Long-Term Effects of Mild TBI and Blast Exposure in Combat Veterans

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MID ATLANTIC MIRECC POST DEPLOYMENT MENTAL HEALTH

Disclaimer

The views, opinions, and/or findings contained in this presentation are those of the author and do not reflect the official policy of the National Intrepid Center of Excellence, Walter Reed National Military Medical Center, the Department of Defense, Department of Veterans Affairs, or the U.S. Government.

Dr. Martindale has no conflicts of interest to declare.

Learning Objectives

01

Identify how TBI acquisition environment affects long-term outcomes.

02

Explain how blast exposure is associated with long-term outcomes.

03

Interpret and Conceptualize how distress tolerance may influence long-term outcomes among Veterans with different exposure histories.

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Combat Veterans

OEF/OIF/OND

Majority Army

~10 years since deployment

Mild TBI

Symptom and Performance Validity

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Traumatic Brain Injury (TBI)

Mild			
AOC <24 hours	PTA <24 hours	LOC <30 min	GCS 13-15

Moderate			
AOC >24 hours	PTA >24 hours, <7 days	LOC 30 min - 24 hours	GCS 9-12

Severe			
AOC >24 hours	PTA >7 days	LOC >24 hours	GCS 3-8

AOC = Alteration of Consciousness PTA = Posttraumatic Amnesia LOC = Loss of Consciousness GCS = Glasgow Coma Scale

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Mild TBI

Symptoms resolve quickly

- < 3 months to 1 year
- Education is associated with better and faster recovery

Other conditions often influence lasting symptoms

- PTSD
- Depression

Mixed evidence supporting long-term negative effects of mild TBI

- Circumstances of injury
- Injury characteristics
- Pre-existing conditions

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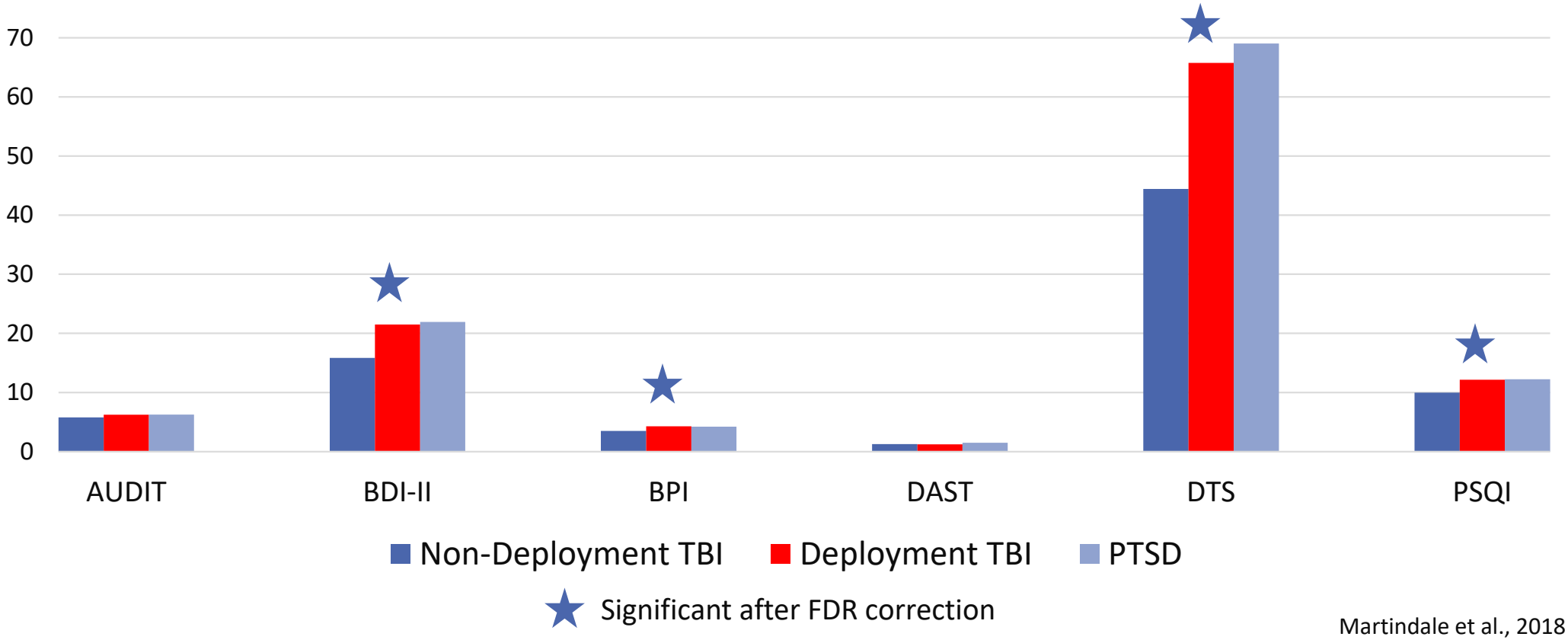
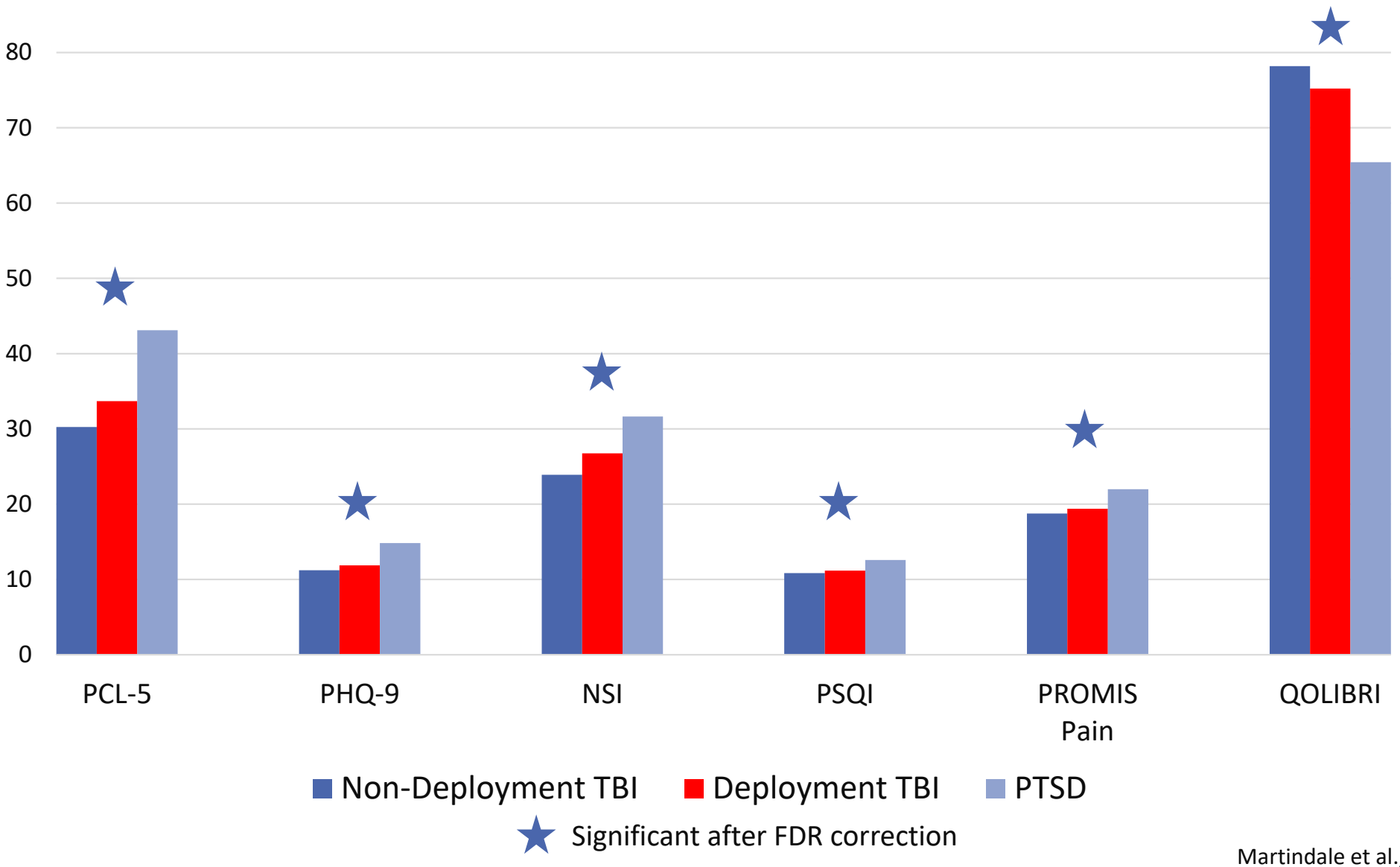
Deployment	Non-Deployment
High Level Blast	Military Training
Environmental Stressors	Low-level Blast
Physical Stressors	Motor Vehicle Accidents
Psychological Stressors	Sports

