

Characterizing Sleep Neurophysiology After Breaching: The Missing Link in Comprehensive Neurological Blast Assessments

Preliminary Findings

Lyndsey Nindl, MAPP^{1,2}; Lillian Skeiky, PhD^{1,2}; Elizabeth Metzger, MSPH^{1,2}; Robert Rossi, PhD^{1,2}; Grant Tays⁴, PhD; Amanda Studnicki, PhD^{1,2}; Angeliki Pollatou, PhD^{1,2}; Connie Thomas, MD, DFAPA^{1,3,4}; J. Kent Werner, MD, PhD^{1,3}

¹ The Geneva Foundation, Tacoma, WA; ² Uniformed Services University of the Health Sciences, Bethesda, MD; ³ Walter Reed National Military Medical Center, Bethesda, MD; ⁴ Walter Reed Army Institute of Research, Silver Spring, MD

Introduction

- Explosive breaching repeatedly exposes Service Members to blast overpressure (BOP); in recent literature, breaching peak overpressure (OP) registered at 7.3 psi and positive impulse at 11.9 psi/ms.
- Current United States (US) interim BOP exposure safety guideline states 4 psi peak overpressure as a threshold for risk management.
- Repetitive low-level blast exposure (rLLBE) is linked to insomnia, neurological symptoms, and decreased cognitive function.
- Sleep is a plausible but understudied mediator or moderator of this relationship.
- Here we present preliminary sleep, cognitive, and blast-exposure data addressing this gap.

