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Objective and Subjective Measurement of Sleep Disturbance in Female Trauma Survivors with Posttraumatic Stress Disorder

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Abstract

Sleep disturbance may be the most often endorsed symptom of posttraumatic stress disorder (PTSD). Much of this research is based on subjective reports from trauma survivors; however, objective measures of sleep-related impairment have yielded findings inconsistent with self-report data. More studies investigating subjective and objective assessments concordantly are needed to understand sleep impairment in PTSD. The current study examined PTSD-related sleep disturbance in a female interpersonal violence cohort with full PTSD diagnoses ($N = 51$) assessing subjective (global and daily diary measures) and objective (actigraphy) sleep measures concurrently. PTSD severity was positively associated with global, subjective reports of sleep impairment and insomnia. Subjective measures of sleep (including global sleep impairment, insomnia, and daily sleep diary reports of total sleep time, sleep efficiency, and sleep onset latency) were moderately to strongly correlated. However, no significant correlations between subjective and objective reports of sleep impairment were found in this cohort. Analyses demonstrated an overall elevation in subjectively reported sleep impairment when compared to objective measurement assessed concurrently. Findings demonstrate a lack of agreement between subjective and objective measurements of sleep in a PTSD-positive female cohort, suggesting objective and subjective sleep impairments are distinct sleep parameters that do not necessarily directly co-vary.

Keywords

Posttraumatic stress disorder; women; sleep; actigraphy

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1. Introduction

The prevalence of posttraumatic stress disorder (PTSD) following a trauma is estimated to fall between 5 and 10% [American Psychiatric Association (APA), 2000; Breslau, 2002] in the general population with higher rates diagnosed in women [10-13%; (Breslau et al., 1998; Kessler et al., 1995)]. With rates of sleep disturbance ranging from 70-87% in PTSD populations, sleep disturbance may be the most frequently endorsed symptom of PTSD following exposure to a traumatic event (Germain, 2013; Leskin et al., 2002; Ohayon and Shapiro, 2000). Although, some researchers argue sleep disturbance experienced after a trauma is transient (Lavie, 2001), others identify sleep disturbance as the hallmark feature of PTSD (Ross et al., 1989). Two clusters of the *Diagnostic and Statistical Manual 5th Edition* [DSM-5; (APA, 2013)] PTSD symptom criteria include sleep problems: re-experiencing cluster (recurrent or distressing dreams) and hyperarousal cluster (difficulty falling or staying asleep), the latter of which is endorsed by most participants with the disorder (Ohayon and Shapiro, 2000). Sleep disturbance, is often considered the most treatment refractory of the 17 symptoms of PTSD (APA, 2000). In fact, the refractory nature of this particular symptom has led to recent reports that over 50% of patients continue to experience insomnia even after treatment with PTSD-specific cognitive behavioral therapy (Zayfert and DeViva, 2004) suggesting insomnia is a primary condition in this population.

Given the significance of sleep disturbance in the PTSD population, numerous investigations have utilized multiple assessment tools including self-report subjective assessments, daily sleep diaries, and objective measures such as polysomnography (PSG) and actigraphy. Collectively, results from these studies have not yielded consistent estimations of sleep impairment across measures or PTSD cohorts. Subjective sleep measures have identified significantly greater sleep disturbance associated with PTSD samples when compared to healthy controls (Ohayon and Shapiro, 2000), trauma survivors without PTSD (Neylan et al., 1998), and non-traumatized elective surgery controls (Koren et al., 2002), while others have reported less disturbance (Calhoun et al., 2007) compared to others without PTSD. Furthermore, objective assessment of PTSD-related sleep disturbance with PSG and, more recently, actigraphy has demonstrated more similarities than differences between non-PTSD and PTSD samples. In a prospective study, Klein et al.(2003) investigated sleep disturbance in motor vehicle accident survivors with actigraphy and compared findings with the subjective reports as measured by the mini-sleep questionnaire. Results showed subjective reports of sleep impairment were predictive of PTSD development one year later, but objective assessment was not significantly related to PTSD. Dagan, Zinger, and Lavie (1997) investigated PTSD-related sleep disturbance with actigraphy in combat veterans in their home environment. They reported that participants with PTSD describe more severe sleep disturbance compared to healthy controls, but, sleep disturbance as measured by actigraphy is within normal limits and not different from sleep in healthy controls. In a meta-analysis of studies utilizing PSG to investigate sleep disturbance in PTSD, (Kobayashi et al., 2007) found that total sleep time and sleep onset latency were not significantly different than individuals without PTSD across studies. Further, a more recent review reported that sleep disturbance measured by actigraphy displayed similar results to PSG findings across sleep

studies (Khawaja et al., 2014) and that sleep disturbance did not differ between PTSD and non-PTSD participants.

