



The Role of Sleep in Multidomain Symptom Reduction Following Concussion in Active Duty Service Members

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The study protocol was approved by the Naval Medical Center San Diego Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects.

Research data were derived from an approved Naval Medical Center San Diego Institutional Review Board protocol number NHCP.2016.0084.



Disclosures



- **Dr. Rosemay A. Remigio-Baker** has no relevant financial or non-financial relationships to disclose relating to the content of this activity.
- **Dr. Katharine Stout** has no relevant financial or non-financial relationships to disclose relating to the content of this activity.
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Background: Sleep Disturbances and TBI



Sleep problems common in the US



An estimated
50–70 million
people have sleep disorders.¹



60%
do not get the recommended
duration of uninterrupted sleep.²



70%
have difficulty staying asleep.²



Sleep disturbances prevalent among patients with traumatic brain injury (TBI)



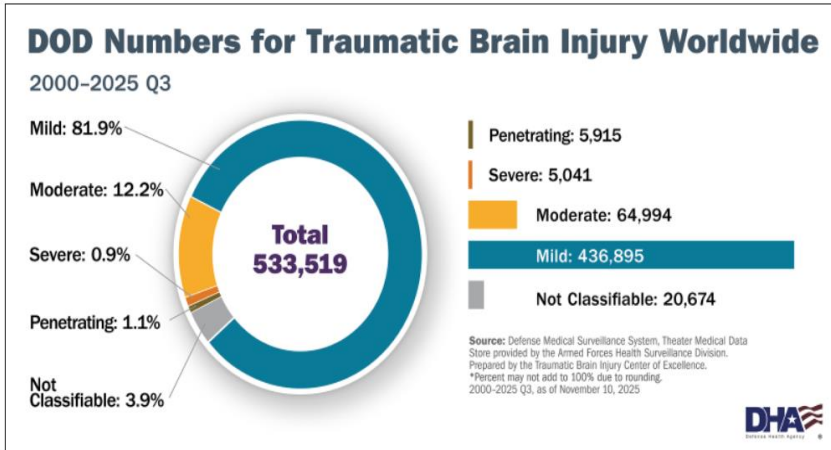
30–70%
report sleeping difficulties
post-TBI.³



Symptoms emerge within weeks
and **can become chronic**.⁴⁻⁷



Background: TBI and Sleep in the Military



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www.health.mil



Background: Post-TBI Guidelines



DOD Clinical Recommendation | January 2024
 Progressive Return to Activity:
 Primary Care for Acute Concussion Management

E. Stages of the PRA: Instructions for Progression

Stage	Objective	Environment	Physical/Vestibular Activity	Cognitive/Oculomotor Activity
Stage 1*: Relative Rest	Avoid symptom provocation, and rest to promote recovery	- Minimize light and noise - Stay home/in quarters	- Daily activities that do not provoke symptoms - Limit large or sudden changes in head position - No exercise	- Limit screen time as needed to avoid symptom provocation - Very light leisure activity (e.g. reading, television, conversation)

- Does improvement in sleep quality during treatment for TBI parallel improvement in post-concussive symptoms?





Objectives



1. Examine the correlation between changes in sleep and changes in mental health and neurobehavioral symptoms.
2. Assess whether change in levels of mental health and neurobehavioral symptom varies across sleep patterns.
3. Evaluate whether there is a difference in the prevalence of clinically-relevant decrease in symptoms between those with improved sleep vs. poor sleep throughout treatment.