Measure	Total Sample (N = 1399) Mean ± SD	Nondeployment TBI		Deployment TBI		PTSD Diagnosis	
		− (n = 835) Mean ± SD	+ (n = 564) Mean ± SD	− (n = 1071) Mean ± SD	+ (n = 328) Mean ± SD	− (n = 786) Mean ± SD	+ (n = 613) Mean ± SD
BDI-II	14.79±12.67	14.08±12.98	15.84±12.12	12.74±12.08*	21.50±12.24*	9.23±10.13*	21.92±12.02*
DTS	41.30±39.67	39.20±40.32	44.42±38.52	33.82±36.98*	65.73±38.37*	19.67±26.60*	69.02±36.30*
PSQI	9.57±4.90	9.29±4.96	9.98±4.77	8.78±4.75*	12.16±4.46*	7.49±4.38*	12.24±4.19*
AUDIT	5.11±6.00	4.65±5.63	5.79±6.44	4.76±5.75	6.24±6.45	4.20±4.86*	6.27±7.03*
DAST	1.08±2.82	0.94±2.62	1.28±3.07	1.03±2.82*	1.24±2.80*,†	0.75±2.14*	1.51±3.45*
BPI‡	3.34±2.51	3.22±2.61	3.50±2.38	3.05±2.51*	4.28±2.30*	2.67±2.36*	4.23±2.43*
CES	11.97±10.36	11.08±10.22	13.30±10.44	9.51±9.11*	20.02±10.12*	8.02±8.69*	17.03±10.13*

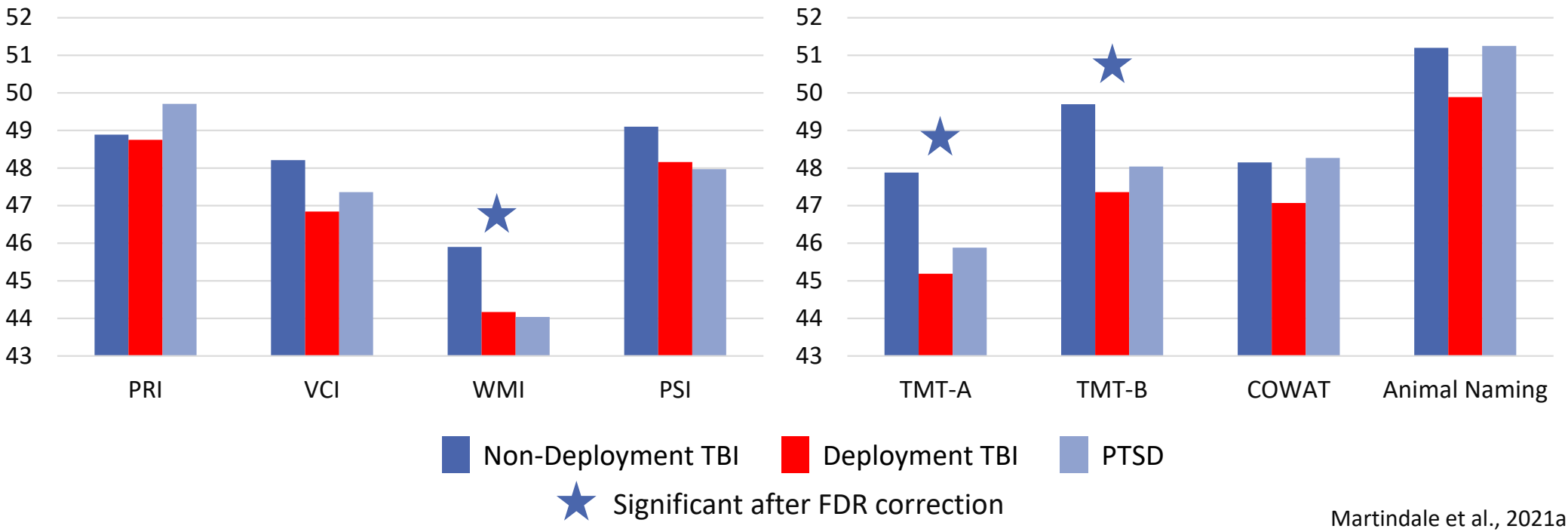


Martindale et al., 2018



Martindale et al., 2021a

Measures	Nondeployment TBI (n = 160)[a]				Deployment TBI (n = 140)[a]				Current PTSD (n = 103)[a]			
	M	*SD*	Range	Imp%	*M*	*SD*	Range	Imp%	*M*	*SD*	Range	Imp%
Cognitive												
WAIS-IV												
PRI	48.89	10.26	25–77	3.8	48.75	10.22	24–77	2.9	49.71	10.29	28–75	1.0
VCI	48.21	9.40	24–71	3.1	46.84	9.61	23–78	5.0	47.36	9.31	23–70	2.9
WMI	45.90	9.63	19–76	1.3	44.17	9.69	19–76	2.9	44.04	9.85	19–76	2.9
PSI	49.10	10.09	22–75	1.9	48.16	10.55	22–75	2.1	47.97	10.36	22–72	2.9
TMT-A	47.88	10.72	15–82	5.6	45.19	11.43	14–86	8.6	45.88	12.35	14–86	9.7
TMT-B	49.70	10.45	23–81	1.9	47.36	10.21	23–75	2.9	48.04	11.17	27–86	1.9
COWAT	48.15	10.95	26–86	1.3	47.07	10.26	26–77	2.9	48.27	11.17	27–86	2.9
Animal Naming	51.20	10.34	26–86	0.6	49.89	10.85	16–86	3.6	51.25	12.10	16–86	1.9



