

SCIENTIFIC INVESTIGATIONS

Sleep Disturbances in Australian Vietnam Veterans With and Without Posttraumatic Stress Disorder

Timothy Baird, BSc, MBBS, DTM&H, FRACP¹; Sarah McLeay, BSc, PhD²; Wendy Harvey, BSc, MBBS, MPH^{1,2}; Rebecca Theal, BSc²; Dayna Law, BSc, MBBS, FRACP¹; Robyn O'Sullivan, MBBS, FRACP¹; on behalf of the PTSD Initiative

¹Greenslopes Private Hospital, Brisbane, Australia; ²Gallipoli Medical Research Institute, Brisbane, Australia

Study Objectives: Posttraumatic stress disorder (PTSD) is a condition that may develop after a traumatic event, particularly combat-related trauma. Although sleep disturbance is a hallmark of PTSD, the prevalence of sleep disturbances in Australian veterans with PTSD remains uncertain. This study aimed to subjectively compare the prevalence of sleep disturbances in Australian Vietnam veterans with and without PTSD.

Methods: A cross-sectional cohort study compared trauma-exposed Australian Vietnam veterans with and without PTSD. PTSD diagnosis was confirmed using the Clinician Administered PTSD Scale for DSM-5. Sleep information was evaluated using supervised structured questionnaires, including Epworth Sleepiness Scale (ESS) and Berlin and Mayo Questionnaires.

Results: Two hundred fourteen male Vietnam veterans (108 with PTSD) were included. Participants with PTSD had higher body mass index (30.3 versus 29 kg/m²; $P < .05$), higher ESS score (9.2 versus 7.6; $P < .05$), and increased alcohol or medication use to assist with sleep (19% versus 6%; $P < .01$; and 44% versus 14%; $P < .01$). Those with PTSD were less likely to sleep well (32% versus 72%; $P < .01$) and reported higher rates of restless legs (45% versus 25%; $P < .01$), nightmares (91% versus 29%; $P < .01$), nocturnal screaming (73% versus 18%; $P < .01$), sleep terrors (61% versus 13%; $P < .01$) and dream enactment (78% versus 11.8%; $P < .01$). The PTSD group had higher rates of diagnosed OSA (42% versus 21%; $P < .01$) and an increased risk of OSA on the Berlin Questionnaire (69% versus 43%; $P < .01$).

Conclusions: Compared to trauma-exposed controls, Australian Vietnam veterans with PTSD demonstrated an increased prevalence of a wide range of sleep disturbances, including OSA. In veterans with PTSD, detailed sleep assessment, including consideration of polysomnography, is paramount.

Keywords: limb movements, nightmares, obstructive sleep apnea, parasomnias, REM sleep behavior disorder, restless legs syndrome, sleep disorders, sleep disturbance, posttraumatic stress disorder, PTSD, veterans

Citation: Baird T, McLeay S, Harvey W, Theal R, Law D, O'Sullivan R; PTSD Initiative. Sleep disturbances in Australian Vietnam veterans with and without posttraumatic stress disorder. *J Clin Sleep Med*. 2018;14(5):745–752.

BRIEF SUMMARY

Current Knowledge/Study Rationale: Although sleep disturbance is a hallmark of PTSD, the prevalence of sleep disturbances in the Australian veteran population with PTSD remains uncertain. This study compared trauma-matched Australian Vietnam veterans with and without PTSD, in order to assess the prevalence of a variety of sleep disturbances in this cohort using supervised, structured questionnaires.

Study Impact: Compared to trauma-matched controls, Vietnam veterans with PTSD reported poorer sleep quality and an increased prevalence of a variety of sleep disturbances, including restless legs, limb movements, parasomnias, and OSA. In veterans with PTSD, thorough sleep assessment, including appropriate consideration of polysomnography, is warranted.