Registry: Description of Data



	Description
Sample	Active duty service members with mild TBI at intake
Site	Camp Pendleton & Naval Medical Center San Diego
Time Points	Intake and last follow-up/discharge
Study Timeframe	2/22/2017 to 1/31/2020





Overall Sample Characteristics, N=374



Demographics

Mean age (SD), in years	31.1 (8.6)
% Men	85.6%
% Non-Hispanic White	68.5%
% High school diploma/GED	34.8%
% Married	25.4%



SD: Standard Deviation; GED: General Education Development;
IQR: Interquartile Range



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Military

% Navy / % Marines	55.1% / 41.4%
% Non-commissioned officers	44.1%
% Combat deployment history	55.4%
Median (IQR) years in active duty	10 (4, 18)
Median (IQR) months in treatment	3.4 (1.8, 6.4)

Injury

Median (IQR) years injury to intake	1.4 (1.8, 6.4)
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Methods: Sleep Quality Assessment

- Instrument: The Pittsburg Sleep Quality Index (PSQI)⁸
 - Poor Sleep: $PSQI > 5$ ⁸
- Measured at intake and discharge/last follow-up
 - Change in sleep quality
 - Sleep patterns

Sleep Pattern	Intake (Pre-treatment)	Discharge/ Last Follow-up (Post-treatment)
Good Sleep Throughout	PSQI ≤ 5	PSQI ≤ 5
Worsened Sleep	PSQI ≤ 5	PSQI > 5
Improved Sleep	PSQI > 5	PSQI ≤ 5
Poor Sleep Throughout	PSQI > 5	PSQI > 5



Methods: Outcome Measures

- **Mental health (two measures)**

- Posttraumatic stress (PTS) symptoms

- ✓ Posttraumatic stress disorder (PTSD) checklist, DSM-5, PCL-5⁹

- Continuous (correlation)

- Clinically-relevant improvement, PCL-5 decrease ≥ 7 (prevalence ratio)¹⁰

- Depressive symptoms

- ✓ Patient Health Questionnaire-8 (PHQ-8)¹¹⁻¹²

- Continuous (correlation)

- Clinically-relevant improvement, PHQ-8 decrease ≥ 10 (prevalence ratio)¹³

- **Neurobehavioral (one measure)**

- Neurobehavioral symptoms

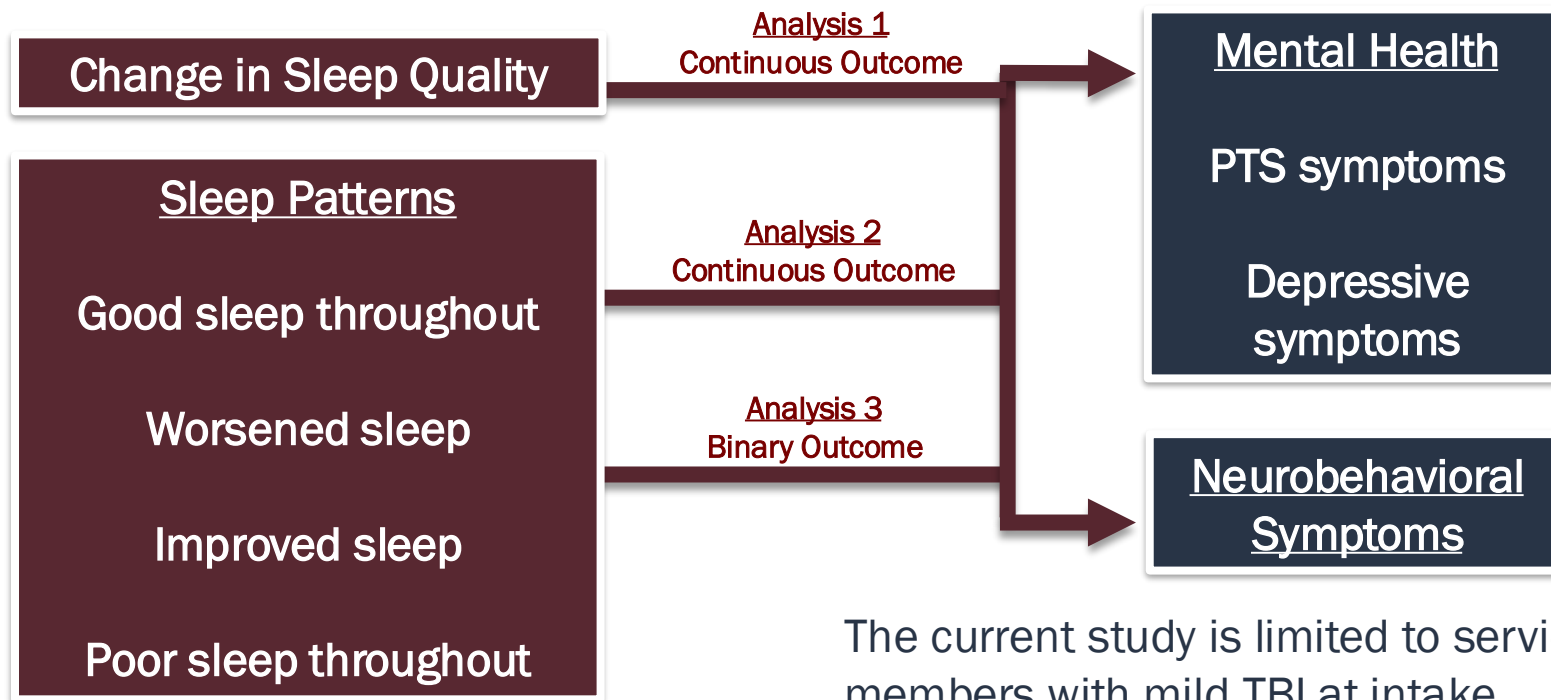
- ✓ Neurobehavioral Symptom Inventory (NSI)¹⁴

