAPS items were significantly and negatively correlated with both self-report and actigraphy assessment of sleep (see Table 5 and Table 6): intrusive thoughts (r = -.506, n = 30, p = .004; vs r = -.453, n = 30, p = .012), dreams (r = -.573, n = 30, p = .001; vs r = -.419, n = 30, p = .017), psychological distress (r = -.576, n = 30, p = .001; vs r = -.430, n = 30, p = .018), physiological distress (r = -.584, n = 30, p = .001; vs r = -.368, n = 30, p = .046) distress and startle response (r = -.696, n = 30, p = .000; vs r = -.372, n = 30, p = .043). Additionally, self-report of sleep duration was significantly and negatively correlated with diminished interest (r = -.397, n = 30, p = .030), difficulty falling asleep (r = -.366, n = 30, p = .047), irritability/anger (r = -.414, n = 30, p = .023), and poor concentration (r = -.384, n = 30, p = .036). Sleep duration as assessed by actigraphy was significantly and negatively correlated with restricted range of affect (r = -.368, n = 30, p = .045).

CHAPTER FOUR: DISCUSSION

War time factors contributing to sleep restriction such as fear of attack, hazardous working conditions, and inconsistent work hours may put combat veterans at higher risk of sleep difficulties. What is unclear is if these sleep disturbances may extend past their combat deployment, and if so, whether this disturbed sleep pattern is a result of combat deployment and not necessarily combat-related PTSD. One purpose of this study was to determine if combat veterans continue to have sleep difficulties after their combat experiences using both self-report and objective methods of sleep assessment. The results of this investigation reveal that veterans of the OIF/OEF/OND conflicts report sleeping 6 hours and 47 minutes per night (6 hours and 6.6 minutes per night based on actigraphy data). These figures are less than, but not inconsistent with, a recent poll of adults over the age of 18 who reported sleeping an average of 7 hours and 6 minutes per night (National Sleep Foundation, 2015). These data suggest that, overall, the sleep restriction that occurs during military deployment may not, in itself, have significant lasting effects once the veteran returns home.

Although returning combat veterans, as a group, do not suffer from significant sleep deprivation, this investigation, as well as others, reveals that self-reports of sleep are not entirely accurate. When compared to actigraphy, participants in this investigation overestimated their sleep duration by an average of 37.11 minutes, consistent with another sample of young adult participants' who over- reported their sleep duration by an average of 48 minutes (Lauderdale et al., 2008). In contrast, Westermeyer (2007) reported that veterans with lifetime PTSD under-reported their sleep by an average of 51 minutes than recorded by actigraphy. Although it is not clear why some samples, under-report and others over-report, it appears that all adults are able to

assess their sleep duration within one hour of objective measures such as actigraphy. Whether that estimate is sufficient for clinical or research purposes (diagnosis, assessment, or treatment planning) will be a decision made by each particular program.

Actigraphy data revealed that there were no group differences in objective measures of sleep for veterans with PTSD and without PTSD. Specifically, there were no group differences for sleep length, WASO, sleep latency, or sleep efficiency. If sleep patterns for returning personnel are similar regardless of the presence of PTSD, then it may be unrealistic to expect major gains in sleep duration as an appropriate treatment outcome target. It could however suggest that interventions for sleep, particularly sleep duration, should be more commonly offered to all returning service personnel.

Comparing actigraphy to self-report, veterans with PTSD were more accurate self-reporters than veterans without PTSD, who over reported their sleep duration by 1 hour and 9 minutes. It is possible that this over reporting by veterans without PTSD represented satisfaction with their sleep or perhaps good sleep quality, allowing them to feel rested and refreshed upon awakening. The intriguing question is why this group so grossly overestimated their sleep duration. Polysomnography may shed some light on this issue.

A meta-analysis (Kobayashi, Boarts, & Delahanty, 2007) suggested that the sleep of adults with PTSD (but not necessarily combat-PTSD), as assessed by polysomnography, was characterized by more stage 1 sleep, less slow wave sleep, and great rapid-eye movement density. These three sleep characteristics are suggested to reflect hyperarousal of the central nervous system during the sleep of patients with PTSD (Mellman, Kumar et al., 1995; Woodward, Murberg, & Bliwise, 2000). In an attempt to determine if hyper arousal (or lack

thereof) might explain why participants without PTSD over-estimated their sleep duration, this study examined self-report measures of arousal and behaviors known to affect sleep. The results indicated that while there was no association between sleep duration and variables such as caffeine or exercise, there was a significant relationship with variables that indicate the presence of hyperarousal. Specifically whether self-reported or assessed by actigraphy, less sleep was significantly correlated with more nightmares, more anger, more anxiety, more flashbacks, and more episodes of physical rage, and there was a significant group difference in the frequency of these behaviors. Although we were not able to assess sleep via polysomnography, our data are consistent with the previous studies regarding hyper arousal, PTSD, and sleep. Specifically, these higher levels of daytime arousal probably reflect central nervous system arousal, which does not diminish nocturnally. Instead, this hyperarousal leads to more stage 1 sleep, less slow wave sleep, and greater rapid-eye movement density as noted above (Kobayashi et al. 2007). These altered sleep patterns are associated with poorer sleep quality. Thus, the lower levels of hyperarousal found among combat veterans without PTSD may lead to better sleep quality, and allowing them to perceive sleeping longer than they actually did. Of course, polysomnography studies are needed to more clearly delineate these relationships.