INTRODUCTION

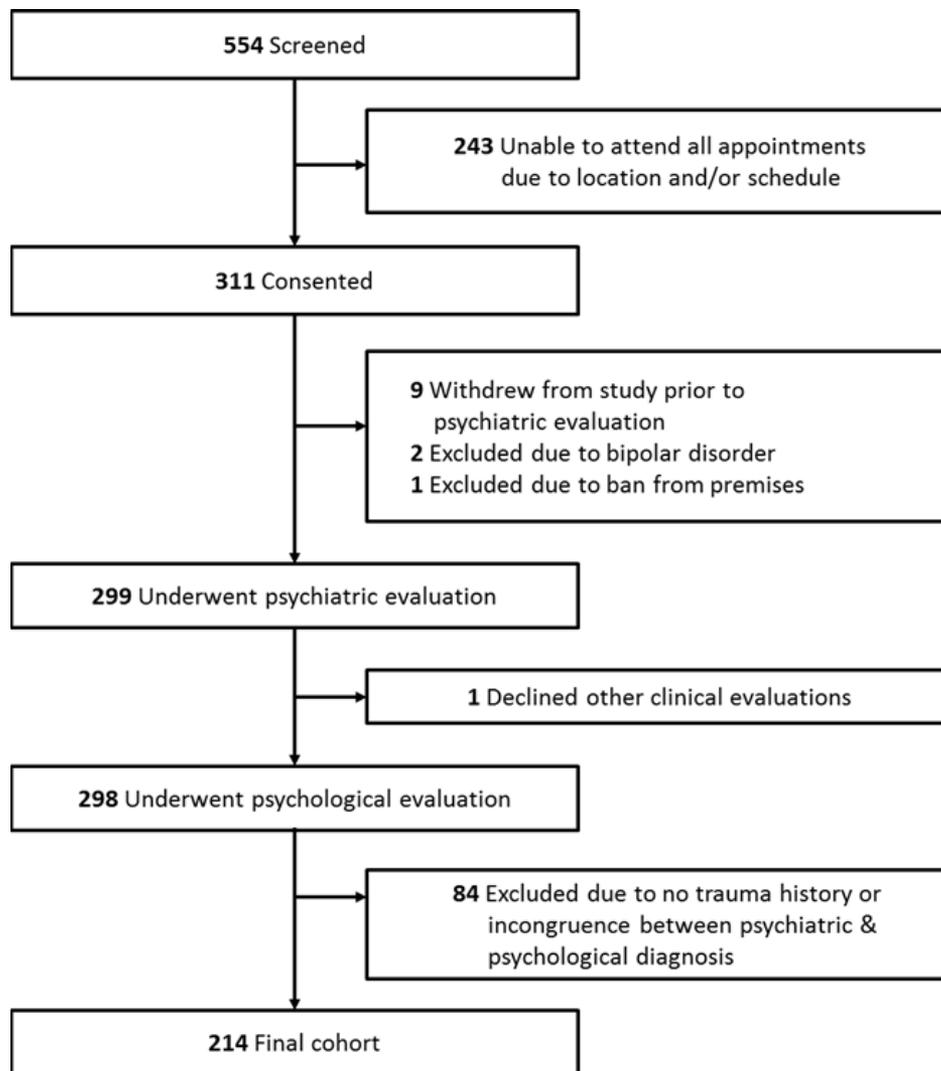
Posttraumatic stress disorder (PTSD) is a mental health condition that may develop after one or more traumatic events.¹ Although the lifetime prevalence of PTSD varies from 1.9% to 8.8%, the disorder is more common among war veterans, with prevalence rates in Australian veterans reported up to 20.9%.^{1,2}

PTSD symptoms are divided into four main phenomena: re-experiencing of the event; avoidance of event cues; negative mood and cognitions; and hyperarousal.³ Sleep disturbance is a hallmark feature, with up to 87% of patients with PTSD reporting insomnia, nightmares, and sleep fragmentation.⁴ Additionally, it has been suggested that the presence of sleep disorders in individuals with PTSD is associated with

an increased severity of PTSD symptoms and higher rates of comorbid mood and substance disorders.^{3,5,6}

However, despite the recent interest surrounding sleep disturbances in veterans with PTSD, the true prevalence, particularly for OSA, remains controversial.^{6,7} Furthermore, only a paucity of studies investigating sleep disturbances in veterans with PTSD have utilized trauma-matched controls, possibly resulting in an overestimation or inconsistent interpretation across the PTSD cohort.^{3,6} Finally, although previous studies have examined sleep disturbances in United States veterans, Dutch veterans, and Israel veterans, the prevalence of sleep disturbances in the Australian veteran population remains unknown.^{7–13}

This study aimed to subjectively assess the prevalence of sleep disturbances in Australian Vietnam veterans with PTSD

Figure 1—Study design of the Gallipoli Medical Research Institute posttraumatic stress disorder study.

through direct comparison with trauma-matched non-PTSD Vietnam veteran controls.

METHODS

This study was part of the PTSD Initiative, a large cross-sectional cohort study that comprehensively investigated physical comorbidities in trauma-exposed male Australian Vietnam veterans with and without PTSD.¹⁴ Australian male veterans who had served in the armed services during the Vietnam War were recruited between February 2014 and July 2015. Recruitment was for any Vietnam veteran in the Brisbane area and targeted both those with and without PTSD. Participants were recruited by a specialized veteran mental health unit at Greenslopes Private Hospital in Brisbane via two modalities: direct physician referral by physicians at Greenslopes Private Hospital (including the study investigators); and by advertising via the Gallipoli Medical Research Foundation and Returned and Services League of Australia (RSL) websites, RSL

publications, and newspaper and television advertisements¹⁴ (Figure 1). Assessment for sleep disorders was done after enrollment and did not affect participation.

PTSD diagnosis and severity was determined by both psychiatric interview and psychologist assessment using the Clinician Administered PTSD Scale for DSM-5 (CAPS-5). Trauma exposure was evaluated using DSM-5 criteria with those not meeting trauma-exposed criteria excluded from the analysis. All final participants in both the PTSD and non-PTSD groups met the DSM-5 Criterion A for trauma exposure.

Baseline characteristics including age, body mass index (BMI), smoking history, and marital status were recorded. All regular medications taken at the time of the study period were documented, including medications used to assist with sleep. Specific duration of individual medication use was not recorded. Subjective sleepiness was assessed using the Epworth Sleepiness Scale (ESS).¹⁵ Alcohol use was determined using the Alcohol Use Disorders Identification Test.¹⁶

Structured sleep questionnaires were designed and administered under direct supervision. Information assessed included

Table 1—Baseline characteristics of Australian Vietnam War veterans with and without PTSD, including alcohol and medication use.