Martindale et al., 2021a

Deployment vs Non-Deployment TBI Summary

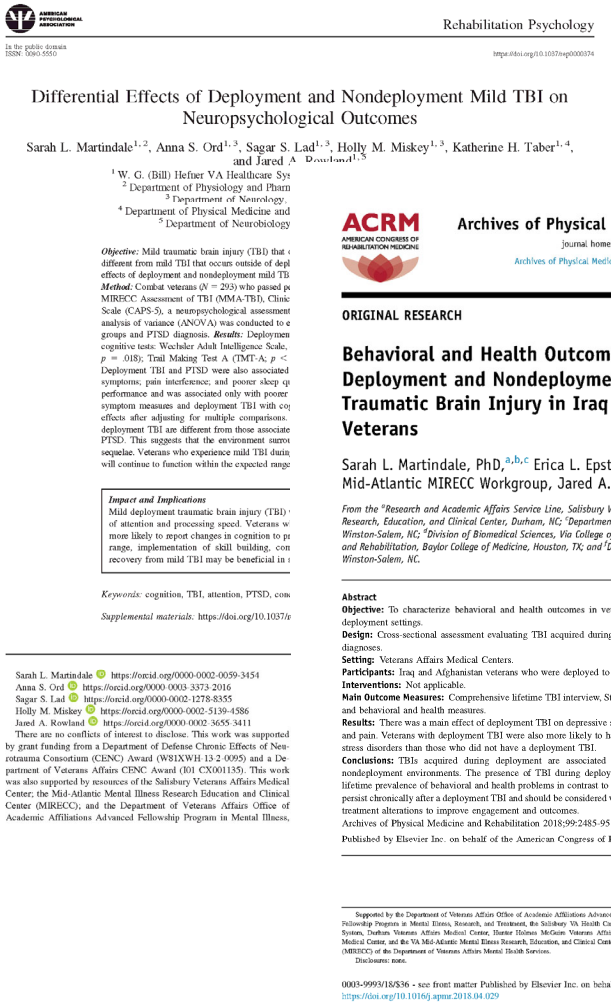
History of Deployment Mild TBI is associated with poorer long-term

Psychological Outcomes

- Posttraumatic stress symptom
- Depressive symptoms
- Neurobehavioral symptoms
- Sleep Quality
- Pain
- Quality of Life

Cognitive Performance

- Working Memory
- Attention
- Executive Function



Rehabilitation Psychology

Differential Effects of Deployment and Nondeployment Mild TBI on Neuropsychological Outcomes

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[4] Department of Physical Medicine and
[5] Department of Neurobiology

Objective: Mild traumatic brain injury (TBI) that
different from mild TBI that occurs outside of dep
effects of deployment and nondeployment mild TB
Method: Combat veterans (N = 293) who passed pr
MIRECC Assessment of TBI (MMA-TBI), Clinic
Scale (CAPS-5), a neuropsychological assessment
analysis of variance (ANOVA) was conducted to e
groups and PTSD diagnosis. ***Results:*** Deploymen
cognitive tests: Wechsler Adult Intelligence Scale,
p = .018); Trail Making Test A (TMT-A; p <
Deployment TBI and PTSD were also associated
symptoms; pain interference; and poorer sleep qu
performance and was associated only with poorer
symptom measures and deployment TBI with co
effects after adjusting for multiple comparisons.
deployment TBI are different from those associate
PTSD. This suggests that the environment surro
sequelae. Veterans who experience mild TBI durin
will continue to function within the expected range

Impact and Implications
Mild deployment traumatic brain injury (TBI)
of attention and processing speed. Veterans w
more likely to report changes in cognition to pr
range, implementation of skill building, con
recovery from mild TBI may be beneficial in

Keywords: cognition, TBI, attention, PTSD, com

Supplemental materials: https://doi.org/10.1037/r

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ORIGINAL RESEARCH

Behavioral and Health Outcomes Associated With Deployment and Nondeployment Acquisition of Traumatic Brain Injury in Iraq and Afghanistan Veterans

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Abstract

Objective: To characterize behavioral and health outcomes in veterans with traumatic brain injury (TBI) acquired in nondeployment and deployment settings.

Design: Cross-sectional assessment evaluating TBI acquired during and outside of deployment, mental and behavioral health symptoms, and diagnoses.

Setting: Veterans Affairs Medical Centers.

Participants: Iraq and Afghanistan veterans who were deployed to a warzone (N=1399).

Interventions: Not applicable.

Main Outcome Measures: Comprehensive lifetime TBI interview, Structured Clinical Interview for DSM-IV Disorders, Combat Exposure Scale, and behavioral and health measures.

Results: There was a main effect of deployment TBI on depressive symptoms, posttraumatic stress symptoms, poor sleep quality, substance use, and pain. Veterans with deployment TBI were also more likely to have a diagnosis of bipolar, major depressive, alcohol use, and posttraumatic stress disorders than those who did not have a deployment TBI.

Conclusions: TBIs acquired during deployment are associated with different behavioral and health outcomes than TBI acquired in nondeployment environments. The presence of TBI during deployment is associated with poorer behavioral outcomes, as well as a greater lifetime prevalence of behavioral and health problems in contrast to veterans without deployment TBI. These results indicate that problems may persist chronically after a deployment TBI and should be considered when providing care for veterans. Veterans with deployment TBI may require treatment alterations to improve engagement and outcomes.

Archives of Physical Medicine and Rehabilitation 2018;99:2485-95

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Disclosures: none.

Traumatic brain injury (TBI) is an increasing concern for the US military. The incidence of nonpenetrating TBI is more common among veterans returning from the wars in Iraq and Afghanistan than previous conflicts, with reports of explosion-related injuries an estimated 16% higher.[1-3] TBI is a major concern for health professionals because patients often present with cooccurring mental health and/or medical problems,[4-7] including

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Incoming Enemy Fire

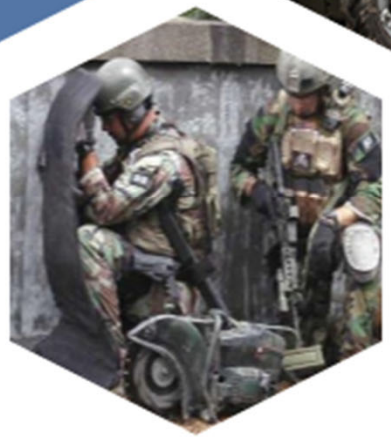
Elimination of Munitions

Improved Explosive Devices

Removal of Explosive Devices

Outgoing Fire

Training in the use of Explosives



Friendly Weapon Systems

Salisbury Blast Interview

Appendix A

Salisbury Blast Interview

"I want to go over any time you were exposed to a blast or explosion. This includes blasts and explosions that were close, as well not so close. If you could see it, hear it, feel it, or had some other indication that there was a blast or explosion we want to talk a

Has the participant been exposed to blasts of any kind? YES/NO

1. When did this happen? Date: ___/___/___
2. During combat? YES/NO During deployment? YES/NO During military service? YES/NO
3. Were you:
   - in a vehicle? YES/NO
     - (if yes) was it flipped or thrown into anything by the blast? YES/NO
   - behind cover? YES/NO
   - Was anything between you and the blast? YES/NO
   - wearing a helmet? YES/NO
   - wearing ear protection? YES/NO
   - wearing eye protection?
   - wearing body armor?
   - injured from the blast (burns, lacerations, etc.)?
   - thrown to the ground by the blast?
   - thrown into anything by the blast (wall, vehicle, or other object)?
   - hit by anything from the blast?
4. What caused the blast? mortar/rocket/IED/grenade/RPG/missile/bomb/la
5. Use the following scale to rate how much you experienced the following
   - a) Wind : 0 1 2 3 4 5
   - b) Debris: 0 1 2 3 4 5
   - c) Ground shaking: 0 1 2 3 4 5
   - d) Pressure change/gradient: 0 1 2 3 4 5
   - e) Temperature change/gradient: 0 1 2 3 4 5
   - f) Sound: 0 1 2 3 4 5
6. How far were you from the blast? quantity: _____ units:_____
7. Is this a multiple exposure rating?