Methods

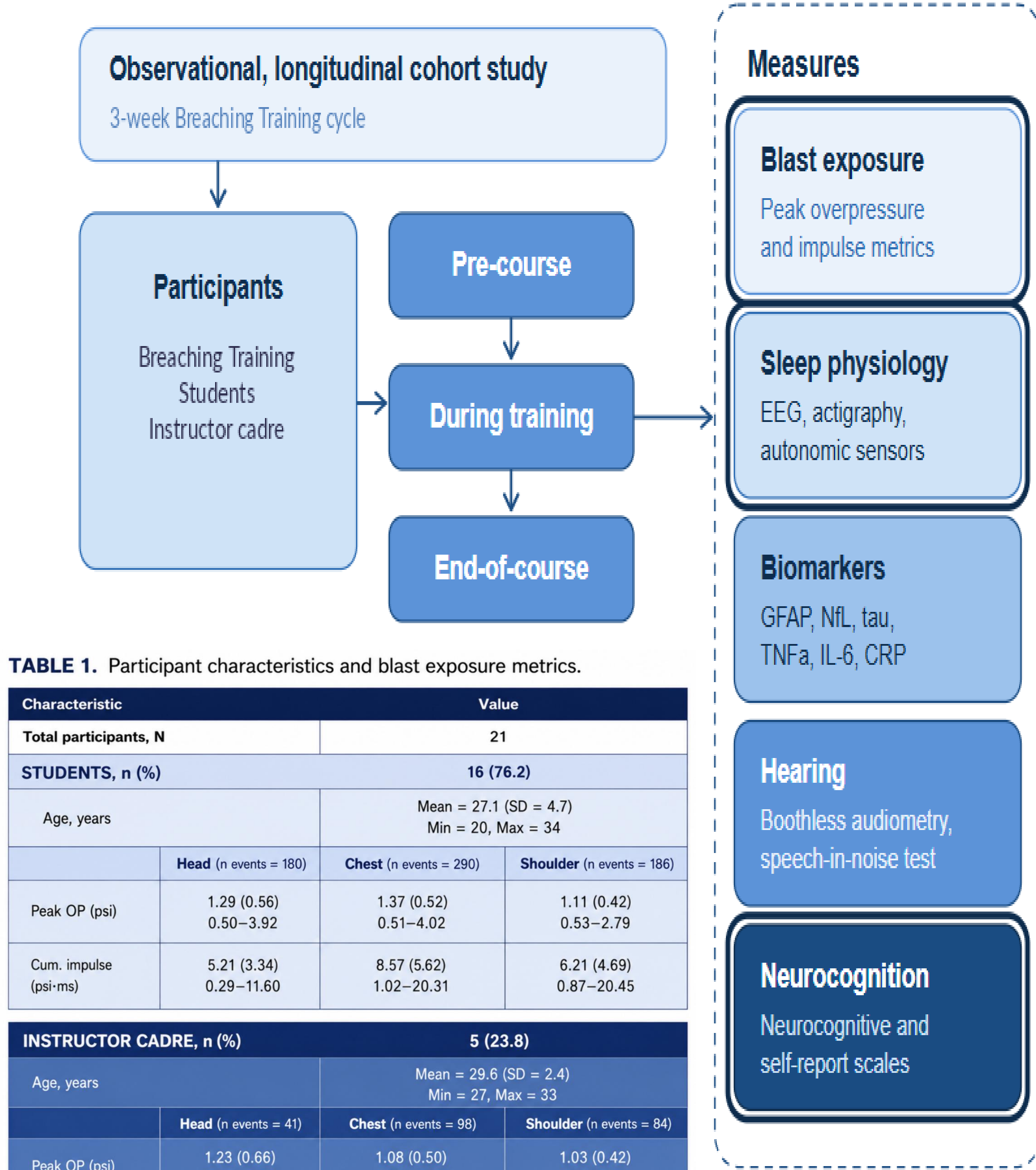
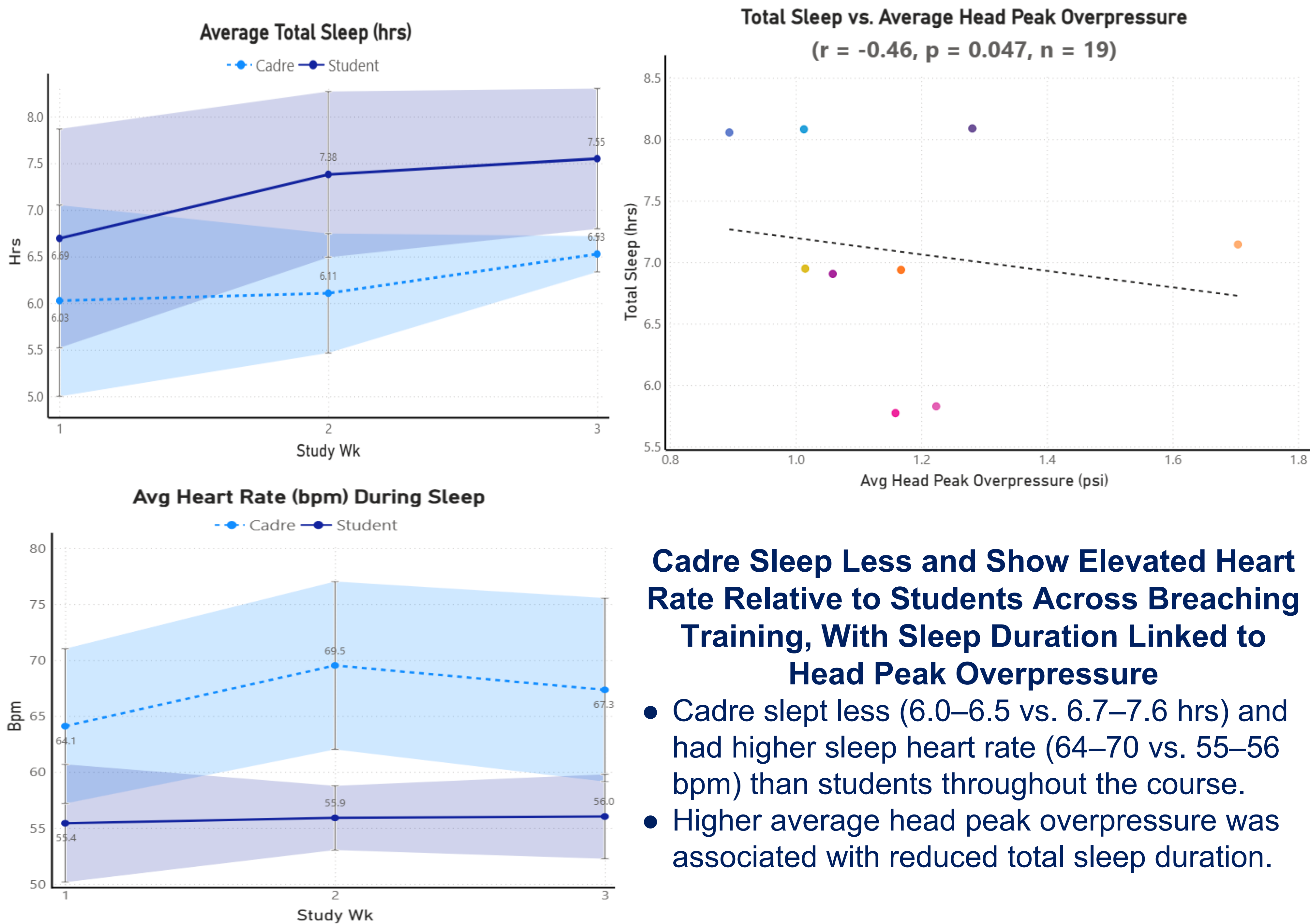


TABLE 1. Participant characteristics and blast exposure metrics.