Characteristic	PTSD (n = 108)	No PTSD (n = 106)	P
Age (years)	69 ± 4 (60–88)	69 ± 4 (63–86)	.194
BMI (kg/m ²)	30.3 ± 4.8 (21.2–45.8)	29 ± 4.2 (20.6–43)	
< 25	12 (11)	17 (16)	< .05
25–29.9	44 (41)	50 (47)	
> 30	52 (48)	39 (37)	
Smoking status			
Current smoker	14 (13)	8 (8)	.26
Former smoker	88 (82)	80 (76)	.32
Marital Status			
Single	1 (1)	1 (1)	.98
Married	95 (88)	93 (88)	
Divorced	9 (8)	9 (8)	
Widowed	1 (1)	2 (2)	
Other	2 (2)	1 (1)	
Epworth Sleepiness Scale score	9.2 ± 5.7 (0–24)	7.6 ± 4.0 (1–18)	< .05
Alcohol to assist with sleep	21 (19)	6 (6)	< .01
Medication to assist with sleep	47 (44)	15 (14)	< .001

Values are presented as mean ± standard deviation (range) or n (%). PTSD = posttraumatic stress disorder.

sleep quality; sleep patterns; self- and partner-reported restless legs; partner-reported limb movements; abnormal nocturnal behaviors (nightmares, sleep terrors, vocalization, sleep-walking); and self- and partner-reported dream enactment. Partner-reported information was attained using the validated Mayo Questionnaire.¹⁷ Any known diagnosis of OSA was documented. The risk of OSA was additionally determined using the Berlin Questionnaire.¹⁸

Statistical analysis was performed using R 3.1.3 (R Foundation for Statistical Computing). Risk ratio and 95% confidence interval were determined for binary variables, with categorical variables compared between groups using Fisher exact tests, and continuous variables compared by *t* tests.

Correlation between self-reported and partner-reported dream enactment was assessed in veterans with and without PTSD. Logistic regressions were performed to assess the relationship between PTSD or PTSD severity with dream enactment and prevalence of nightmares. Daily alcohol consumption and OSA were accounted for in the models.

Ethics approval was obtained from the Greenslopes Research and Ethics Committee (reference 13/53) and the Department of Veteran's Affairs (reference 014/002).

RESULTS

Two hundred fourteen trauma-exposed Australian Vietnam veterans (all male; 108 with PTSD) were included for analysis (**Figure 1**).

Age, smoking history, and marital status were similar between the PTSD and non-PTSD cohorts. Participants with PTSD had higher mean BMI (30.3 ± 4.9 kg/m² versus

29 ± 4.3 kg/m²; *P* < .05) and a higher mean ESS (9.2 ± 5.7 versus 7.6 ± 4; *P* < .05). Vietnam veterans with PTSD reported increased medication and alcohol use to assist with sleep (44% versus 14%; *P* < .01; 19% versus 6%; *P* < .01) (**Table 1**). A detailed medication list can be seen in **Table 2**.

With regard to sleep patterns, participants with PTSD were less likely to report sleeping well (32% versus 72%; *P* < .01); and were less likely to have a regular bedtime (69% versus 83%; *P* < .05) (**Table 3**). The PTSD cohort reported increased sleep latencies (*P* < .01), and were more likely to report a delay in returning to sleep after nocturnal awakenings (*P* < .01) (**Table 3**). No difference between groups was observed for estimated total sleep duration or reported nocturnal awakenings (**Table 3**). The PTSD group demonstrated increased bed avoidance, increased sleep related anxiety or panic, and suffered a greater effect on previous and current relationships (**Figure 2**).

Forty-nine of the PTSD cohort (45%) reported symptoms of restless legs compared to 27 in the non-PTSD cohort (25%) (*P* < .01). Only eight participants without PTSD (8%) reported frequently awaking with disheveled bedclothes compared to 49 of the PTSD participants (45%) (*P* < .01). Specific questions in relation to restless legs and limb movements can be seen in **Table 4**.

In relation to abnormal nocturnal behaviors, the PTSD cohort reported more nightmares (91% versus 29%; *P* < .01); more sleep terrors (61% versus 13%; *P* < .01); and were more likely to yell or scream in their sleep (73% versus 18%; *P* < .01). The prevalence of nightmares increased with increasing CAPS-5 severity score. No statistical difference between groups was noted in relation to sleepwalking (11% versus 4%; *P* = .06).

Table 2—Sleep-related medications in Australian Vietnam War veterans with and without PTSD.

Medication Class	Single Agent		Multiple Agents	
	PTSD (n = 108)	No PTSD (n = 106)	PTSD (n = 108)	No PTSD (n = 106)
Antidepressants	53	4	11	0
Benzodiazepines	18	7	2	0
Nonbenzodiazepine hypnotics	13	1	2	0
Opiates	5	3	6	3
Dopamine agonists	0	1	0	0
Prazosin	4	0	0	0
Nonopiate analgesics	8	6	15	4
Antiepileptics	7	2	0	0
Antipsychotics	12	0	0	0

PTSD = posttraumatic stress disorder.

Table 3—Reported sleep patterns in Australian Vietnam War veterans with and without PTSD.

Reported Sleep Patterns	PTSD (n = 108)	No PTSD (n = 106)	Risk Ratio (95% CI)	P
Sleeps well	35 (32)	76 (72)	0.45 (0.34–0.61)	< .01
Regular bedtime	75 (69)	88 (83)	0.84 (0.72–0.97)	< .05
Total sleep time (hours)	7.9 ± 1.9 (3–13) n = 105	7.8 ± 1.3 (4–11.5)		.64
Sleep duration (n = 106)				
< 6 hours	12 (11)	7 (7)	1.7 (0.7–4.2)	.33
> 10 hours	7 (7)	2 (2)	3.5 (0.74–16)	.17
Estimated Sleep Latency				< .01
< 10 minutes	21 (19)	34 (32)		
10–30 minutes	26 (24)	46 (43)		
30–60 minutes	27 (25)	14 (13)		
1–2 hours	15 (14)	2 (1.9)		
> 2 hours	10 (9.3)	1 (0.94)		
Varies	7 (6.5)	7 (6.6)		
Not reported	2 (1.9)	2 (1.9)		
Nighttime Awakenings				.09
Don't wake at night	10 (9.3)	12 (11)		
Once	20 (19)	27 (25)		
2 times	18 (17)	27 (25)		
3 times or more	58 (54)	40 (38)		
Doesn't go to sleep	2 (1.9)	0 (0)		
Delay in return to sleep	61 (64) n = 96	29 (31) n = 94	2.1 (1.5–2.9)	< .01

Values are presented as mean ± standard deviation (range) or n (%). CI = confidence interval, PTSD = posttraumatic stress disorder.