- Continuous (correlation)

- Clinically-relevant improvement, NSI decrease ≥ 8 (prevalence ratio)¹⁰



Conceptual Model/Analysis



The current study is limited to service members with mild TBI at intake.



Results



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Results: Correlation Between Change in Sleep and Change in Outcome Measures



Change in Outcomes	Correlation Coefficient	95% Confidence Interval
Mental health symptoms		
PTS symptoms, PCL-5 score (n= 369)	0.46	0.38, 0.55*
Depressive symptoms, PHQ-8 score (n= 352)	0.57	0.38, 0.55*
Neurobehavioral symptoms		
NSI score (n= 366)	0.54	0.46, 0.61*

*Significant p-value < 0.05



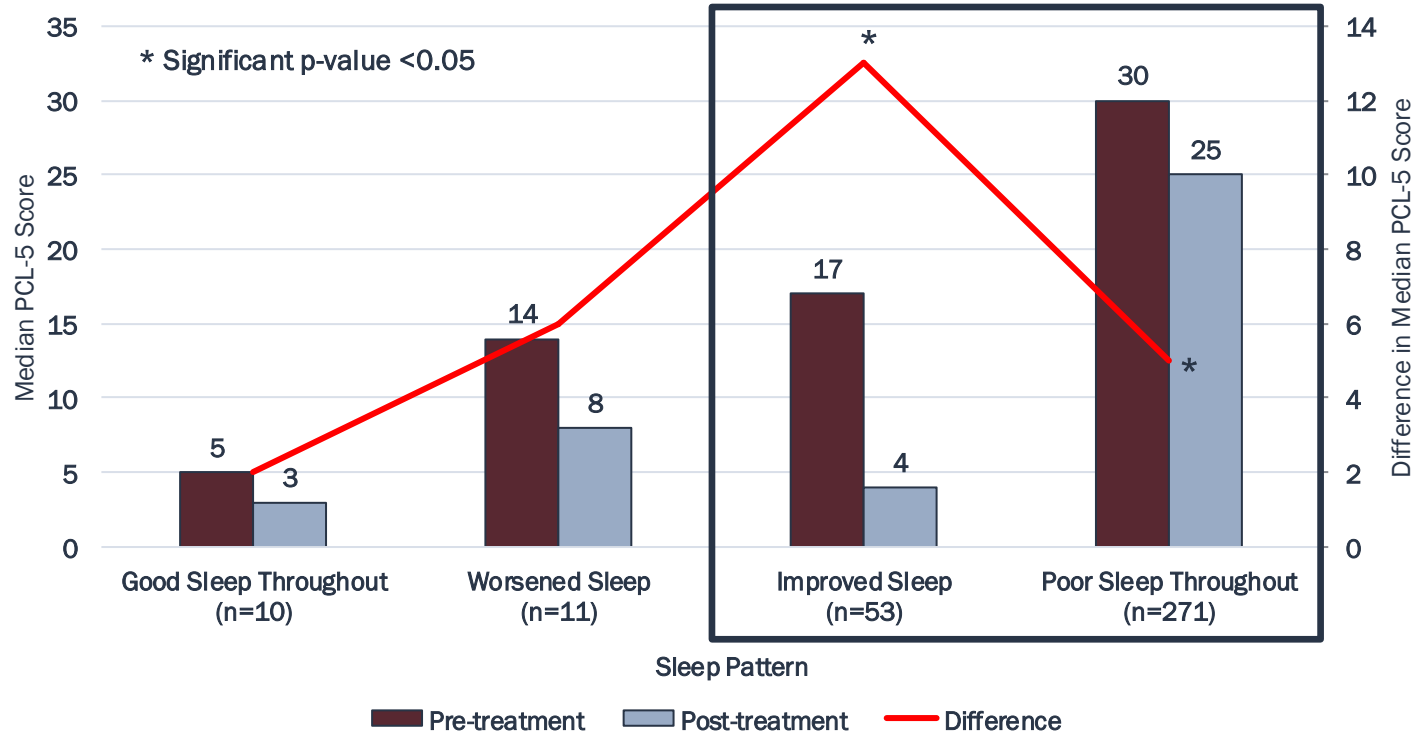
Results: Prevalences of Sleep Patterns



Sleep Pattern	N (%)	Median (IQR) Pre-treatment	Median (IQR) Post-treatment
Good sleep throughout	11 (2.9%)	4 (3, 5)	4 (2, 5)
Worsened sleep	11 (2.9%)	5 (4, 5)	8 (6, 10)
Improved sleep	54 (14.4%)	10 (7, 13)	4 (3, 5)
Poor sleep throughout	298 (79.7%)	14 (11, 16)	12 (9, 15)