Within-subject studies comparing subjectively assessed (self-report) and objectively measured PTSD-related sleep disturbance have demonstrated discrepancies across methods of measurement. Studies utilizing PSG have shown that those with PTSD report less total sleep time and greater sleep onset latency on self-report measures compared to PSG (Hurwitz et al., 1998; Woodward et al., 1996). More recent comparison studies with actigraphy technology have also reported inconsistencies in PTSD-related sleep. Westermeyer and colleagues (2007) found that combat veterans with PTSD reported significantly less total sleep time and fewer episodes of wakening after sleep onset compared to the same aspects of sleep impairment as measured by actigraphy. Calhoun and colleagues (2007) within subject comparisons also demonstrated that those with PTSD described less time lost to awakenings after sleep onset but more total sleep time on daily diary measures as compared to actigraphy assessment of sleep on the same night. The observed discrepant patterns of subjectively and objectively measured sleep are inconsistent across studies. Finally, others have reported the subjective and objective sleep discrepancies may not be unique to sleep impairment in the context of PTSD (Kobayashi et al., 2012).

Research examining sleep in women with PTSD is lacking and, as gender differences have been specifically found in subjectively assessed sleep impairment and PTSD following trauma (Kobayashi and Delahanty, 2013), patterns of discrepancies in subjective and objective reports of sleep impairment in men may not emerge similarly in women. In fact, the only study to investigate subjectively reported and objectively measured PTSD-related sleep disturbance in an all-female PTSD cohort, found significantly less sleep impairment as measured by self-report compared to sleep impairment measured objectively (Calhoun et al., 2007). Calhoun et al. investigated sleep in women diagnosed with PTSD secondary to mixed trauma histories using the Pittsburgh Sleep Quality Index [PSQI; (Buysse et al., 1989)] morning sleep logs and actigraphy. Participants with PTSD reported significantly poorer sleep on the PSQI, lower sleep efficiency on the sleep logs, and decreased sleep efficiency and increased sleep onset latency on the actigraphy as compared to controls without PTSD. Although often considered a strength in sleep research, this study excluded individuals using sleep medication, limiting generalizability to a large cohort of PTSD positive individuals who use sleep medication, and did not assess the impact of PTSD severity on sleep impairment. As Calhoun and colleague's findings only partially support previous findings in male veteran and mixed gender, mixed trauma cohorts further research is warranted in female PTSD cohorts.

The current study aims to disentangle the assessment of sleep impairment as measured by global, standardized self-report measures, daily sleep diaries, and objective measures by investigating sleep impairment with these measures within a sample of adult women suffering from full PTSD secondary to interpersonal violence (IPV). In addition, we will extend and clarify previous findings in a cohort of women by investigating the impact of PTSD severity and reported level of sleep medication use on concurrently-measured, objectively assessed, and subjectively-reported sleep impairment. To address these overarching goals, we (a) tested the relationship between measures of sleep impairment

including global self-report (PSQI and Insomnia Severity Index), daily sleep diaries and actigraphy and assess the relationship of these measures with reported PTSD severity. Further, we also (b) assessed differences in sleep characteristics between those who endorse having taken medication to help sleep in the past month (sleep medication users) and those not using sleep medication (non-users) across all sleep measures. Lastly, we (c) examined differences between sleep characteristics – total sleep time, sleep onset latency, wakening after sleep onset, and sleep efficiency – across concurrently measured daily sleep diaries and actigraphy.

2. Methods

The following protocol was approved by the Institutional Review Board at the University of Missouri –Saint Louis as part of a larger PTSD treatment study. Participants were recruited by word of mouth and through victim assistance agencies, newspapers, and flyers posted to communal areas including but not limited to restaurants, college campuses, grocery stores, and community bulletin boards. All participants were assessed for psychopathology by trained M.A. and Ph.D. level clinicians. All participants gave written informed consent prior to beginning the study and were compensated for their participation in the initial assessment portion of the study.