Participants with PTSD had increased self-reported dream enactment (60% versus 11%; $P < .01$) and partner-reported dream enactment (75% versus 20%; $P < .01$) (Table 4). There was a higher correlation between self-reported and partner-reported dream enactment in Vietnam veterans without PTSD compared to Vietnam veterans with PTSD (phi coefficient of 0.468 [$P < .001$] versus 0.272 [$P = .019$], respectively). PTSD was a significant predictor of dream enactment when daily alcohol consumption and OSA were accounted for with logistic regression (odds ratio = 5.65, $P < .001$) (Table 5).

Participants with PTSD were more likely to have a previous diagnosis of OSA (42% versus 22%; $P < .01$) and were

more likely to be at higher risk of underlying OSA on Berlin Questionnaire (69% versus 43%; $P < .01$). In participants with a known previous diagnosis of OSA, no difference between groups was seen in relation to active OSA treatment (93% versus 86%; $P = .39$) (Table 4).

DISCUSSION

This cross-sectional cohort study is the first to investigate the prevalence of sleep disturbances in the Australian Vietnam veteran population. Through structured, supervised

Table 4—Reported sleep disorders in Australian Vietnam War veterans with and without PTSD.

	PTSD (n = 108)	No PTSD (n = 106)	Risk Ratio (95% CI)	P
Restless Legs and Limb Movements				
Do you ever have restless legs that disrupt your ability to fall or stay asleep? (Yes)	49 (45)	27 (25)	1.8 (1.2–2.6)	< .01
Do the patient's legs repeatedly jerk or twitch during sleep? (Mayo Questionnaire) (Yes)	50 (70) n = 71	23 (28) n = 82	2.5 (1.7–3.7)	< .01
Does the patient complaint of restless, nervous, tingling, or creepy-crawly feeling in his/her legs? (Mayo Questionnaire) (Yes)	36 (51) n = 71	17 (21) n = 82	2.4 (1.5–4.0)	< .01
Nightmares and Nocturnal Behaviors				
Report nightmares	98 (91)	31 (29)	3.1 (2.3–4.2)	< .01
Yell or scream in sleep	79 (73)	19 (18)	4.1 (2.7–6.2)	< .01
Sleep terrors	66 (61)	14 (13)	4.6 (2.8–7.7)	< .01
Sleep walking	12 (11)	4 (4)	2.9 (0.98–8.8)	.06
Dream Enactment Behavior				
Self-reported questionnaire	65 (60)	12 (11)	5.3 (3.1–9.3)	< .01
Mayo Questionnaire	57 (75) n = 76	17 (20) n = 83	3.7 (2.4–5.7)	< .01
Mayo and self-reported	39 (78) n = 50	8 (11.8) n = 68	6.6 (3.4–13)	< .01
OSA				
Diagnosed OSA	45 (42)	22 (21)	2.0 (1.3–3.1)	< .01
Berlin Questionnaire ≥ 2 positive categories	75 (69)	46 (43)	1.6 (1.2–2.1)	< .01
If no known OSA, Berlin Questionnaire ≥ 2 positive categories	40 (63) n = 63	33 (39) n = 84	1.6 (1.2–2.3)	< .01

Values are presented as n (%). CI = confidence interval, OSA = obstructive sleep apnea, PTSD = posttraumatic stress disorder.

Table 5—Logistic regression: PTSD and dream enactment, self- or partner-reported (n = 215).

Predictors	Beta	Wald T	OR	95% CI	P
PTSD	1.730	26.50	5.65	2.920–10.900	< .001
Daily alcohol	0.219	0.448	1.25	0.655–2.370	.503
OSA	0.034	0.010	1.04	0.536–2.000	.919

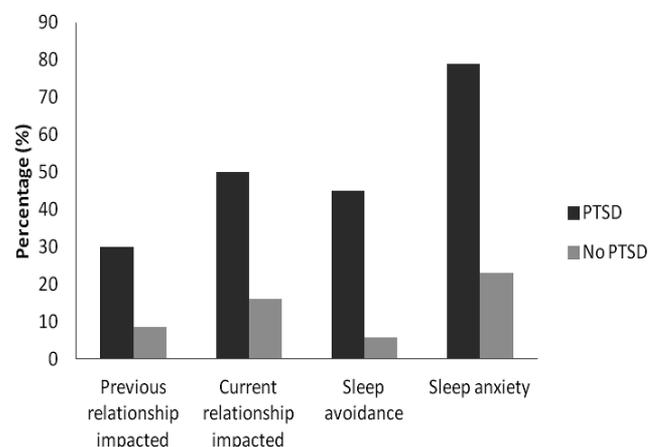
χ^2 (3, n = 215) = 32.7 $P < .001$. CI = confidence interval, OR = odds ratio, OSA = obstructive sleep apnea, PTSD = posttraumatic stress disorder.

questionnaires, it demonstrates that Vietnam veterans with PTSD report a variety of increased sleep disturbances compared to trauma-matched non-PTSD Vietnam veteran controls.