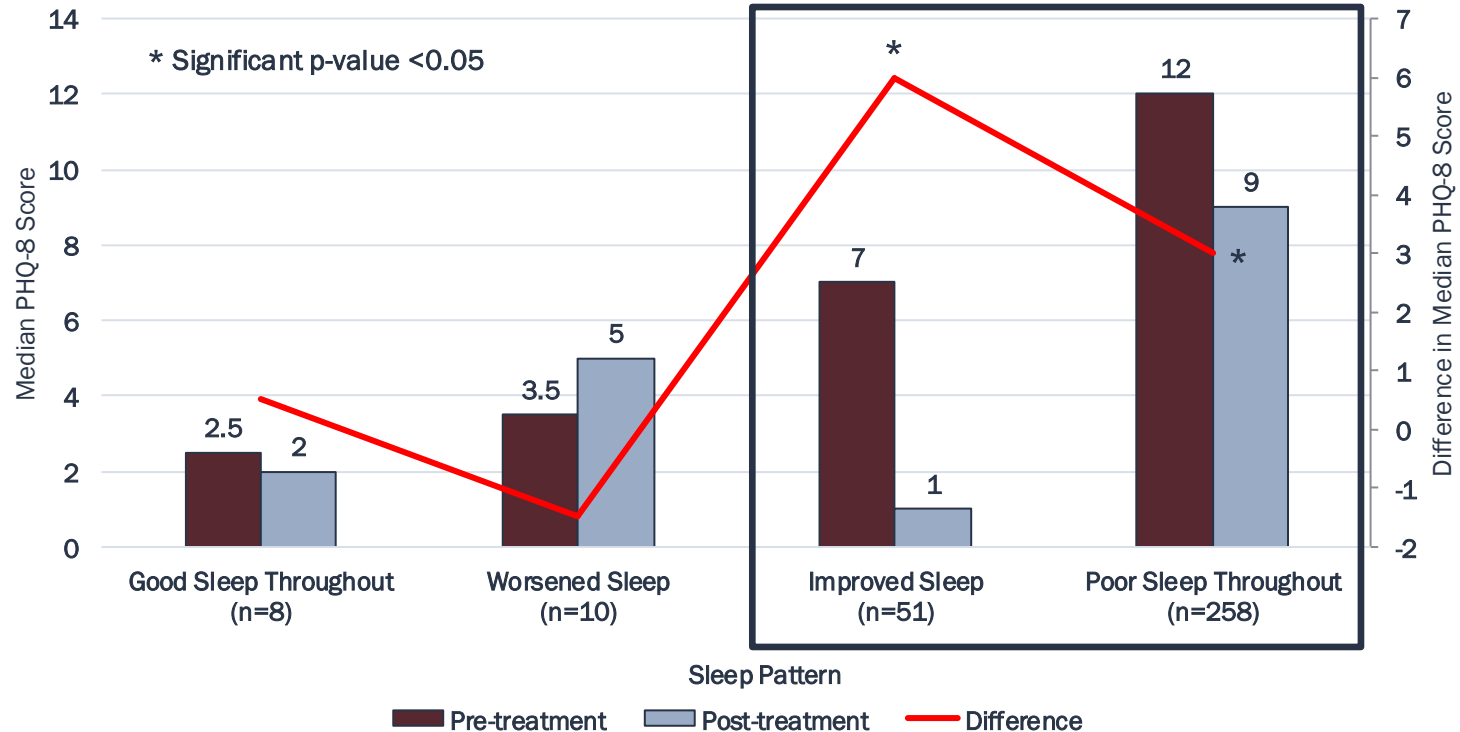


Median Pre- and Post-Treatment PCL-5 Score By Sleep Patterns



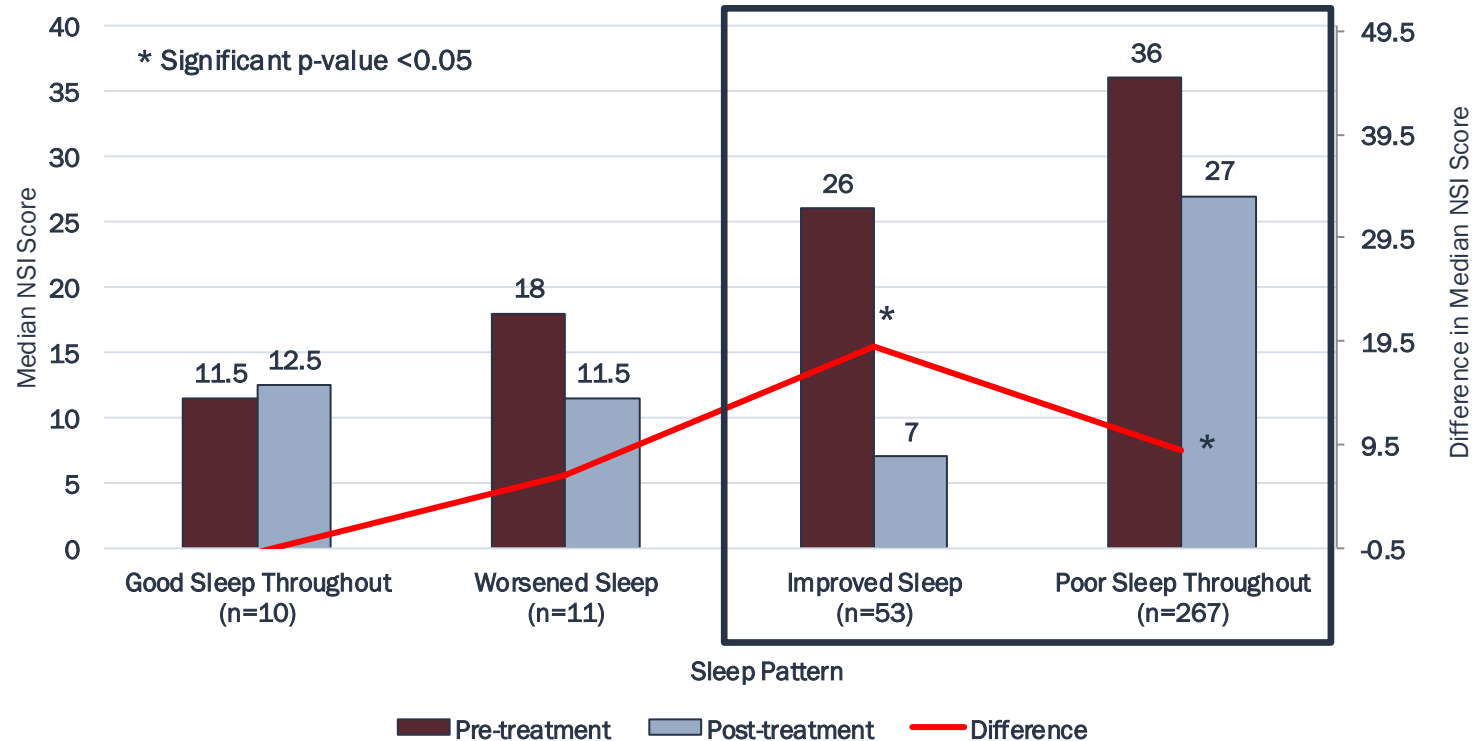


Median Pre- and Post-Treatment PHQ-8 Score By Sleep Patterns



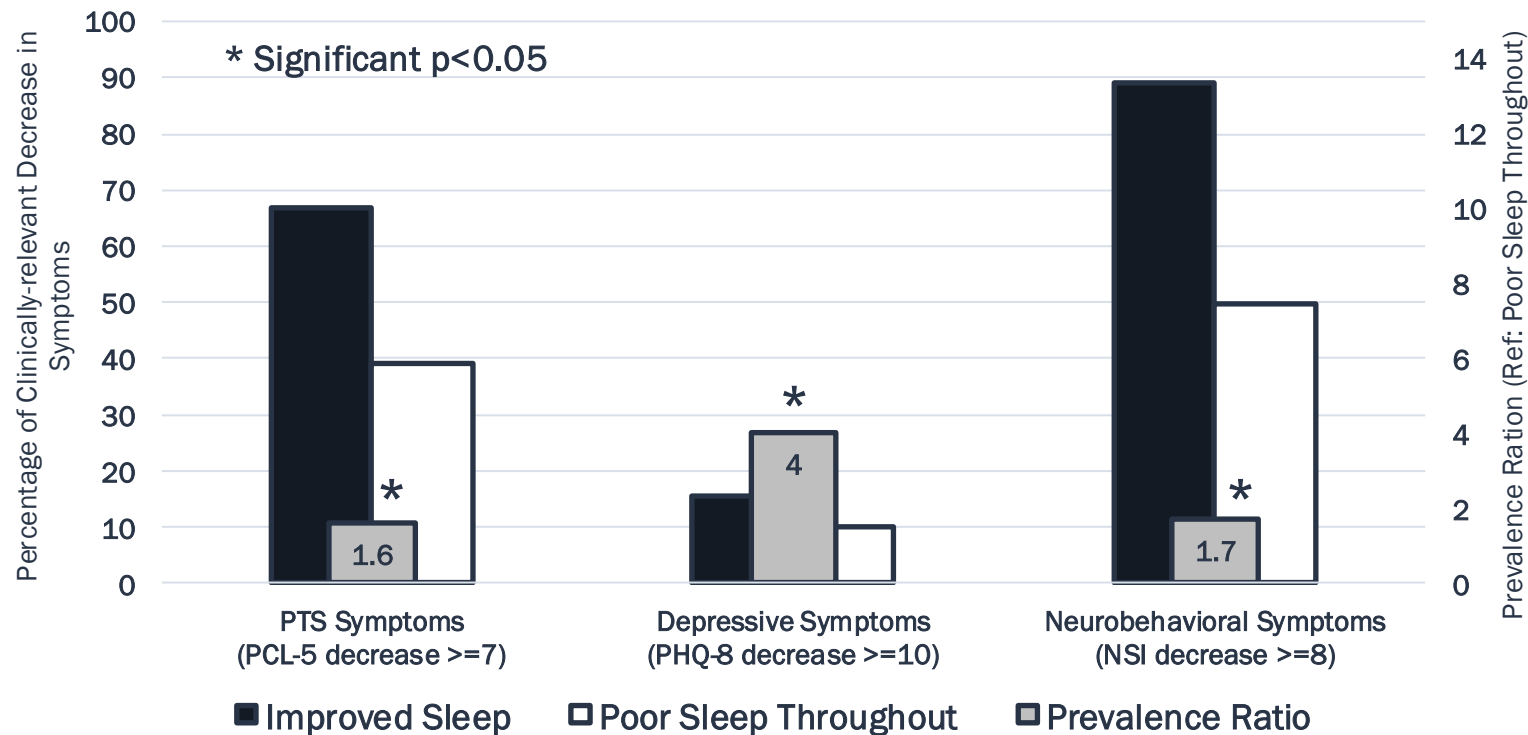


Median Pre- and Post-Treatment NSI Score by Sleep Patterns





Prevalence Ratio of Clinically-Relevant Decreases in Symptom Levels Among Improved Sleep Pattern vs. Reference



Ref: Reference

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Summary



- The vast majority of patients (~80%) experienced persistent poor sleep throughout the course of treatment.
- Overall, higher severity of sleep disturbance significantly correlated with elevated post-concussive symptom burden.
- Improved sleep vs. poor sleep throughout
 - Lower post- vs. pre-treatment symptoms
 - A clinically relevant improvement in symptoms was twice as likely among individuals with improved sleep compared to those with poor sleep throughout treatment.