2.1 Subjects

Participants were drawn from a larger treatment-outcome study ($N = 92$) focusing on sleep-directed treatment as a complement to cognitive processing therapy for PTSD. The sample consisted of treatment-seeking female interpersonal violence (IPV) survivors of childhood or adult physical or sexual abuse, who completed up to seven nights of actigraphy monitoring ($n = 51$). Inclusion criteria included a PTSD diagnosis with sleep impairment as defined as a total score of 3 or higher for frequency and intensity on symptom D1 (trouble initiating or falling asleep) on the Clinician-Administered PTSD Scale [CAPS (Blake et al., 1990)] and an age of 18 years or older. Exclusion criterion for this study included current psychosis, active suicidality, current dependence on drugs or alcohol, and living in an ongoing traumatic situation (e.g., domestic violence). Psychotropic medication usage was not excluded, but the participants were required to be stabilized on their medication for a month prior to and during the course of the study. Sleep medication use was not excluded and its effects on sleep parameters are considered in the main analyses. Participants could not receive any outside trauma- or sleep-focused psychotherapy throughout the course of the study. Data used in the current analyses were collected at the pre-treatment assessment and participants were not receiving any study-related treatment at the time.

2.2 Clinical measures

2.2.1 Trauma Interview—All participants completed a locally derived standardized trauma interview to collect demographic information, information about the trauma, prior trauma history, and treatment history. Each participant’s assault type was coded as physical or sexual assault based on the information provided in the trauma interview.

2.2.2 Clinician-Administered PTSD Scale—Participants were assessed for PTSD symptoms using the CAPS (Blake et al., 1990). The CAPS is a 22-item scale with three associated features – avoidance, re-experiencing, and hyperarousal – assessing frequency and intensity of symptoms. The CAPS contains separate 5-point frequency and intensity rating scales (0-4) for symptoms identified with PTSD in the Diagnostic and Statistical Manual of Mental Disorders – IV Edition (APA, 2000). High internal consistency has been reported for all three subscales using intensity ratings (alpha = 0.87;(Weathers et al., 2001) and acceptable reliability in the current sample (0.51 - 0.69). PTSD symptom severity minus sleep item “difficulty falling or staying asleep” was employed in analyses to reduce covariance of PTSD severity with sleep measures.

2.3 Sleep measures

2.3.1 Daily sleep diaries—Daily sleep diaries were locally constructed and considered to be the primary subjective sleep assessment for comparison with actigraphy recording over concurrent nights of assessment. Sleep diaries allowed for a daily, subjective assessment of sleep and sleep disturbance and took approximately 5-7 minutes to complete daily. The diary was adapted from previous research (Galovski and Blanchard, 2002) and participants were instructed to complete the diary each morning upon awakening, which corresponded to nightly sleep assessed by actigraphy. Specific domains assessed by diaries included: total hours of sleep (total sleep time; TSTDiary), number of minutes required to fall asleep (sleep onset latency; SOLDiary), and total number of minutes of sleep loss when awakened (wakening after sleep onset; WASODiary). Sleep efficiency (SEDiary) was also computed from these scores (SEDiary = TSTDiary/ (TSTDiary + SOLDiary +WASODiary) × 100%) to produce a percent of sleep efficiency.

2.3.2 Pittsburgh Sleep Quality Index—The Pittsburgh Sleep Quality Index (PSQI) was utilized as a more global index of sleep quality and specifically assessed subtypes of sleep disturbance during the past month.(Buysse et al., 1989) The PSQI is a self-report assessment containing 19 individual items scored from 0 to 3 that query seven sleep domains as reflected in the following subscales: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The sum of the subscale scores generates one global score on which a total score of 5 or above indicates poor sleep. The PSQI shows good internal consistency in previous studies (alpha = 0.80; Carpenter and Andrykowski, 1998) and acceptable reliability in the current sample (alpha = 0.60). To protect against inflated values, PSQI total score minus the sleep medication subscale was used for comparisons across sleep medication status.

2.3.3 Insomnia Severity Index—Subjective sleep disturbance over the past week was also assessed with the Insomnia Severity Index (ISI; Bastien et al., 2001) A seven item measure that assesses perceived insomnia severity and daytime distress caused by insomnia. The scale yields a total score indicating level of insomnia with clinical cutoffs as follows: 0–7 = no clinically significant insomnia, 8–14 = sub-threshold insomnia, 15–21 = moderately severe clinical insomnia, 22–28 = severe clinical insomnia. The ISI has shown good internal

consistency (alpha = 0.74) in a clinical sample (Bastien et al., 2001) and high reliability in the current sample (alpha = 0.83).