Baseline Characteristics, Subjective Sleepiness, and Substance Use

Although the baseline characteristics age, sex, smoking history, and marital status were similar between cohorts, Vietnam veterans with PTSD had greater BMI (30.3 versus 29.4 kg/m²; $P < .05$) and higher rates of subjective sleepiness (ESS score 9.2 versus 7.6; $P < .05$) (Table 3). Furthermore, participants with PTSD were more likely to use medications or alcohol to assist with sleep (Table 1 and Table 2). This is likely a result of the higher rates of insomnia and mood disorders reported in individuals with PTSD.^{3,6,14} The greater BMI highlights an important comorbidity in our PTSD group and likely affects the comparison rates of OSA described in the next paragraphs, as BMI is a well-known risk factor for OSA.¹⁹

The increased use of alcohol to assist with sleep is of relevance, as poor sleep consolidation and OSA risk associated with substance abuse has been well described.^{20,21} Additionally,

Figure 2—Reported individual and relationship effects of sleep disturbance in Australian Vietnam War veterans with and without PTSD.

Previous relationship ($P < .01$), current relationship ($P < .01$), sleep avoidance ($P < .01$), sleep anxiety ($P < .01$). PTSD = posttraumatic stress disorder.

the increase in medication use to assist with sleep is of particular interest, as it is known that benzodiazepines and other sedatives can be associated with an increased risk of nocturnal hypoxemia and both obstructive and central sleep apnea.^{22,23} Furthermore, it has been shown that antidepressants, particularly selective serotonin reuptake inhibitors (SSRIs), are associated with an increased risk of periodic limb movements (PLMs) and parasomnias.^{24,25}

Finally, the higher subjective sleepiness reported in participants with PTSD, in addition to the sleep-related anxiety and negative effect on relationships (**Figure 2**), highlights the effect that sleep disturbance has on daytime functioning and quality of life, reinforcing the importance of optimizing sleep quality in this cohort.

Sleep Patterns

Poor sleep was more commonly reported in participants with PTSD; however, this did not appear to relate to the total amount of sleep, but rather to increased sleep latency and a delay in return to sleep postnocturnal waking (**Table 3**). This may well relate to avoidance of event cues, as individuals avoid sleep through fear of traumatic re-experiences occurring during sleep. This notion is supported by the increased prevalence of nightmares and dream enactment seen in our PTSD cohort, in addition to the associations seen between PTSD severity and nightmare incidence as well as PTSD diagnosis and dream enactment (**Table 5**).

Restless Legs and Limb Movements

Restless legs syndrome (RLS) is defined as an uncomfortable urge to move the legs that is worse at rest and in the evenings, and transiently relieved by movement. Comparatively, PLMs are involuntary, jerking movements of the legs during sleep that can be associated with sleep disturbance.²² Our study demonstrated that Vietnam veterans with PTSD have an increased rate of self-reported RLS, as well as an increase in partner-reported limb movements (**Table 3**). Although these data are subjective, minimal previous literature has outlined the risk and prevalence of both RLS and PLM in individuals with PTSD.³

As mentioned previously, the increased rates of RLS and/or PLM may be confounded by the increased use of SSRI antidepressant medications seen across our PTSD cohort, as SSRI use is a known risk factor for RLS and PLM.^{24,25} Nonetheless, it is still an important finding because it may relate to hyperarousal seen with PTSD, and, with recent progress of targeted RLS/PLM treatments, may provide an important management adjunct in veterans with PTSD.²⁶

Nightmares

Nightmares have been reported in up to 71% of PTSD sufferers and reflect reexperiencing of the traumatic event, one of the main phenomena of PTSD.^{3,21,27} In our study, Vietnam veterans with PTSD were three times more likely to report nightmares compared to the non-PTSD group (91% versus 29%; risk ratio 3.1; $P < .01$) (**Table 4**). This higher prevalence is in line with previous literature and outlines the importance of identifying and managing this frequent sleep disturbance. Of interest,

although the treatment of nightmares in trauma-exposed individuals remains challenging, recent studies suggest possible benefit in both nightmare reduction and PTSD severity with CPAP therapy (if comorbid OSA is present) or with pharmacotherapy using prazosin.^{28–30} Further studies looking at these specific treatment options for nightmares and associated PTSD symptoms are needed.

Parasomnias

Parasomnias are abnormal manifestations of central nervous system activation during sleep and may also reflect reexperiencing of the traumatic event in individuals with PTSD. In addition to the increased rate of nightmares described previously, our study demonstrated that veterans with PTSD experienced more sleep terrors (61% versus 13%; $P < .01$) and have a higher rate of abnormal vocalization in sleep (73% versus 19%; $P < .01$) (**Table 4**). To the knowledge of the authors, these specific nocturnal behaviors in veterans with PTSD have not been well explored and our study serves to highlight the significant issues surrounding all trauma-related sleep disturbances.

REM sleep behavior disorder (RBD) is a specific type of parasomnia characterized by dream enactment behaviors that emerge during a loss of REM sleep atonia. Specific rates of RBD within the veteran and PTSD populations have been poorly described, with one study in 27 veterans with RBD reporting a coinciding PTSD frequency of 56%.³¹ When using self- and partner-reported dream enactment as a guide to the presence of RBD, our study indicated an overall rate of 78% in Vietnam veterans with PTSD compared to 11.8% in those without PTSD ($P < .01$) (**Table 4**). Although these numbers may be confounded by the increased use of antidepressant medications as mentioned previously, the striking difference remains clear and is further supported by PTSD diagnosis being a significant predictor of dream enactment in our cohort.