Characteristic	Value		
Total participants, N	21		
STUDENTS, n (%)	16 (76.2)		
Age, years	Mean = 27.1 (SD = 4.7) Min = 20, Max = 34		
	Head (n events = 180)	Chest (n events = 290)	Shoulder (n events = 186)
Peak OP (psi)	1.29 (0.56) 0.50–3.92	1.37 (0.52) 0.51–4.02	1.11 (0.42) 0.53–2.79
Cum. impulse (psi·ms)	5.21 (3.34) 0.29–11.60	8.57 (5.62) 1.02–20.31	6.21 (4.69) 0.87–20.45
INSTRUCTOR CADRE, n (%)	5 (23.8)		
Age, years	Mean = 29.6 (SD = 2.4) Min = 27, Max = 33		
	Head (n events = 41)	Chest (n events = 98)	Shoulder (n events = 84)
Peak OP (psi)	1.23 (0.66) 0.51–2.90	1.08 (0.50) 0.51–2.72	1.03 (0.42) 0.51–2.61
Cum. impulse (psi·ms)	6.45 (3.80) 0.58–11.02	11.70 (14.29) 3.19–50.33	12.41 (12.60) 0.44–33.36

Note. Instructor cadre were reassessed across multiple training cycles. Data are presented as mean (SD), minimum, and maximum.

Results

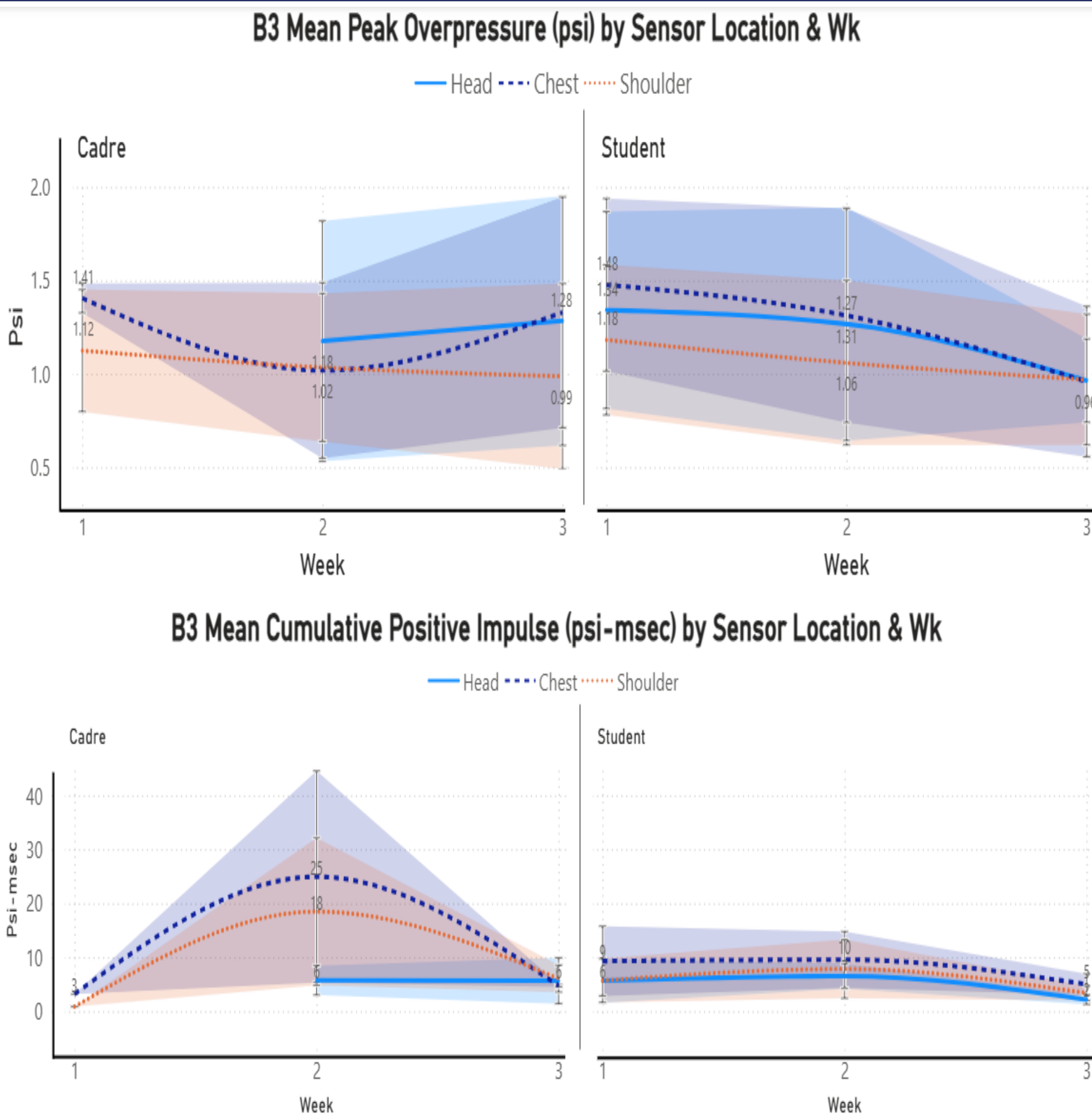
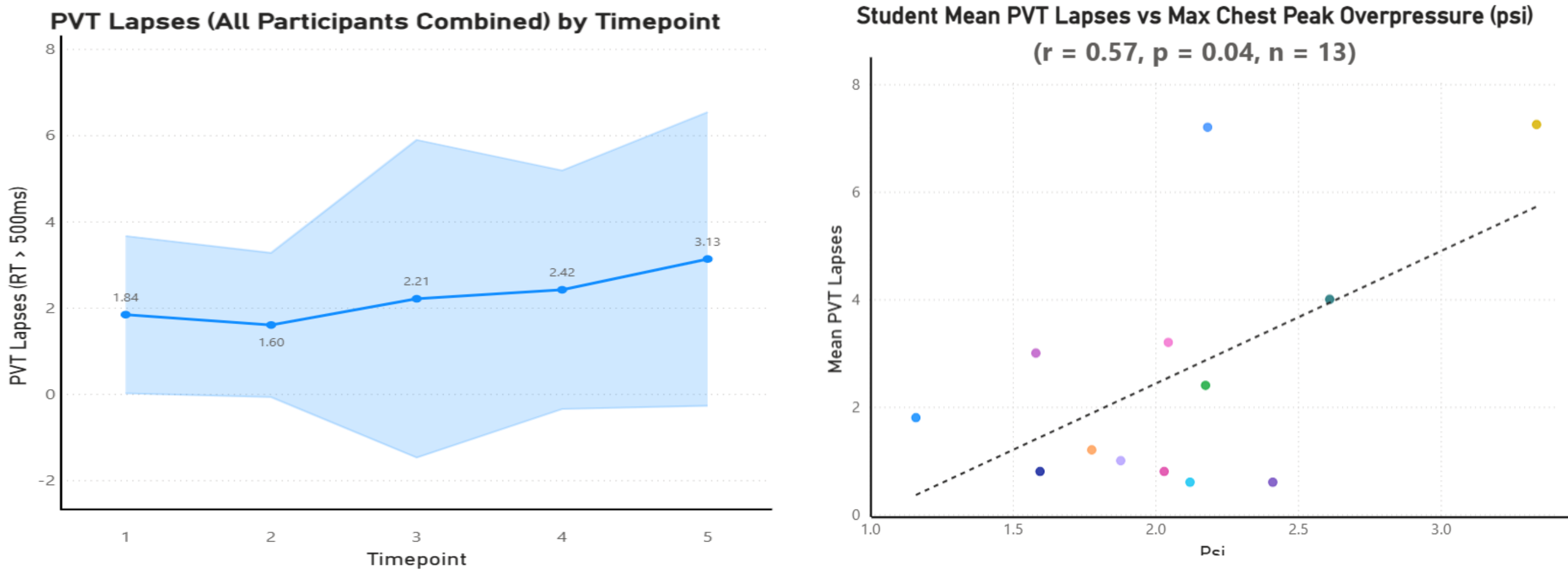