Notes:_____

a) Start date: ___/___/___ End date: ___/___/___
b) "How many events do you estimate occurred during this time perio
c) for any event were you:
   - i. thrown to the ground by the blast?
   - ii. thrown into anything by the blast (wall, vehicle, or other object)? YES/NO
   - iii. hit by anything from the blast? YES/NO
   - iv. If yes to any, did ppt strike their head as a result? YES/NO

Appendix B

a) Wind:
- **0 = none,**
- **1 = slightly**, leaves blowing, but not flags,
- **2** = flags waving,
- **3 = moderately**, light objects blowing away
- **4** = difficult to stand or walk
- **5 = strongly**, not possible to stand or walk

b) Debris:
- **0 = none**
- **1 = slightly**, dirt, sand, or paper blowing along ground
- **2** = small amounts of debris blowing through air
- **3 = moderately**, moderate amount of debris in the air including small pebbles or similar objects,
- **4** = significant amount of debris in air including small rocks
- **5 = strongly**, significant amount of debris including medium to large objects.

c) Ground shaking:
- **0 = none**
- **1 = slightly**, minimal vibration in ground
- **2** = moderate ground vibration, easily seen in a glass of water, no movement of objects
- **3 = moderately**, strong ground vibration, feel rattled, small objects moved, minimal effects on balance/stability
- **4** = small earthquake, noticeable ground movement, balance/stability affected
- **5 = strongly**, strong earthquake, thrown about even if lying prone.

d) Pressure change/gradient:
- **0 = none**
- **1 = slightly**, noticeable but not uncomfortable
- **2** = noticeable and uncomfortable

SBI Pressure Change/Gradient Scale	
0	none
1	slightly, noticeable but not uncomfortable
2	noticeable and uncomfortable
3	moderately, results in minor pain or alteration of function
4	resulted in minor injury
5	strongly, resulted in greater than minor injury

Rowland et al., 2020

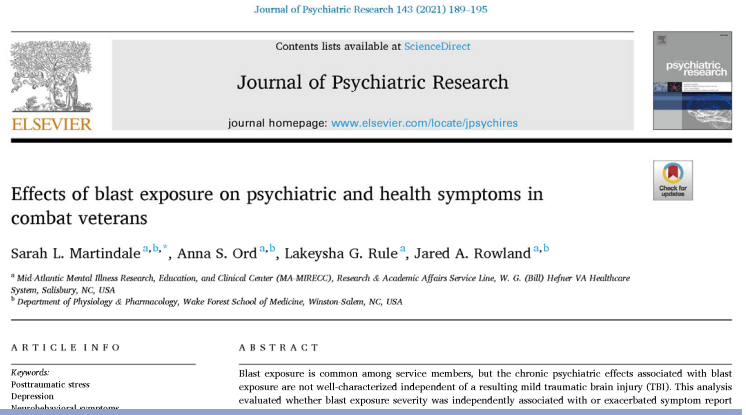
Blast: Psychiatric Outcomes

Model 1: PTSD diagnosis

Model 2: PTSD diagnosis, Deployment TBI

Model 3: PTSD diagnosis, Deployment TBI, Max Blast Pressure

Cov: Combat Exposure



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Effects of blast exposure on psychiatric and health symptoms in combat veterans

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ARTICLE INFO

Keywords:
Posttraumatic stress
Depression

ABSTRACT

Blast exposure is common among service members, but the chronic psychiatric effects associated with blast exposure are not well-characterized independent of a resulting mild traumatic brain injury (TBI). This analysis evaluated whether blast exposure severity was independently associated with or exacerbated symptom report

Associations with Blast	B	p
PTSD Symptoms	**2.00**	**.009**
Depressive Symptoms	**0.76**	**.011**
Neurobehavioral Symptoms	**1.69**	**.013**
Sleep Quality	0.35	.148
Pain Interference	0.06	.899
Quality of Life	-1.91	.136

Martindale et al., 2021b

Blast: Cognitive Outcomes

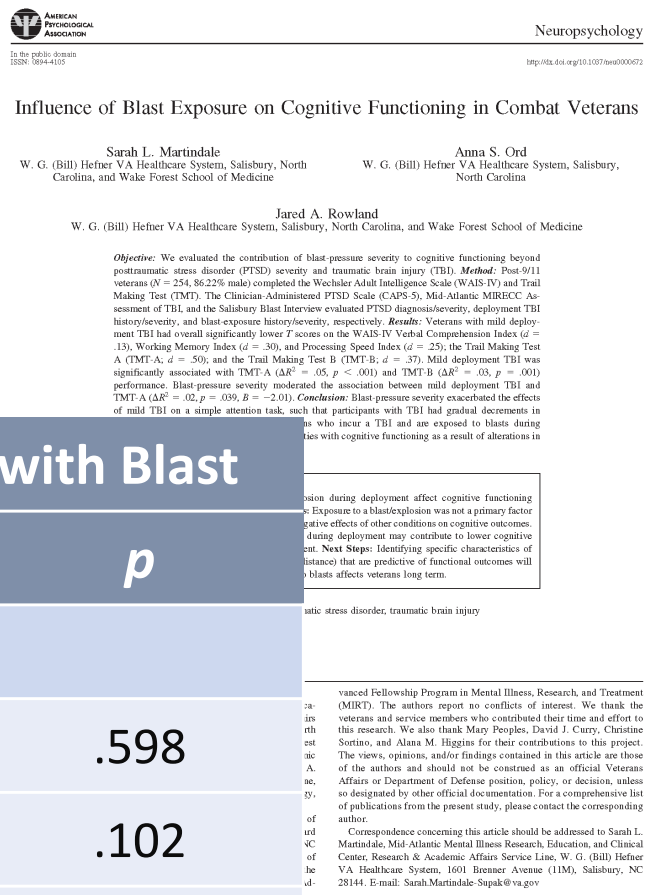
Model 1: PTSD severity

Model 2: PTSD severity, Deployment TBI

Model 3: PTSD severity, Deployment TBI, Maximum Blast Pressure

Cov: Combat Exposure

Cognitive Outcomes		Associations with Blast	
		B	*p*
WAIS-IV			
	PRI	-0.31	.598
	VCI	0.85	.102
	WMI	-0.04	.945
	PSI	0.29	.602
TMT-A		0.55	.361
TMT-B		-0.15	.788



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Influence of Blast Exposure on Cognitive Functioning in Combat Veterans

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Objective: We evaluated the contribution of blast-pressure severity to cognitive functioning beyond posttraumatic stress disorder (PTSD) severity and traumatic brain injury (TBI). ***Method:*** Post-9/11 veterans (N = 254, 86.22% male) completed the Wechsler Adult Intelligence Scale (WAIS-IV) and Trail Making Test (TMT). The Clinician-Administered PTSD Scale (CAPS-5), Mid-Atlantic MIRECC Assessment of TBI, and the Salisbury Blast Interview evaluated PTSD diagnosis/severity, deployment TBI history/severity, and blast-exposure history/severity, respectively. ***Results:*** Veterans with mild deployment TBI had overall significantly lower T scores on the WAIS-IV Verbal Comprehension Index (d = .13), Working Memory Index (d = .30), and Processing Speed Index (d = .25); the Trail Making Test A (TMT-A; d = .50); and the Trail Making Test B (TMT-B; d = .37). Mild deployment TBI was significantly associated with TMT-A (ΔR^2 = .05, p < .001) and TMT-B (ΔR^2 = .03, p = .001) performance. Blast-pressure severity moderated the association between mild deployment TBI and TMT-A (ΔR^2 = .02, p = .039, B = −2.01). ***Conclusion:*** Blast-pressure severity exacerbated the effects of mild TBI on a simple attention task, such that participants with TBI had gradual decrements in ns who incur a TBI and are exposed to blasts during ties with cognitive functioning as a result of alterations in

sion during deployment affect cognitive functioning e Exposure to a blast/explosion was not a primary factor gative effects of other conditions on cognitive outcomes. during deployment may contribute to lower cognitive ent. **Next Steps:** Identifying specific characteristics of istance) that are predictive of functional outcomes will blasts affects veterans long term.