Of recent interest in this area, Mysliwiec et al. has proposed a novel, trauma-induced parasomnia “trauma associated sleep disorder.”^{32,33} This is characterized by a history of trauma; reports of disruptive nocturnal behaviors; symptoms or PSG-confirmed autonomic hyperarousal; and either dream enactment or REM sleep without atonia on PSG. Although examining this newly proposed parasomnia is beyond the scope of this study, a planned follow-on study assessing PSG in this cohort may help to further define and characterize this novel sleep disorder.

Obstructive Sleep Apnea

OSA is a disorder caused by obstruction of the upper airway during sleep that results in a reduction or cessation of breathing with resultant sleep fragmentation and/or oxygen desaturation.³ Although the overall prevalence in males is estimated to be approximately 3% to 7%, the prevalence in individuals with PTSD remains controversial.^{3,34} Our study highlighted that Vietnam veterans with PTSD were more likely to have received a previous diagnosis of OSA (42% versus 21%; $P < .01$), as well as experience an increased risk of OSA based on Berlin Questionnaire (69% versus 43%; $P < .01$) (**Table 4**).¹⁸

In line with our results, some studies have reported higher subjective screening rates for OSA in veterans with

PTSD.^{3,12,13,35} Additionally, a recent systematic review looking at OSA and psychiatric disorders concluded there to be an increased OSA prevalence in individuals with both major depressive disorder and PTSD.³⁶ Furthermore, two large observational studies utilizing PSG in 105 United States Vietnam veterans and 130 active duty soldiers with combat-related PTSD demonstrated the presence of OSA in 69% and 67.3%, respectively.^{12,37} Our study illustrated rates of 69% based on Berlin Questionnaire, with 42% with a previous diagnosis of OSA. Although our study used the Berlin Questionnaire to determine the presence of OSA, the high prevalence rates in the aforementioned PSG studies were similar to ours.

Possible explanations for these high OSA rates may be the increased use of medication and alcohol to assist with sleep as previously discussed, or may be linked to hyperarousal and a lowered arousal threshold in patients with PTSD. Investigation into this nonanatomic OSA phenotype recently reported by Edwards et al. would be of interest to study in the PTSD and veteran cohorts going forward.³⁸

In contrast to these aforementioned results, the only controlled prospective trial comparing 20 Dutch veterans with PTSD, 24 veterans without PTSD, and 17 healthy controls reported no objective difference in OSA diagnosed using PSG.⁷ Similarly, a prospective study by Breslau et al. that examined sleep complaints via PSG in 292 participants (71 with lifetime PTSD) showed no difference in OSA in individuals with PTSD compared to those without PTSD.³⁹ Unlike these two studies, our data are limited by the subjective nature of the diagnoses and it will be of interest to determine if PSG diagnosed OSA in our cohort. Clarification of this is important, because although the role of OSA in precipitating and maintaining the symptoms of PTSD is emerging, studies have suggested a correlation between apnea index and PTSD severity, in addition to demonstrating an improvement in PTSD symptoms with targeted OSA treatment.^{7,8,29}

Limitations

Our study has several limitations, some already discussed. The self-report nature of the information may have resulted in inaccurate prevalence rates across both the PTSD and non-PTSD cohorts. This is particularly relevant for the PTSD cohort, as previous studies have acknowledged discrepancies between subjective and objective sleep disturbances in this group.⁴⁰ Additionally, as recruitment was largely voluntary, it is possible that individuals with worse sleep complaints may have been more likely to participate in the study. Although this may have resulted in a degree of selection bias, it is unlikely to have affected the final comparison data, as the PTSD and non-PTSD groups were trauma matched using DSM-5 criteria and, apart from BMI and substance use, baseline characteristics between cohorts were similar. Additionally, assessment of sleep disorders was performed after study enrolment and did not directly impact recruitment or participation.

Finally, it must be noted that the mean age across our entire study was 69 years, with all participants being male. Although this was dictated by the target cohort being Australian Vietnam veterans, it must be considered when comparing to younger veteran cohorts and other PTSD cohorts, as the risk for OSA is

likely greater in our participants. This is particularly important with regard to objective sleep assessment using PSG, as PSG is costly and resource intensive. Nonetheless, similar results demonstrating increased sleep disturbance and higher rates of sleep disorders have been reported in other veteran and PTSD cohorts, including sexual assault victims, crime victims, traffic accident victims, and natural disaster victims.⁴¹

CONCLUSIONS

Compared to trauma-matched controls, Vietnam veterans with PTSD had poorer sleep quality, greater sleep onset latencies, and an increased prevalence of a wide range of sleep disturbances including RLS, limb movements, parasomnias, and OSA. In veterans with PTSD, detailed sleep assessment is paramount, with appropriate consideration of PSG, and management aimed at effectively addressing all sleep disturbances present.