2.3.4 Actigraphy—Actigraphy – a wrist worn device – is a non-invasive method of monitoring rest/activity cycles during sleep, allows for a daily measure of objective sleep and sleep disturbance in the home environment, and can be worn for several days at a time. A minimally invasive objective sleep measure is particularly important for those with PTSD as this type of measurement enables sleep disturbance in the participant's natural environment. Although, actigraphy does not allow for investigation of sleep architecture and sleep stages, it provides a good measure of general sleep characteristics including sleep efficiency, total sleep time, sleep onset latency, and wakenings after sleep onset (Ancoli-Israel et al., 2003). Actigraphy measurement has been validated as an objective measure of sleep/wake cycles compared to PSG (Edinger et al., 2004; Sadeh et al., 1995) and a strong correlation has been observed ($r = 0.70$) between actigraphy and PSG sleep recordings (Lichstein et al., 2006). The actigraph in this study was programmed to sample movement at 30-second epochs – intervals – and measurements were recorded over the course of seven days/nights (completed concurrently with daily sleep diaries). Each participant was fitted with the actigraphy equipment on their non-dominant wrist and instructed to wear the actigraph 24 hours per day removing the device only when an activity could possibly damage the device (emersion in water for long periods of time, strenuous activity, etc.). Participants were instructed to press a marker button twice when getting out of bed in the morning and once when getting into bed at night to indicate time to bed and time awakened. After seven days, each participant returned to the laboratory at which time the actigraphy and diary measures were collected.

2.4 *Data* analyses

The Action–W analysis software (version 2.0) provided by the actigraphy manufacturer (Ambulatory Monitoring, Inc.) was utilized for scoring of actigraphy data and allowed for automated scoring by computing a down interval – time in bed – and estimates of normal sleep and wake time parameters. Estimates of sleep onset and maintenance, sleep quality, and sleep quantity were calculated by computing sleep onset latency (SOLAct), total sleep time (TSTAct), wake after sleep onset time (WASOAct) and sleep efficiency (SEAct) values for each night of recording. To indicate when the participant is asleep and awake, the proportional integrating mode (PIM) data collection method, which provides an estimation of the intensity of movement, was used in this investigation and the actigraphy scoring was completed utilizing the University of California – San Diego (UCSD) algorithm (Cole et al., 1992). The UCSD algorithm calculates an average every 30-seconds to take into account the activity level immediately preceding and following each time point to determine if each measurement should be coded as sleep or wake (Ancoli-Israel et al., 2003). The PIM data collection and UCSD algorithm and scoring method have been validated as a robust analysis tool of actigraphy recordings compared to polysomnography recordings (Ancoli-Israel et al., 2003) . Analyses included only nights where actigraphy and daily diary data were available ($M = 3.9$ nights/participant). Once scored, actigraphy data, as well as sleep diary data, were averaged across nights of monitoring for each participant and mean scores for each variable were analyzed.

2.4.1 Statistical analyses—Descriptive statistics for the total sample were computed to determine participants' average PTSD severity as measured by the CAPS as well as global sleep impairment as measured by the PSQI and ISI. To assess the relationship between measures of sleep impairment through global self-report (PSQI and Insomnia Severity Index), daily sleep diaries and actigraphy as well as the relationship between these measures and PTSD severity, bivariate correlations were conducted. In addition, independent samples-t-tests were utilized to examine differences in sleep characteristics and PTSD severity between sleep medication users and non-users. Further, to investigate the relationship between concurrently measured daily subjective report and objective assessment of sleep impairment we conducted a multivariate analysis of variance (MANOVA) across four sleep characteristics: total sleep time, sleep efficiency, sleep onset latency, and wakenings after sleep onset. Additional analyses were considered including PTSD severity as a covariate; however no significant effects were found, and therefore the MANOVA results are reported. Adjustment for multiple analyses was completed using the false discovery rate (FDR; Benjamini and Hochberg, 1995) procedure.

3. Results

3.1 Initial Analyses

After checking univariate statistical assumptions, missing data from subjective target variables were found to be 2% of the total data and were missing completely at random (Little MCAR χ^2 (48) = 48.03, p = 0.472). Therefore, the maximum likelihood estimates procedure using the expectation maximization algorithm (Allison, 2002) was appropriate and applied to replace missing values.