atic stress disorder, traumatic brain injury

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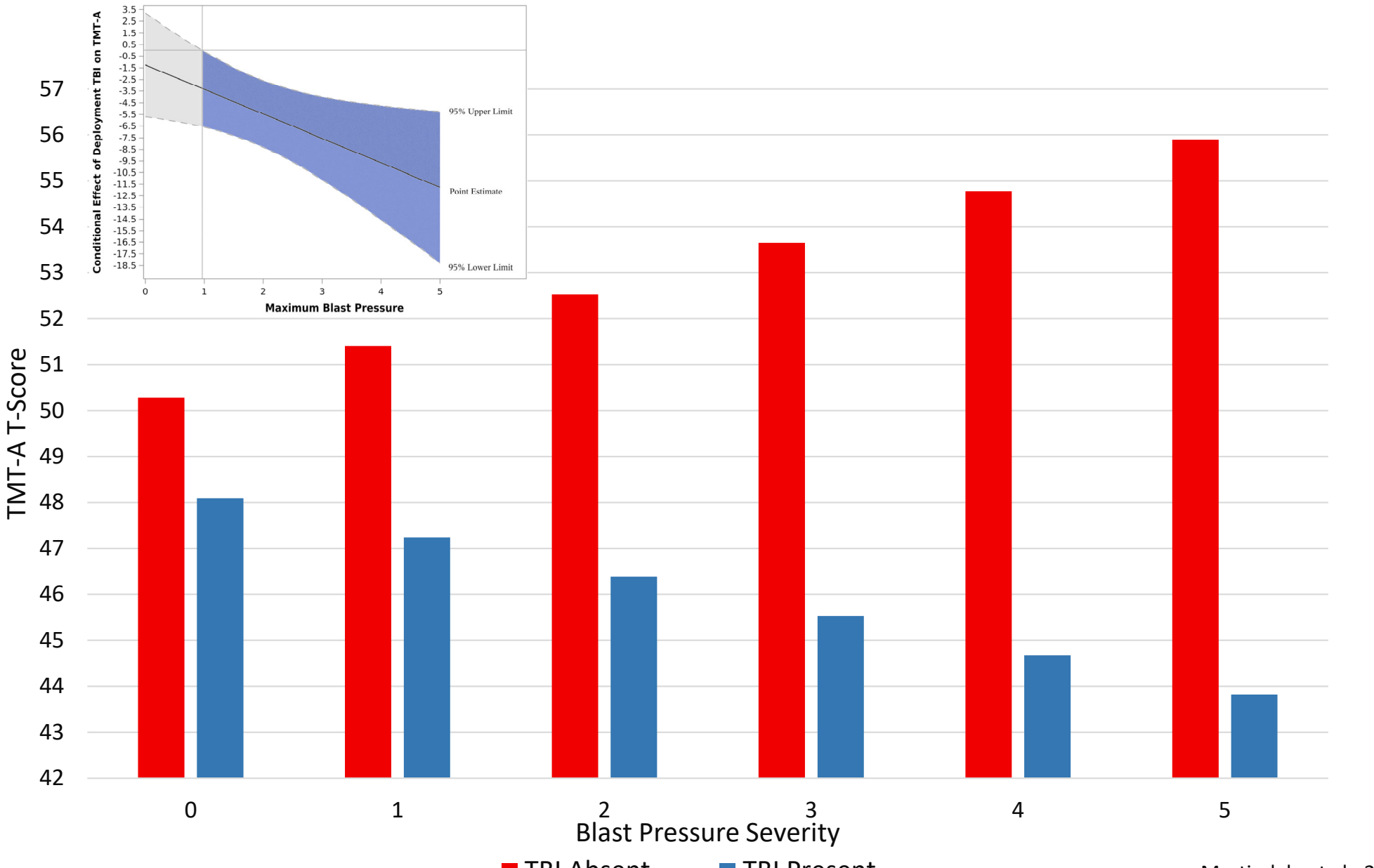
Martindale et al., 2020



Martindale et al., 2020

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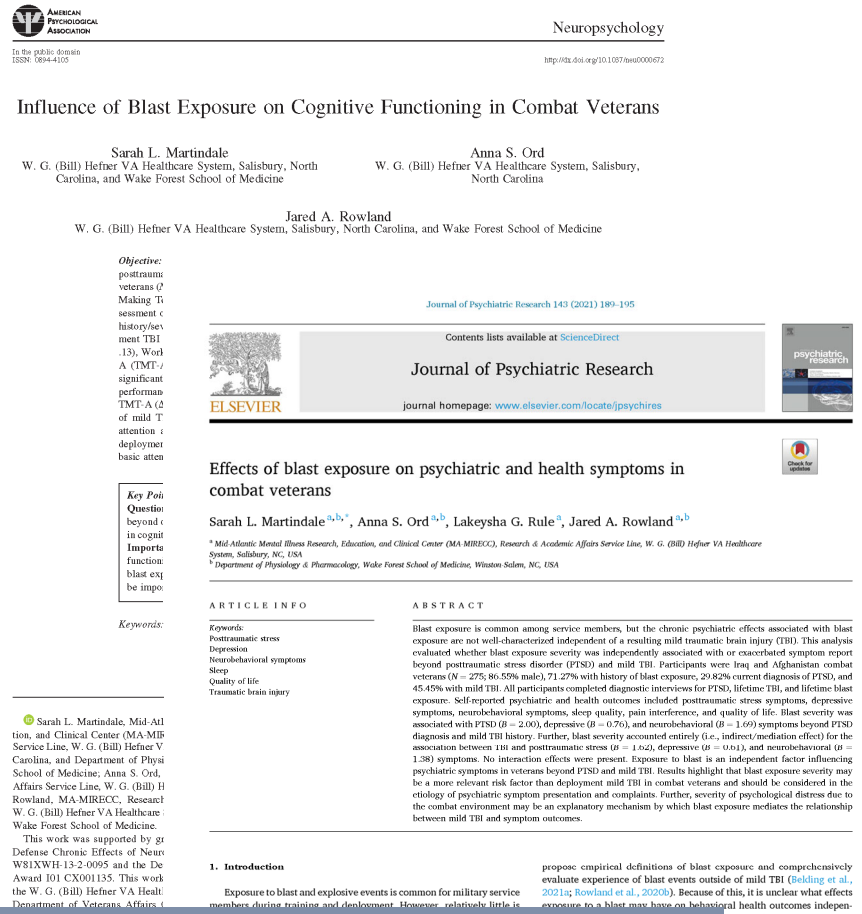
Blast Summary

Exposure to significant blast pressure has effects **independent from TBI**

Blast exposure is associated with poorer long-term **Psychological Outcomes**

- PTSD symptoms
- Depressive symptoms
- Neurobehavioral symptoms

Blast exposure *exacerbated* effects of Deployment TBI on **Cognitive Function**



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Effects of blast exposure on psychiatric and health symptoms in combat veterans

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ARTICLE INFO

Keywords:
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Quality of life
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ABSTRACT

Blast exposure is common among service members, but the chronic psychiatric effects associated with blast exposure are not well-characterized independent of a resulting mild traumatic brain injury (TBI). This analysis evaluated whether blast exposure severity was independently associated with or exacerbated symptom report beyond posttraumatic stress disorder (PTSD) and mild TBI. Participants were Iraq and Afghanistan combat veterans ($N = 275$; 86.55% male), 71.27% with history of blast exposure, 29.82% current diagnosis of PTSD, and 45.45% with mild TBI. All participants completed diagnostic interviews for PTSD, lifetime TBI, and lifetime blast exposure. Self-reported psychiatric and health outcomes included posttraumatic stress symptoms, depressive symptoms, neurobehavioral symptoms, sleep quality, pain interference, and quality of life. Blast severity was associated with PTSD ($\beta = 2.00$), depressive ($\beta = 0.76$), and neurobehavioral ($\beta = 1.69$) symptoms beyond PTSD diagnosis and mild TBI history. Further, blast severity accounted entirely (i.e., indirect/mediation effect) for the association between TBI and posttraumatic stress ($\beta = 1.62$), depressive ($\beta = 0.61$), and neurobehavioral ($\beta = 1.38$) symptoms. No interaction effects were present. Exposure to blast is an independent factor influencing psychiatric symptoms in veterans beyond PTSD and mild TBI. Results highlight that blast exposure severity may be a more relevant risk factor than deployment mild TBI in combat veterans and should be considered in the etiology of psychiatric symptom presentation and complaints. Further, severity of psychological distress due to the combat environment may be an explanatory mechanism by which blast exposure mediates the relationship between mild TBI and symptom outcomes.