Cadre Sleep Less and Show Elevated Heart Rate Relative to Students Across Breaching Training, With Sleep Duration Linked to Head Peak Overpressure

- Cadre slept less (6.0–6.5 vs. 6.7–7.6 hrs) and had higher sleep heart rate (64–70 vs. 55–56 bpm) than students throughout the course.
- Higher average head peak overpressure was associated with reduced total sleep duration.

Vigilant Attention Declined During Training, With Increased Lapses Linked to Higher Max Peak OP in Students

- PVT lapses (RT > 500 ms) by time point, mean ± SEM. Lapses rose from 1.6 at T2 to 3.1 at T5, indicating declining vigilance across the training cycle, with no differences between students and cadre.
- More lapses on the PVT were associated with higher max OP triggered on the chest sensor in students.



Peak Overpressure and Cumulative Positive Impulse by Personnel Role, Sensor Location, and Training Week

Top: Mean peak overpressure (psi) by week, Cadre (left)z vs. Student (right).

Bottom: Mean cumulative positive impulse (psi·msec) summed by week, Cadre (left) vs. Student (right)

Discussion

- Cadre slept less and had elevated sleep heart rate throughout training; post-breaching sleep physiology may differ by exposure role and history (not reflected herein).
- Vigilant attention declined across training with increased PVT lapses tracking higher max OP in students, an early novel cognitive signal.
- Together, these position sleep as a plausible, measurable link between BOP and reported brain-health symptoms.
- Given the small sample and body-worn sensors, further investigation is needed.
- Next steps:** Continue enrollment (target N = 50) and integrate wearable EEG, auditory, and biomarker data to characterize the neurophysiological impact of cumulative blast exposure.