Participants (N = 51) were largely Caucasian (50%) and African-American (46%) and mostly from low-income households (71% reported earning less than $20,000 per year). Age ranged from 18 to 59 years with an average age of 36.1 years (SD = 12.0 years). Most participants were single (53%) and had received an average of 13.7 years of education (SD = 2.6 years). Overall, participants experienced PTSD symptoms at the severe level as indicated by total score on the CAPS (M = 77.8; SD = 16.6). The complete cohort endorsed poor global sleep over the past month on the PSQI (M = 13.8; SD = 3.5) and moderately severe insomnia over the past week as indicated by the ISI total score (M = 19.1; SD = 5.4). About half the sample (46%) endorsed medication use to help with sleep at least once in the month leading up to the assessment. Of those who endorsed sleep medication use, 84% (n = 21) reported using medication to help with sleep at least once-a-week. The remaining participants (n = 26) denied using medication to aid in sleep during the past month.

3.2 Relationship of Sleep Disturbance Characteristics and PTSD severity

Analyses displayed moderate to strong correlations between all indices of subjective sleep impairment on both global and daily sleep diary measures (Table 1). Global sleep impairment (PSQI) in the last month and insomnia (ISI) over the past week had the strongest correlation (r = 0.72, p < 0.001). Daily sleep diary characteristics of TSTDiary, SOLDiary, and SEDiary were all moderately correlated with both the PSQI and ISI total scores, while WASODiary was moderately associated with PSQI total score, but not ISI. Global sleep

impairment, insomnia, and daily sleep diary measures were not correlated to objectively assessed sleep characteristics. CAPS severity minus sleep impairment ("difficulty falling or staying asleep") scores were moderately correlated with both PSQI total score ($r = 0.51$, $p < 0.001$) and ISI total score ($r = 0.48$, $p < 0.001$). PTSD severity was not significantly associated with any daily diary or actigraphy characteristics.

3.3 Differences in PTSD Severity and Sleep Measures between Sleep Medication Users and Non-Users

Analyses revealed a significant difference in global sleep disturbance on the PSQI [$t(1, 49) = 3.06$, $p = 0.006$] however this difference did not remain when the sleep medication domain was removed from the PSQI total score (Table 2). No significant differences in PTSD severity, insomnia, global sleep, daily sleep diary, or actigraphy sleep characteristics were displayed across sleep medication use status.

3.4 Differences in Sleep Parameters across Measurement Type

A MANCOVA was used to examine differences between concurrently assessed subjective report and objective measurement of four sleep characteristics – total sleep time, sleep efficiency, wakening after sleep onset, and sleep onset latency. Overall, the MANOVA omnibus test was significant suggesting differences across sleep measurement type [$F(97, 4) = 28.16$, $p < 0.001$, partial $\eta^2 = 0.537$]. More specifically, results show that reported total sleep time, sleep onset latency, and sleep efficiency differed by measurement type with subjective reports displaying elevated sleep impairment compared to objective measurement across sleep characteristics (Table 3).

Main effects for measurement type indicated subjective reports of SOL were significantly higher ($M = 35.98$, $SD = 23.10$) than objective measures ($M = 18.03$, $SD = 11.61$) of sleep onset latency [$F(100, 1) = 24.60$, $p < 0.001$; $\eta^2 = 0.20$]. Main effects for measurement type on sleep efficiency and total sleep type revealed subjective reports of sleep efficiency [$F(100, 1) = 24.77$, $p < 0.001$; $\eta^2 = 0.20$] and total sleep time [$F(100, 1) = 15.97$, $p < 0.001$; $\eta^2 = 0.14$] were significantly lower (SE: $M = 82.45$, $SD = 8.94$; TST: $M = 352.78$, $SD = 76.89$) when compared to objective assessment with actigraphy (SE: $M = 89.88$, $SD = 5.80$; TST: $M = 410.56$, $SD = 68.92$). No significant main effect of measurement type was found between subjective reports ($M = 38.53$, $SD = 28.15$) and objective assessment ($M = 45.30$, $SD = 25.42$) of wakening after sleep onset [$F(100, 1) = 1.63$, $p = 0.212$; $\eta^2 = 0.02$].