ABBREVIATIONS

BMI, body mass index
 CAPS-5, Clinician Administered PTSD Scale for DSM-5
 CI, confidence interval
 CPAP, continuous positive airway pressure
 DSM, Diagnostic and Statistical Manual of Mental Disorders
 ESS, Epworth Sleepiness Scale
 OSA, obstructive sleep apnea
 PLM, periodic limb movement
 PSG, polysomnography
 PTSD, posttraumatic stress disorder
 RBD, REM sleep behavior disorder
 REM, rapid eye movement
 RLS, restless legs syndrome
 RSL, Returned and Services League of Australia

REFERENCES

1. Bisson JI, Cosgrove S, Lewis C, Roberts NP. Post-traumatic stress disorder. *BMJ*. 2015;351:h6161.
2. Creamer M, Burgess P, McFarlane AC. Post-traumatic stress disorder: findings from the Australian National Survey of Mental Health and Well-being. *Psychol Med*. 2001;31(07):1237–1247.
3. Khazaie H, Rasoul Ghadami M, Masoudi M. Sleep disturbances in veterans with chronic war-induced PTSD. *J Inj Violence Res*. 2016;8(2):99–107.
4. Maher MJ, Rego SA, Asnis GM. Sleep disturbances in patients with post-traumatic stress disorder: epidemiology, impact and approaches to management. *CNS Drugs*. 2006;20(7):567–590.
5. van Liempt S. Sleep disturbances and post-traumatic stress disorder: a perpetual circle? *Eur J Psychotraumatol*. 2012;3.
6. Krakow BJ, Ulibarri VA, Moore BA, McIver ND. Posttraumatic stress disorder and sleep-disordered breathing: a review of comorbidity research. *Sleep Med Rev*. 2015;24:37–45.
7. van Liempt S, Westenberg HGM, Arends J, Vermetten E. Obstructive sleep apnea in combat-related posttraumatic stress disorder: a controlled polysomnography study. *Eur J Psychotraumatol*. 2011;2.
8. Engdahl BE, Eberly RE, Hurwitz TD, Mahowald MW, Blake J. Sleep in a community sample of elderly war veterans with and without posttraumatic stress disorder. *Biol Psychiatry*. 2000;47(6):520–525.

9. Lavie P, Katz N, Pillar G, Zinger Y. Elevated awaking thresholds during sleep: characteristics of chronic war-related posttraumatic stress disorder patients. *Biol Psychiatry*. 1998;44(10):1060–1065.
10. Neylan TC, Marmar CR, Metzler TJ, et al. Sleep disturbances in the Vietnam generation: findings from a nationally representative sample of male Vietnam veterans. *Am J Psychiatry*. 1998;155(7):929–933.
11. Mysliwiec V, Gill J, Lee H, et al. Sleep disorders in US military personnel: a high rate of comorbid insomnia and obstructive sleep apnea. *Chest*. 2013;144(2):549–557.
12. Williams SG, Collen J, Orr N, Holley AB, Lettieri CJ. Sleep disorders in combat-related PTSD. *Sleep Breath*. 2015;19(1):175–182.
13. Colvonen PJ, Masino T, Drummond SP, Myers US, Angkaw AC, Norman SB. Obstructive sleep apnea and posttraumatic stress disorder among OEF/OIF/OND veterans. *J Clin Sleep Med*. 2015;11(5):513–518.
14. McLeay SC, Harvey WM, Romaniuk MN, et al. Physical comorbidities of post-traumatic stress disorder in Australian Vietnam War veterans. *Med J Aust*. 2017;206(6):251–257.
15. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep*. 1991;14(6):540–545.
16. Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption—II. *Addiction*. 1993;88(6):791–804.
17. Boeve BF, Molano JR, Ferman TJ, et al. Validation of the Mayo Sleep Questionnaire to screen for REM sleep behavior disorder in a community-based sample. *J Clin Sleep Med*. 2013;9(5):475–480.
18. Netzer NC, Sttohs RA, Netzer CM, Clark K, Strohl KP. Using the berlin questionnaire to identify patients at risk for the sleep apnea syndrome. *Ann Intern Med*. 1999;131(7):485–491.
19. Romero-Corral A, Caples SM, Lopez-Jimenez F, Somers VK. Interactions between obesity and obstructive sleep apnea: Implications for treatment. *Chest*. 2010;137(3):711–719.
20. Stein MD, Friedmann PD. Disturbed sleep and its relationship to alcohol use. *Subst Abus*. 2005;26(1):1–13.
21. Mahfoud Y, Talih F, Strem D, Budur K. Sleep disorders in substance abusers: How common are they. *Psychiatry*. 2009;6(9):38–42.
22. Zutler M, Holty JE. Opioids, sleep, and sleep-disordered breathing. *Cur Pharm Des*. 2011;17(15):1443–1449.
23. Webster LR, Choi Y, Desai H, Webster L, Grant BJ. Sleep-disordered breathing and chronic opioid therapy. *Pain Med*. 2008;9(4):425–432.
24. Yang C, White DP, Winkelman JW. Antidepressants and periodic leg movements of sleep. *Biol Psychiatry*. 2017;58(6):510–514.
25. Haba-Rubio J, Marques-Vidal P, Andries D, Tobback N, Tafti M, Heinzer R. Antidepressants and RLS/PLMS in the general population. *Sleep Med*. 2013;14(Suppl 1):e146.
26. Garcia-Borreguero D, Cano-Pumarega I. New concepts in the management of restless legs syndrome. *BMJ*. 2017;356:j104.
27. Mohsenin S, Mohsenin V. Diagnosis and management of sleep disorders in posttraumatic stress disorder: a review of the literature. *Prim Care Companion CNS Disord*. 2014;16(6).
28. Tamanna S, Parker JD, Lyons J, Ullah MI. The effect of continuous positive air pressure (CPAP) on nightmares in patients with posttraumatic stress disorder (PTSD) and obstructive sleep apnea (OSA). *J Clin Sleep Med*. 2014;10(6):631–636.
29. Krakow B, Lowry C, Germain A, et al. A retrospective study on improvements in nightmares and post-traumatic stress disorder following treatment for comorbid sleep-disordered breathing. *J Psychosom Res*. 2000;49(5):291–298.
30. Kung S, Espinel Z, Lapid MI. Treatment of nightmares with prazosin: a systematic review. *Mayo Clin Proc*. 2012;87(9):890–900.
31. Husain AM, Miller PP, Carwile ST. REM sleep behavior disorder: potential relationship to post-traumatic stress disorder. *J Clin Neurophysiol*. 2001;18(2):148–157.
32. Mysliwiec V, O'Reilly B, Polchinski J, Kwon HP, Germain A, Roth BJ. Trauma associated sleep disorder: a proposed parasomnia encompassing disruptive nocturnal behaviors, nightmares, and REM without atonia in trauma survivors. *J Clin Sleep Med*. 2014;10(10):1143–1148.
33. Mysliwiec V, Brock MS, Creamer JL, O'Reilly BM, Germain A, Roth BJ. Trauma associated sleep disorder: a parasomnia induced by trauma. *Sleep Med Rev*. 2018;37:94–104.
34. Park JG, Ramar K, Olson EJ. Updates on definition, consequences, and management of obstructive sleep apnea. *Mayo Clin Proc*. 2011;86(6):549–555.
35. Ocasio-Tascón ME, Alicea-Colón E, Torres-Palacios A, Rodríguez-Cintrón W. The veteran population: one at high risk for sleep-disordered breathing. *Sleep Breath*. 2006;10(2):70–75.
36. Gupta MA, Simpson FC. Obstructive sleep apnea and psychiatric disorders: a systematic review. *J Clin Sleep Med*. 2015;11(2):165–175.
37. Yesavage JA, Kinoshita LM, Kimball T, et al. Sleep-disordered breathing in vietnam veterans with posttraumatic stress disorder. *Am J Geriatr Psychiatry*. 2012;20(3):199–204.
38. Edwards BA, Eckert DJ, McSharry DG, et al. Clinical predictors of the respiratory arousal threshold in patients with obstructive sleep apnoea. *Am J Respir Crit Care Med*. 2014;190(11):1293–1300.
39. Breslau N, Roth T, Burduvali E, Kapke A, Schultz L, Roehrs T. Sleep in lifetime posttraumatic stress disorder. *Arch Gen Psychiatry*. 2004;61(5):508–516.
40. Lavie P. Sleep disturbances in the wake of traumatic events. *N Engl J Med*. 2001;345(25):1825–1832.
41. Jaoude P, Vermont LN, Porhomayon J, El-Solh AA. Sleep-disordered breathing in patients with post-traumatic stress disorder. *Ann Am Thorac Soc*. 2015;12(2):259–268.