Limitations

Although some limitations of this study were unavoidable, future studies can make several improvements that can provide more insight and lead to greater elucidation of the results. A number of our veterans were not compliant with instructions regarding actigraphy or self-monitoring, leading to a smaller sample size than we originally anticipated. A larger sample size

and perhaps more frequent communication with the participants (regarding self-monitoring and reminders to wear the actigraph would improve behavioral compliance. There are now newer actigraphs allowing for increased precision and sensitivity. Polysomnography will never be available to all treating clinicians, and comparisons between these newer watches and polysomnography would elucidate the utility of the former as a reliable and valid alternative for assessing sleep in a clinical setting. In addition, expanding the sleep log to include more specific questions such as, "how many times do you remember waking up," and, "if you woke up, how long did it take you to fall back asleep," may further elucidate the subjective, but important variable of sleep quality. One may also see how nightmares affect sleep by putting both groups in a more comprehensive sleep lab that could allow for the comparison each group's overall REM sleep patterns to their number of nightmares. With regards to hyper arousal, assessment of salivary cortisol, which is a well documented way to measure stress, could objectively measure stress between the two groups. Finally, the influence of bed partners should not be over looked. A study by Pankhurst and Horne (1994) found that, although bed partners moved more in their sleep than people who slept alone, bed partners self-reported sleeping better with a partner in bed with them than they did when their bed partner was absent.

Conclusion

To our knowledge this is the first study to assess the sleep of veterans with combat-related PTSD by including a control group of veterans with the same combat experience but who are not endorsing symptoms of PTSD. Thus, it serves as an important advance in understanding the role of typical combat-deployment conditions such as sleep restriction on returning veterans.

Understanding the relationship between sleep and PTSD is critical as it could directly affect clinical conceptualization and treatment planning. The results of this study suggest that veterans with PTSD self-reported less sleep than veterans without PTSD, but this difference was not confirmed by objective assessment using actigraphy. However, any assessment of sleep will be limited by the method chosen to conduct the assessment, as was the case with this study. Furthermore, this study raises intriguing questions about the role of hyper arousal as a factor in the sleep quality of returning veterans with PTSD. Larger studies need to be conducted of combat veterans to determine if this study's findings of veterans sleep patterns hold true with most returning OEF/OIF veterans.