- For the cohort of patients who still achieved clinical improvement despite persistent poor sleep, recovery was likely attributable to the broader TBI treatment protocol.



Photo by Sgt. 1st Class Crystal Harlow



Concluding Thoughts



- **Future Direction**

- Subsequent phases of this research will assess clinical outcomes following the integration of targeted sleep therapy within this patient population.
- Specifically, future efforts will focus on identifying and evaluating the most effective, scalable, and acceptable sleep interventions to alleviate both sleep disturbances and post-injury symptoms among service members undergoing rehabilitation in TBI clinics.

- **Clinical Implications**

- Implementing targeted training for healthcare providers regarding the secondary benefits of managing sleep disruption is highly recommended to improve overall patient outcomes.

Clinics should establish more vigilant, standardized screening protocols to facilitate early referral to evidence-based sleep therapies.

- Patient-facing materials (e.g., educational information sheets) that actively promote, encourage, and destigmatize sleep therapy should be integrated and distributed throughout the course of TBI treatment.



Military Sleep Resources



APPS AND WEB TOOLS

The DoD and VA provide several free resources to help you improve your sleep.

*Scan the code below
to access VA apps*



*Scan the code below
to access the Military
Health System apps*



*Scan the code below
to access the Path to
Better Sleep app*



1. **Cognitive Behavioral Therapy for Insomnia (CBT-i) Coach:** Includes a sleep diary to help you pinpoint behaviors that are contributing to your sleep problems. Also provides interactive exercises to adopt positive sleep habits and guide you through progressive muscle relaxation.
2. **Mindfulness Coach:** Provides nine different guided mindfulness exercises and strategies for overcoming challenges to mindfulness practice.
3. **Breathe2Relax:** Provides instruction on diaphragmatic “belly” breathing, which helps lower stress and reduce anxiety. Graphics, animation, narration, and videos lead you through several breathing exercises.
4. **Tactical Breather:** Provides guided breathing instruction to gain control over heart rate, emotions and concentration during stressful situations.
5. **Path to Better Sleep:** A free, anonymous course that delivers the core components of Cognitive Behavioral Therapy for Insomnia. The course takes advantage of natural sleep rhythms to improve sleep. It includes a sleep diary, personalized sleep scheduling, and relaxation exercises to better “set the stage” for sleep.

FOR ONLINE INFORMATION:

To learn about harmful sleep habits and hear personal stories, visit health.mil/sleep.



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Questions?