4. Discussion

This study is only the second to examine the consistency between subjectively assessed and objectively assessed sleep parameters in a female cohort with PTSD. Subjective assessments were measured globally on psychometrically sound self-report measures (PSQI and ISI), and through the use of daily sleep diaries. The reports of sleep impairment as described on these measures were compared to sleep impairment measured by actigraphy on the same nights. The current study extends the existing literature by investigating the impact of levels of reported sleep medication use and PTSD severity on sleep impairment. The results of this study suggest that while global measures of sleep impairment and daily symptom diaries

seem to show similar levels of sleep loss, objectively measured sleep impairment is not consistent with self-report. Specifically, a strong positive relationship between PTSD severity and global sleep impairment and insomnia emerged, however no association between PTSD severity and daily diary or objective sleep was discovered. As participants reported severe levels of PTSD, the relationship between PTSD and diary and actigraphy sleep characteristics may have been truncated – limiting our ability to fully describe this relationship. Global reports of sleep impairment and insomnia were also significantly, positively associated with daily sleep diary reports. Consistent with previous reports, subjective reports of global subjective sleep impairment were not correlated with objective actigraphy assessment (Calhoun et al., 2007; Dagan et al., 1997; Klein et al., 2003). Daily sleep diary parameters also were not correlated with objective measurements across concurrent nights of reporting on any sleep variable under investigation in this study.

These findings are in contrast to previous reports of moderate correlations between objective measures and daily sleep logs in women with PTSD (Calhoun et al., 2007). Although Calhoun and colleagues suggested daily sleep logs are more consistent with objectively assessed sleep than global sleep measures, the current data suggest neither global sleep measures nor daily sleep diaries mapped onto objectively measured sleep. Our current findings support the idea that subjective and objective sleep might be considered as unique parameters and both should be assessed. Differential findings in this study as compared to previous reports could be attributed to differences in actigraphy brand and scoring algorithm utilized, however the validity of the methodology used in the current study has been previously demonstrated (Ancoli-Israel et al., 2003).

Significant differences across subjective and objective measures of sleep onset, sleep quantity, and sleep efficiency also emerged in this cohort. Overall, participants reported more impairment in sleep onset, sleep quantity, and sleep efficiency on subjective reports compared to sleep as measured by actigraphy. Although these relationships are consistent with the majority of previous research studies (Carskadon et al., 1976; Hurwitz et al., 1998; Westermeyer et al., 2007), these findings are in contrast to Calhoun and colleagues (2007) study which found the opposite: more impairment (sleep efficiency and latency to sleep onset) assessed through actigraphy as compared to self-report. While no significant differences between subjectively and objectively measures WASO were reported here, the trend toward subjective underestimation of WASO compared to objective measurement is consistent with previous reports (Calhoun et al., 2007; Kobayashi et al., 2012; Westermeyer et al., 2007).

Overall, the discrepancy in reports between the studies could be due to methodological differences. The current study included female survivors of interpersonal violence with complex histories and multiple traumas while only 64% of Calhoun et al.(2007) participants endorsed interpersonal violence, with the remaining participants endorsing witnessing/ experiencing death as a child or adult and other non-specified traumas. Interpersonal violence has been associated with elevated rates of PTSD compared to other trauma types (Cortina and Kubiak, 2006; McCutcheon et al., 2010), thus the level of PTSD severity may not have been equivalent. The current cohort reported PTSD symptoms in the severe range and PTSD severity was moderately correlated with global sleep impairment and insomnia in

our sample, suggesting that severity may influence sleep impairment or perhaps the reports of sleep impairment. PTSD severity was not reported by Calhoun et al. (2007), therefore it is difficult to make direct comparisons between the current findings and their report.

Another methodological discrepancy between the current investigation and Calhoun's study is use of sleep medications by approximately half the sample in this study, while Calhoun and colleagues excluded these participants. Calhoun et al. (2007), reported individuals excluded for using sleep medication endorsed significantly higher sleep impairment as compared to PTSD participants not using sleep medications. We found similar increases in global sleep disturbance for those endorsing use of sleep medications compared to those who did not endorse using medication to help them sleep in the current sample. However, differences in global sleep impairment were not conserved when the sleep medication subscale was removed from the PSQI total score. Additionally, analyses comparing sleep medication users and non-users did not reveal any differences in PTSD severity, insomnia, daily reported sleep characteristics, or objectively measured sleep. These results are interesting because those using sleep medication would be expected to experience less impaired sleep. That is, using medication to help with sleep should improve sleep. Further research into the use and effects of sleep medication in PTSD cohorts is needed.