APPENDIX A: FIGURES

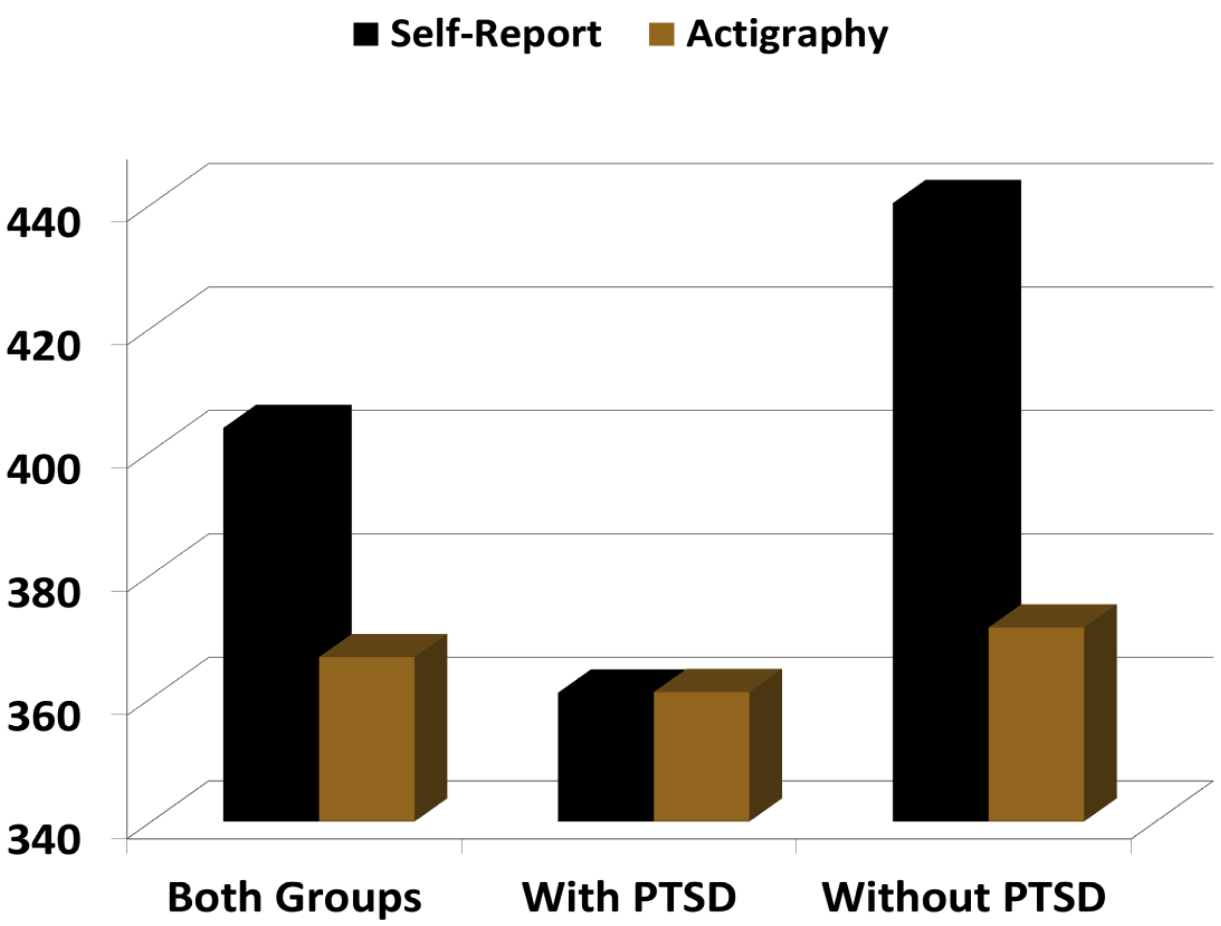


Figure 1. Self-Report and Actigraphy sleep duration averages (in minutes) of veterans

APPENDIX B: TABLES

Table 1. Demographics

	With PTSD	Without PTSD	Sig Different .05	T tests/ Chi Square
	Age			
Range	27-46	25-42	Y	t (35)=-2.96, p = .006
Mean	34.29	29.40		Mean of Both 31.65
	Time Served in Combat			
Range	7-33	8.5-25	N	t (35)=-.115, p = .909
Mean	17	16.775		Mean of Both 16.88
	Sex/Gender			
Males	15	18	N	$\chi(2)$ = 0.030, p = .863
Females	2	2		
	Race/Ethnicity			chi square
Caucasian	9	14	N	$\chi(5)$ = 2.479, p = .479
Hispanic	5	2		
African American	1	2		
Asian	2	2		
	Branch			
Army	14	10	N	$\chi(3)$ = 4.453, p = .108
USMC	3	9		
Navy	0	1		
	Employment Status			chi square
Employed	11	20	Y	$\chi(2)$ = -3.212, p = .003

	With PTSD	Without PTSD	Sig Different .05	T tests/ Chi Square
	Highest Rank Obtained			chi square
E4	9	10	N	$\chi(4) = 0.096$, $p = .992$
E5	6	8		
E7	1	1		
O3	1	1		
	Marital Status			chi square
Single	5	10	N	$\chi(4) = 5.04$, $p = .169$
Married	7	9		
Separated	2	1		
Divorced	3	0		
	With PTSD	Without PTSD	Sig Different .05	*t* tests
	(N=17) Mean (SD)	(N=20) Mean (SD)		
PCLM	60.82 (16.13)	25.45(8.01)	Y	$t(23) = -8.648$, $p < .000$, $d = 2.78$
	(N=17)	(N=15)		
CAPS	82.59 (26.57)	17.87 (15.28)	Y	$t(26) = -8.292$, $p < .000$, $d = 0.35$

Table 2. Self-Report and Sleep Duration of Veterans With and Without PTSD

	With PTSD	**Without PTSD**
	Mean (SD) (N=17)	Mean (SD)(N=20)
Sleep Actigraphy	360.96 (65.74)	371.42 (38.34)
Sleep Self-Report	360.85 (97.03)	440.16 (43.77)
Self-Report & Actigraphy	Pearson Correlation	Pearson Correlation
	$r = .556$	$r = .361$
Sig. (2-tailed)	$p = .020$	$p = .118$