1. Introduction

Exposure to blast and explosive events is common for military service members during training and deployment. However, relatively little is

SBI Pressure Change/Gradient Scale	
0	none
1	slightly, noticeable but not uncomfortable
2	noticeable and uncomfortable
3	moderately, results in minor pain or alteration of function
4	resulted in minor injury
5	strongly, resulted in greater than minor injury

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MID ATLANTIC MIRECC POST DEPLOYMENT MENTAL HEALTH

Resilience

The capacity to withstand or recover quickly from difficulties

The process and outcome of successfully adapting to difficult or challenging life experiences

Distress Tolerance

The ability to manage internal emotional state in response to stress-inducing factors

Perceived ability to withstand aversive states

Look Back: Blast and Psychiatric Outcomes

Model 1: PTSD diagnosis

Model 2: PTSD diagnosis, Deployment TBI

Model 3: PTSD diagnosis, Deployment TBI, Max Blast Pressure

Cov: Combat Exposure

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Effects of blast exposure on psychiatric and health symptoms in combat veterans

Sarah L. Martindale[a,b,*], Anna S. Ord[a,b], Lakeysha G. Rule[a], Jared A. Rowland[a,b]

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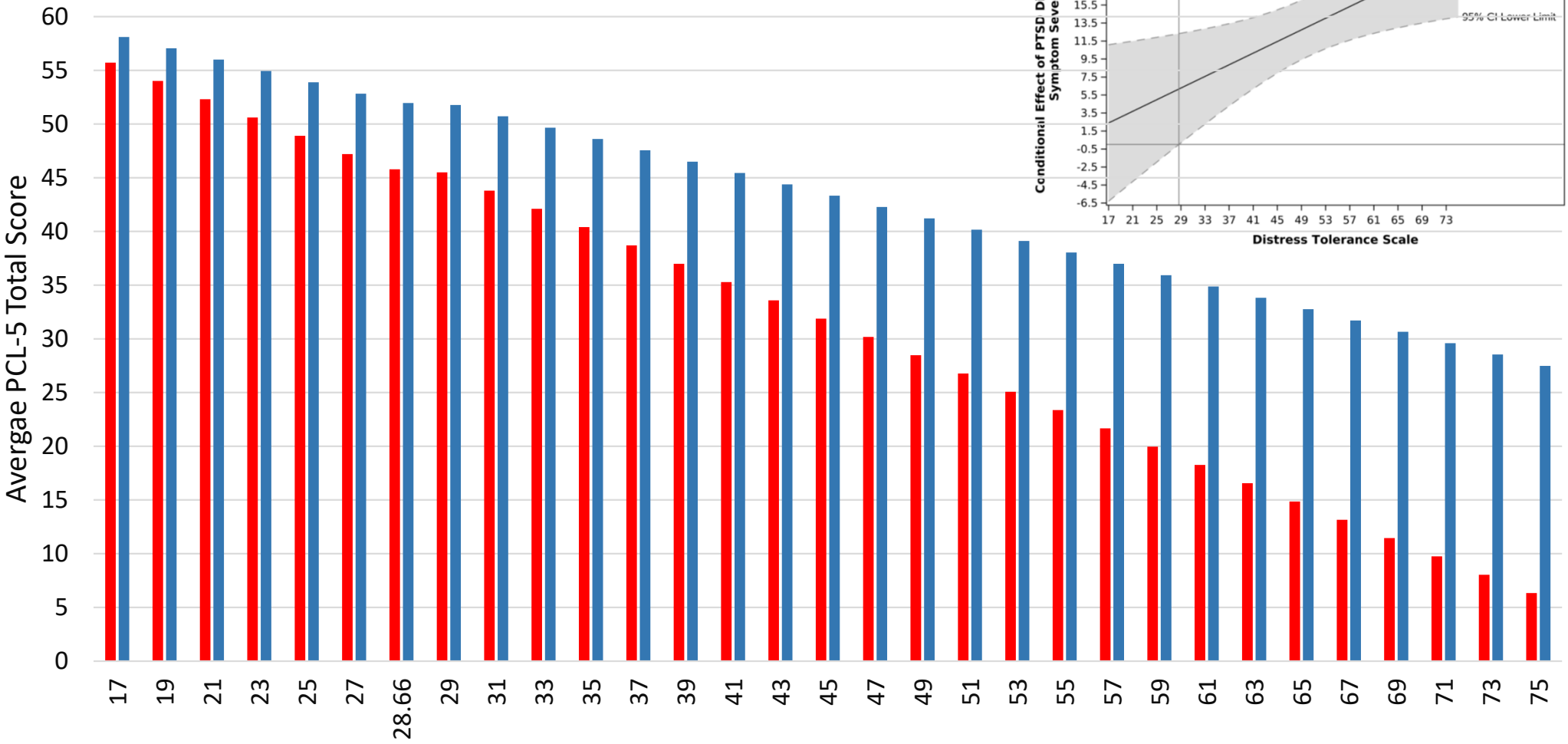
Associations with Blast	B	p
PTSD Symptoms	**2.00**	**.009**
Depressive Symptoms	**0.76**	**.011**
Neurobehavioral Symptoms	**1.69**	**.013**
Sleep Quality	0.35	.148
Pain Interference	0.06	.899
Quality of Life	-1.91	.136