Sleep appears to be easily operationalized, but the literature is wrought with inconsistencies across measures of sleep impairment in PTSD. As sleep impairment is experienced by most individuals with PTSD and has significant physical, health, and mental health consequences (Altevogt and Colten, 2006), a better understanding of sleep and sleep impairment in PTSD is essential. One possible interpretation of the discordance across measures of sleep disturbance is that distress, which is inherent in the PTSD population, may be influencing perceptions of sleep and sleep impairment. Additionally, subjective reports of sleep may be attenuated by a lack of time cues or alteration of memory when falling asleep. Or, conversely, the objective measures that have been utilized are not capturing alterations in sleep specific to PTSD. Although inconsistencies in subjective reports and objective assessment are experienced outside of PTSD and are diagnosed as "paradoxical insomnia", those with PTSD may benefit from treatments integrating effective sleep-focused cognitive and behavioral treatments with trauma-focused treatment. Further, pairing subjective and objective sleep assessments with such treatment might help elucidate the mechanism of sleep impairment in this sample. This study has several limitations. The cohort included in this investigation was recruited because of sleep difficulties associated with full PTSD and reported severe sleep impairment over the past month and severe insomnia over the past week on global self-report sleep measures. This limits the generalizability of the findings to less sleep-impaired cohorts; although, studies do suggest the vast majority of participants with PTSD endorsed significant sleep impairment (Harvey et al., 2003; Neylan et al., 1998). In addition, because this was a treatment seeking-sample selected to have PTSD and sleep difficulties, the severity of PTSD and sleep impairment reported in this sample resulted in a truncated range of more severe scores, potentially increasing the risk of Type II error.

The goal of the present study was to examine subjective and objective sleep impairment in an under-investigated cohort of PTSD-positive female IPV survivors. The current study did not include a control group for comparison of subjective reports and objective assessments.

Therefore, no conclusions can be made as to the relative agreement in measurement of sleep disturbance in a non-PTSD sample. Further, although this study does contribute to the sparse sleep literature in female PTSD population, subjects were IPV survivors and therefore findings may not be generalizable to other trauma types (i.e. combat exposure, natural disaster). The absence of a male comparison group limits our understanding of any sex differences beyond comparison with the extant literature.

The use of actigraphy allowed for minimally invasive nightly assessment of objective sleep impairment, but does not allow for investigation of sleep architecture, parasomnias such as periodic leg movement and sleep apnea, or neurological alterations. Previous research points to alterations in REM (Kobayashi et al., 2007), and parasomnias such as sleep-related breathing disturbance and periodic leg movement have been reported in PTSD cohorts (Brown and Boudewyns, 1996; Krakow et al., 2002). Future investigations may want to screen for parasomnias as these may contribute to the development or increased severity of subjective and/or objective insomnia.

The current findings have implications for understanding PTSD-related sleep disturbance and have clinical relevance for assessment of PTSD, sleep disorders associated with PTSD, and related symptoms. Reports of sleep impairment, whether subjective or objective, should be considered when assessing PTSD and treatments should address such complaints accordingly. That is, clinicians should consider comorbid paradoxical insomnia in addition to primary insomnia when assessing and addressing sleep issues associated with PTSD as the current findings suggest subjective and objective sleep are uncorrelated and distinct. At minimum, multiple tools to assess sleep should be considered when sleep impairment is a complaint in this population. Further research is warranted as our findings are the first to support elevated subjective sleep impairment as compared to objective measurement in a PTSD-positive female cohort.

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Highlights

- We concurrently measured subjective and objective sleep disturbance in females with PTSD.
- Inconsistencies between subjective and objective measurements of sleep were found.
- Subjective reports of sleep disturbance were elevated compared to objective assessment.
- Findings show subjective complaints and objective assessment sleep should be considered in PTSD.

Table 1

Correlations between Sleep Measures and PTSD Severity

	Daily Diary Variables					Actigraphy Variables					
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1 ISI		.72***	−0.48***	0.59***	0.24	−0.61***	0.00	−0.07	0.05	−0.03	0.48***
2 PSQI	0.72***		−0.41**	.51***	.34*	−0.57***	0.11	−0.06	0.07	−0.03	0.51***
Daily Diary											
3 TSTDairy	−0.48***	−0.41**		−0.42**	−0.15	0.57***	0.22	−0.09	−0.12	0.16	0.17
4 SOLDairy	0.59***	.51***	−0.42**		0.23	−0.80***	−0.09	−0.21	0.12	−0.07	0.17
5 WASODairy	0.24	0.34*	−0.15	0.23		−0.71***	0.11	−0.08	−0.02	0.06	−0.27
6 SEDairy	−0.61***	−0.57***	.57***	−0.80***	−0.71***		0.05	0.16	−0.12	0.09	−0.24
Actigraphy											
7 TSTAct	0.00	0.11	0.22	−0.09	0.11	0.01		0.15	−0.26	.49***	0.13
8 SOLAct	−0.07	−0.06	−0.09	−0.21	−0.08	0.16	0.15		0.20	−0.03	0.13
9 WASOAct	0.05	0.07	−0.12	0.12	−0.02	−0.14	−0.26	0.20		−0.95***	0.15
10 SEAct	−0.03	−0.03	0.16	−0.07	0.06	0.10	.49***	−0.03	−0.95***		−0.13
11 PTSD Severity	0.48***	0.51***	0.17	0.17	−0.27	−0.24	0.13	0.13	0.15	−0.13	