Table 3. Comparison of Combat Veterans on Various Sleep Variables

	With PTSD Mean (SD)	Without PTSD Mean (SD)	*t* tests
PSQIA Total	10.65	2.70	t (35)=-7.95, p = .000
PSQI-A 1-a	1.41	0.20	t (35)=-3.88, p = .000
PSQI-A 1-b	2.53	0.85	t (35)=-5.82, p = .000
PSQI-A 1-c	2.06	0.50	t (35)=-5.11, p = .000
PSQI-A 1-d	1.47	1.23	t (35)=-3.94, p = .000
PSQI-A 1-e	1.24	0.65	t (35)=-1.81, p = .079
PSQI-A 1-f	0.71	0.00	t (35)=-2.87, p = .007
PSQI-A 1-g	1.24	0.20	t (35)=-7.95, p = .000
PSQI-A 2-a	2.35	0.45	t (35)=-7.95, p = .000
PSQI-A 2-b	2.12	0.40	t (35)=-7.95, p = .000
# of Nightmares	4.31	0.75	t (35)=-3.08, p = .004
Sleep Efficiency	90.85	91.12	t (35)= 0.14, p = .894
Sleep Latency	0.0	0.37	t (34)=.352, p = 0.054

Table 4. Comparison of Combat Veterans on Variables Associated with Sleep

	With PTSD Mean (SD)	Without PTSD Mean (SD)	*t* tests
# of Flashbacks	8.69	0.40	t (34)= -2.50, p = .018*
# of Caffeine Drinks	9.31	10.10	t (34)= 0.377, p = .709
Exercise (Minutes)	191.31	223.15	t (34) = 1.94, p = .061
Global Anger Average	4.79	2.19	t (34)=-3.67, p = .001**
# Verbal Rage	6.19	5.42	t (33)=-.209, p = .835
# Physical Rage	1.44	0.63	t (33)=-0.964, p = .342
Global Anxiety Average	5.73	2.45	t (33)=-3.70, p = .001**
Social Activities (minutes)	1006.95	1169.32	t (32)= 0.357, p = .723
# of Social Activities	6.75	65.63	t (33)= 1.17, p = .251
# of Tobacco	24.31	3.68	t (33)=-1.71, p = .096

Table 5. Correlations between Self- Report of Sleep Duration and PTSD Variables

Both groups	Self-Report Sleep	Sig (2-tailed)
Nightmares	-.478	*p*= 0.007
Flashbacks	N	N
Social Activities	N	N
PSQIA Total	N	N
Anger Ratings	-.523	*p*= 0.001
Anxiety Ratings	-.*513*	*p*= 0.002
Total Exercise	N	N
Caffeine	N	N
CAPS 1 Intrusive	-.506	*p*=0.004
CAPS 2 Dreams	-.573	*p*=0.001
CAPS 4 Psych. Distress	-.576	*p*=0.001
CAPS 5 Physio Distress	-.584	*p*=0.001
CAPS 17 Startle Response	-.696	*p*=0.000
CAPS 6 Avoidance of Thoughts	-.443	*p*=0.*014*
CAPS 9 Diminished Interest	-.397	*p*=0.*030*
CAPS13 Diff. Falling Asleep	-.366	*p*=0.*047*
CAPS 14 Irritability, Anger	-.414	*p*=0.*023*
CAPS 15 Poor Concentration	-.384	*p*=0.*036*

Table 6. Correlations between Actigraphy Sleep Duration and PTSD Variables

Both groups	Sleep Actigraph	Sig (2-tailed)
Nightmares	-.365	*p*= 0.029
Flashbacks	N	N
Social Activities	N	N
PSQIA Total	N	N
Anger Ratings	-.513	*p*= 0.032
Anxiety Ratings	-.*391*	*p*= 0.020
Total Exercise	N	N
Caffeine	N	N
Physical Rage	-.367	*p*= 0.030
Race Ethnicity	N	N
CAPS 1 Intrusive	-.453	*p*= 0.012
CAPS 2 Dreams	-.419	*p*= 0.017
CAPS 4 Psych. Distress	-.430	*p*= 0.018
CAPS 5 Physio Distress	-.368	*p*= 0.046
CAPS 17 Startle Response	-372	*p*= 0.043
CAPS 11 Restricted Affect	-.368	*p*= 0.045

APPENDIX C: IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Jeremy W. Stout** and Co-PI: **Sandra M. Neer**

Date: **September 23, 2014**

Dear Researcher:

On 9/23/2014 the IRB approved the following human participant research until 9/22/2015 inclusive:

Type of Review:	IRB Continuing Review Application Form Expedited Review
Project Title:	Sleep Disturbances Among Combat Military Veterans: A Comparative Study
Investigator:	Jeremy W. Stout
IRB Number:	SBE-13-09654
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 9/22/2015, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

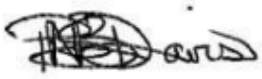
Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a signed and dated copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Patria Davis on 09/23/2014 02:04:42 PM EDT



IRB Coordinator

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