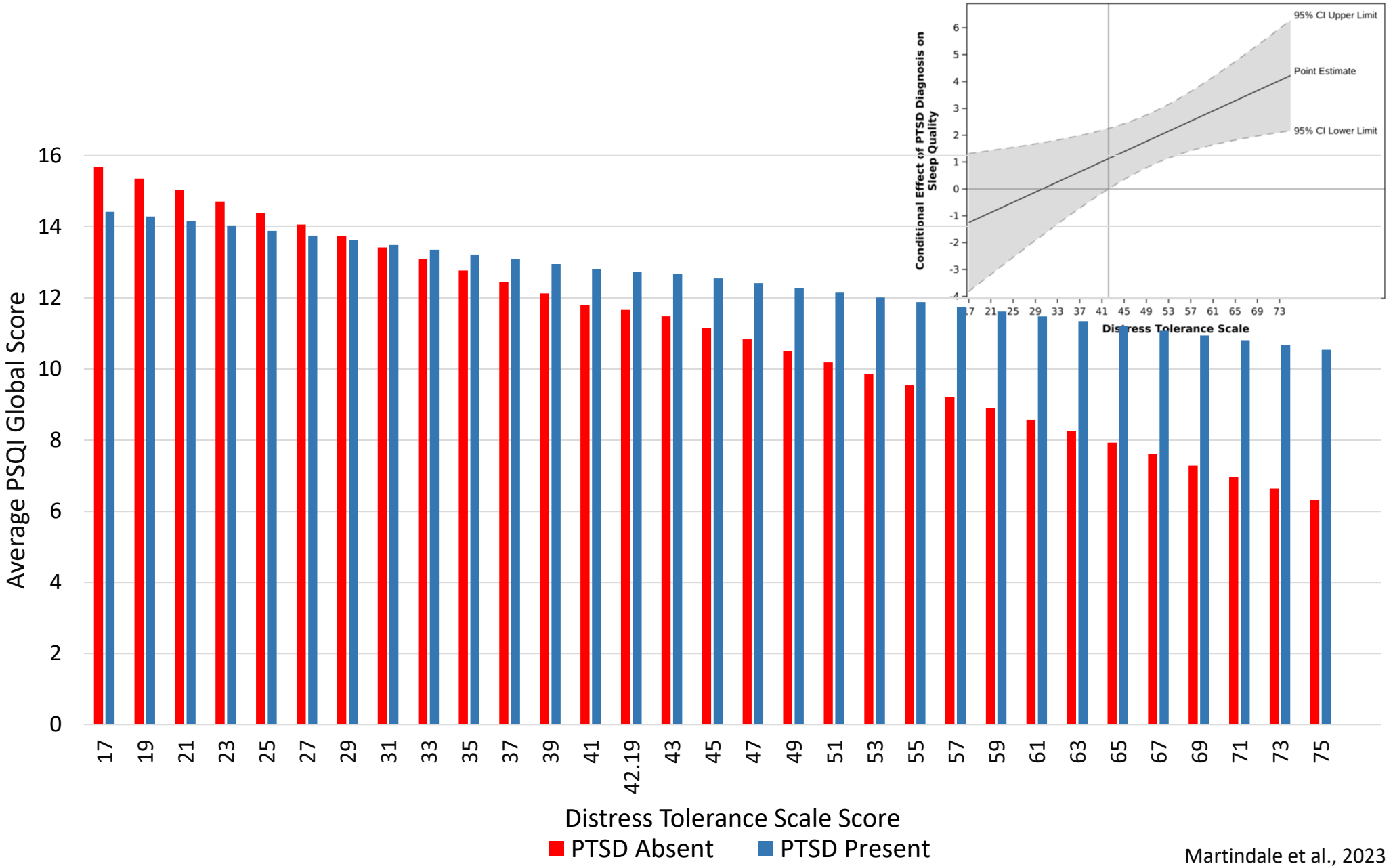
Martindale et al., 2021b

	PTSD Diagnosis		Deployment TBI		Maximum Blast Pressure		Distress Tolerance	
	B	*p*	B	*p*	B	*p*	B	*p*
Posttraumatic Stress Symptom Severity (PCL-5)	**13.04**	**< .001**	1.01	0.579	1.10	0.072	**-0.75**	**< .001**
Depressive Symptom Severity (PHQ-9)	**3.63**	**< .001**	0.55	0.431	0.41	0.086	**-0.29**	**< .001**
Neurobehavioral Symptom Severity (NSI)	**6.96**	**< .001**	1.68	0.322	0.97	0.091	**-0.60**	**< .001**
Sleep Quality (PSQI)	**1.86**	**< .001**	0.08	0.881	0.19	0.290	**-0.13**	**< .001**
Pain Interference (PROMIS-PI)	**4.41**	**< .001**	1.68	0.171	-0.20	0.623	**-0.19**	**< .001**
Quality of Life (QOLIBRI)	**-11.29**	**< .001**	-2.11	0.495	-0.38	0.713	**1.34**	**< .001**

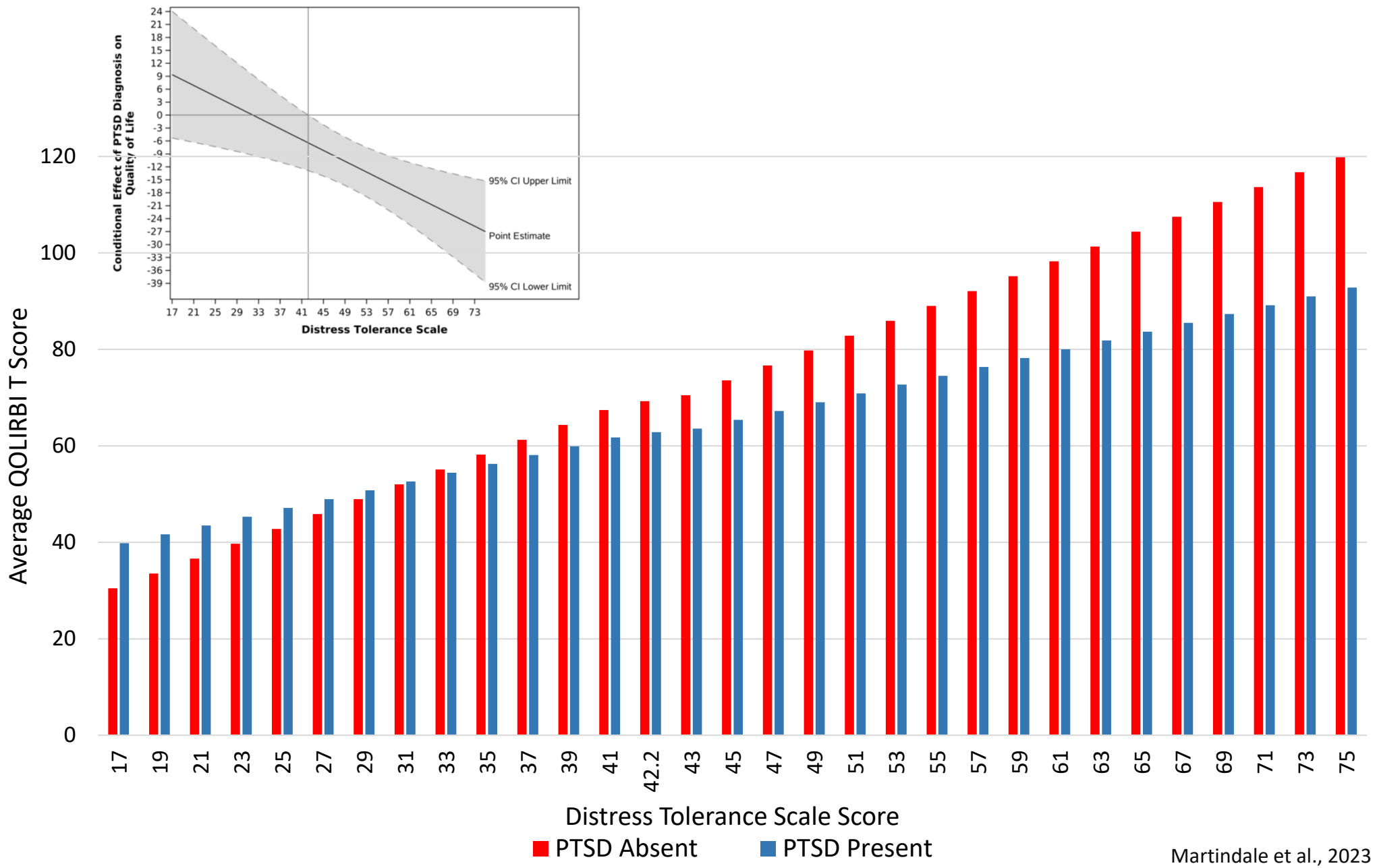
Martindale et al., 2023



Martindale et al., 2023



Martindale et al., 2023



Martindale et al., 2023

Distress Tolerance Summary

Related to long-term psychological function

- Protective against developing psychiatric symptoms?
- Lower distress tolerance may be related to lower baseline psychopathology

Possible explanatory mechanism for blast exposure or deployment TBI

Altered by blast exposure or TBI?