Note: $N = 51$; PSQI (Pittsburgh Sleep Quality Index); ISI (Insomnia Severity Index); SOL (Sleep onset latency in minutes); WASO (Wakening after sleep onset in minutes); TST (Total sleep time in minutes); SE (Sleep Efficiency %)

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$

Table 2

Difference in Sleep Characteristics and PTSD Severity across Sleep Medication Use Status

	Total Sample		Sleep Medication Users		Non Sleep Medication Users		
Measure	***M***	***SD***	***M***	***SD***	***M***	***SD***	***t* (1,49)**
PTSD Severity (no sleep)	70.82	16.48	72.68	16.48	69.04	16.60	0.79
ISI	19.06	5.43	19.16	5.42	18.97	5.54	0.12
PSQI							
Global score	13.84	3.48	15.25	3.30	12.49	3.14	3.06**
Global score (minus medication)	12.66	3.21	12.84	3.34	12.49	3.14	0.40
Sleep quality	2.31	0.69	2.32	0.75	2.30	0.63	0.08
Sleep latency	2.31	0.94	2.28	1.06	2.35	0.83	0.25
Sleep duration	2.12	0.75	2.12	0.71	2.13	0.81	0.07
Habitual sleep efficiency	1.75	1.34	1.81	1.33	1.68	1.39	0.32
Sleep disturbances	2.31	0.62	2.32	0.69	2.30	0.56	0.09
Daytime drowsiness	1.85	0.80	2.04	0.68	1.65	0.88	1.18
Daily Diary							
TSTDairy	352.78	76.89	359.70	79.21	346.12	75.55	0.63
SOLDairy	35.98	23.10	39.27	27.83	32.81	17.38	1.00
WASODiary	38.53	28.15	45.52	34.89	31.81	17.92	1.78
SEDairy	82.45	8.94	80.84	10.26	84.00	7.33	1.27
Actigraphy							
TSTAct	410.56	68.92	415.98	78.22	405.34	59.75	0.55
SOLAct	18.03	11.61	17.81	13.32	18.23	9.95	0.13
WASOAct	45.30	25.42	46.42	28.17	44.23	22.99	0.30
SEAct	89.88	5.80	89.77	6.48	89.98	5.19	0.13

Note: $N = 51$; PTSD (Posttraumatic Stress Disorder); ISI (Insomnia Severity Index); PSQI (Pittsburgh Sleep Quality Index); SOL (Sleep onset latency in minutes); WASO (Wakening after sleep onset in minutes); TST (Total sleep time in minutes); SE (Sleep Efficiency in minutes)

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$

Table 3

MANOVA Results and Descriptive Statistics for Differences in Sleep Characteristics across Measurement Type

	Daily Diary		Actigraphy		
Variable	***M***	***SD***	***M***	***SD***	
Total Sleep Time	352.78	76.89	410.56	68.92	
Sleep Efficiency	82.45	8.94	89.88	5.80	
Wakening after Sleep Onset	38.53	28.15	45.20	25.42	
Sleep Onset Latency	35.98	23.10	18.03	11.61	
Source	***SS***	***df***	***MS***	***F***	***Partial η^2***
Measurement Type					
Total Sleep Time	85130.23	1	85130.23	15.97***	0.138
Sleep Efficiency	1406.32	1	1406.32	24.77***	0.198
Wakening after Sleep Onset	1169.78	1	1169.78	1.63	0.016
Sleep Onset Latency	8218.72	1	8218.72	24.60***	0.197
Error					
Total Sleep Time	533165.69	100	5331.66		
Sleep Efficiency	5678.59	100	56.79		
Wakening after Sleep Onset	71944.86	100	719.45		
Sleep Onset Latency	33410.75	100	334.11		

Note: $N = 51$;

*** $p < 0.001$