ACKNOWLEDGMENTS

The PTSD Initiative:

Sarah McLeay, BSc(Hons), PhD¹; Wendy Harvey, BSc(Hons), MBBS, MPH¹; Madeline Romaniuk, BA, GradDipPsych, BBehSc(Hons), DPsych(Clinical)^{1,2}; Darrell Crawford, MBBS, FRACP, MD^{1,3,4}; David Colquhoun, MBBS, FRACP^{1,3,4}; Ross McD Young, PhD^{1,5}; Miriam Dwyer, BSc, HDipEd¹; John Gibson, MBBS, FRANZCP^{1,4}; Robyn O'Sullivan, MBBS, FRACP^{1,3,4}; Graham Cooksley, MBBS, MD, FRACP^{1,3}; Christopher Strakosch, MD, FRACP^{1,3,4}; Rachel Thomson, MBBS, GradDipClinEpi, PhD, FRACP^{1,3,4}; Joanne Voisey, BSc(Hons), PhD^{1,2}; Bruce Lawford, MBBS, FRANZCP, FACHAM (RACP)^{1,2,3,4}

¹Gallipoli Medical Research Foundation, Greenslopes Private Hospital, Newdegate St, Greenslopes 4120; ²School of Biomedical Sciences, Faculty of Health and Institute of Health and Biomedical Innovation, Queensland University of Technology, Kelvin Grove, QLD 4059; ³School of Medicine, The University of Queensland, 288 Herston Road, Herston, Queensland 4006; ⁴Greenslopes Private Hospital, Newdegate St, Greenslopes, Queensland, 4120; ⁵Faculty of Health, Queensland University of Technology, Kelvin Grove, QLD 4092.

The authors gratefully acknowledge the dedicated efforts of the participants and their families, and the clinical and support staff involved in data collection.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication September 6, 2017

Submitted in final revised form January 11, 2018

Accepted for publication January 18, 2018

Address correspondence to: Dr. Timothy Baird, SleepCare, Greenslopes Private Hospital, Newdegate Street, Greenslopes, Brisbane, Australia 4120; Tel: +61 7 3397 3036 or +61 439 754 034; Email: tmbaird@gmail.com

DISCLOSURE STATEMENT

Work for this study was performed at Greenslopes Private Hospital and Gallipoli Medical Research Institute, Brisbane, Australia. All authors have seen and approved the manuscript. The Queensland Branch of the Returned and Services League of Australia (RSL) funded the PTSD Initiative at the Gallipoli Medical Research Institute. Sullivan Nicolaidis Pathology and Queensland X-Ray provided in-kind support, and the Australian Government Department of Veterans' Affairs provided transport for eligible participants. The authors report no conflicts of interest.