Rehabilitation Psychology

In the public domain
ISSN: 0090-5550

https://doi.org/10.1037/rep0000502

Distress Tolerance Mitigates Effects of Posttraumatic Stress, Traumatic Brain Injury, and Blast Exposure on Psychiatric and Health Outcomes

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Background: Exposure to blasts is common among service members and history of these exposures has been associated with chronic psychiatric and health outcomes. Evidence suggests that distress tolerance (DT) may moderate this relationship and be a valuable treatment target in this population. The purpose of this manuscript was to evaluate DT as a modifying factor in the association between posttraumatic stress disorder (PTSD), mild traumatic brain injury (TBI), blast exposure, and functional indicators. ***Method:*** Participants were 275 (86.55% male) combat veterans who served in Iraq or Afghanistan after September 11, 2001. Clinical interviews for PTSD diagnosis, TBI history, and blast exposure were administered, and participants completed self-report questionnaires (DT, PTSD symptom severity, depressive symptom severity, neurobehavioral symptom severity, sleep quality, pain interference, and quality of life). ***Results:*** DT was significantly associated with all functional indicators beyond PTSD diagnosis, mild TBI, and blast severity. There were significant interaction effects between DT and PTSD diagnosis for posttraumatic stress symptom severity, sleep quality, and quality of life. Specifically, there were significant differences in these reported functional indicators between individuals with and without a PTSD diagnosis as DT increases, such that reported symptoms were lower (quality of life better) for individuals without PTSD as DT improved. ***Conclusion:*** Our results demonstrate that DT might be a key factor in postdeployment function for military service members. Treatments targeting DT may be particularly effective in individuals who attribute psychiatric symptoms to history of blast exposure.

Impact and Implications
Distress tolerance (DT) mitigated the relationship between posttraumatic stress disorder (PTSD) and functional outcomes of posttraumatic stress symptoms, sleep quality, and quality of life. Effects of DT were exacerbated in veterans without a PTSD diagnosis, suggesting that DT may be a key protective factor against the development of PTSD, and individuals with a higher baseline level of DT may be less likely to develop clinical symptomology in response to stressors. Addressing DT in treatment may lead to better functional outcomes, especially in veterans without a PTSD diagnosis and/or subclinical PTSD symptoms.

Sarah L. Martindale https://orcid.org/0000-0002-0059-3454

We would like to thank the veterans and service members who participated in this research. We would also like to thank Mary Peoples, David J. Curry, MSW, Alana M. Higgins, MA, Christine Sortino, MS, and G. Melissa Evans, MA, for their contributions to this project.

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There are no conflicts of interest to disclose.

The views, opinions, and/or findings contained in this article are those of the authors and should not be construed as an official U.S. Department of Veterans Affairs or U.S. Department of Defense position, policy or decision, unless so designated by other official documentation.

Sarah L. Martindale served as lead for conceptualization, data curation, formal analysis, writing–original draft, and writing–review and editing. Anka A. Vujanovic contributed equally to conceptualization and served in a supporting role for formal analysis, investigation, and writing–original draft. Anna S. Ord served in a supporting role for conceptualization, writing–original draft, and writing–review and editing. Amanda Cary served in a supporting role for conceptualization, writing–original draft, and writing–review and editing. Jared A. Rowland contributed equally to data curation and served in a supporting role for conceptualization, formal analysis, funding acquisition, and writing–original draft. Sarah L. Martindale and Jared A. Rowland contributed equally to investigation, project administration, supervision, and methodology. Anka A. Vujanovic and Jared A. Rowland contributed equally to writing–review and editing.

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MOS Blast Risk

TBI Interviews with Blast Measurement

Boston Assessment of TBI – Lifetime (BAT-L)
Mid-Atlantic MIRECC Assessment of TBI (MMA-TBI)
Virginia Commonwealth University (VCU) retrospective Concussion Diagnostic Interview, Blast version (VCU-rCDI-B)

Occupational Blast Measures

Blast Exposure Threshold Survey (BETS)
Blast Frequency and Symptom Severity (B-FASS)
Blast Ordnance and Occupational Exposure Measure (BOOM)
SOCOM Assessment of Blast Exposure (SABE)

Proxy Measures

Military Occupational Specialty (MOS)
Explosive Ordnance Disposal (EOD) Training

Blast Sensors/Gauges

Definition of Severity

Frequency
Distance
Pressure
Risk Level
Direct Measurement of Force

Belding et al., 2020; Bliese et al., 2008; Fortier et al., 2014; Kuchinsky et al., 2021; Rowland et al., 2020; Sours Rhodes et al., 2022; Walker et al., 2015

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ORIGINAL ARTICLE CLINICAL STUDIES

Validation of Military Occupational Specialty as a Proxy for Blast Exposure Using the Salisbury Blast Interview

Sarah L. Martindale,[1,2,*,**] Jennifer N. Belding,[3] Cameron D. Crawford,[1] and Jared A. Rowland[1,2]

Abstract

Evaluating large data sets precludes the ability to directly measure individual experiences, instead relying on proxies to infer certain constructs. Blast exposure is a construct of study currently in its infancy, resulting in diverse definitions and measurements across studies. The purpose of the present study was to validate military occupational specialty (MOS) as a proxy for blast exposure in combat veterans. A total of 256 veterans (86.33% male) completed the Salisbury Blast Interview (SBI) and Mid-Atlantic Mental Illness Research Education and Clinical Center (MIRECC) Assessment of Traumatic Brain Injury (MMA-TBI). MOS was collected through record review and categorized into low and high risk for blast exposure. Chi-square analyses and *t* tests compared SBI metrics between MOS categories. Receiver operating characteristic (ROC) analyses evaluated the diagnostic accuracy of MOS category in determining blast exposure severity. Veterans in high-risk MOS were more likely to have experienced blast and deployment TBI ($ps < 0.001$) than were those in low-risk MOS. ROC analyses indicated good specificity (81.29–88.00) for blast and deployment TBI outcomes, suggesting that low-risk MOS is generally associated with an absence of blast and deployment TBI outcomes. Sensitivity was low (36.46–51.14), indicating that MOS risk level was not a good predictor of the presence of these outcomes. Results demonstrate that high-risk MOSs will identify individuals with blast exposure and deployment TBI history whereas low-risk MOSs will capture a highly variable g
results su
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Keyword

Introduction

Despite advanc
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(LLB) (overpre

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SBI Pressure Change/Gradient Scale	
0	none
1	slightly, noticeable but not uncomfortable
2	noticeable and uncomfortable
3	moderately, results in minor pain or alteration of function
4	resulted in minor injury
5	strongly, resulted in greater than minor injury

Risk Category	Examples
High-risk category	
Ammunition and explosive ordnance disposal	2311; EOD Support
Field artillery	0811; Cannoneer
Infantry	0311; Machine Gunner
Tank and assault amphibious vehicle	1812; M1A1 Tank Crewman
Moderate-risk category	
Airfield services	7011; Aircraft Recovery
Aviation ordnance	6531; Aviation Ordnance Tech
Chemical, biological, radiological, and nuclear (CBRN) defense	5711; NBC Chief
Combat camera	4612; Combat Videography
Engineer, construction, facilities, and equipment	1345; Heavy Equipment Operator
Ground ordnance maintenance	2111; Small Arms Repairman
Marine air-ground task force (MAGTF)	0511; Civil Affairs
Military police	5811; Detainee Ops
Motor transportation	3521; Motor T Mechanic
Navigation officer and flight crew	7314; UAV Operator
Public Affairs	4341; Combat Correspondent
Low-risk category	
Air control and support	7234; Air Traffic Control
Aircraft maintenance	6019; F/A 18 Airframe Mechanic
Aviation logistics	6672; Aviation Supply Clerk
Avionics	6317; Avionicsman
Communications	0612; Radio Operator
Electronics maintenance	5939; ATC Radar Technician
Financial management	3432; Disbursing Clerk
Food service	3381; Cook
Ground electronics maintenance	2823; Calibration Technician
Intelligence	0211; Intel Operations Specialist
Legal services	4421; Legal Clerk
Linguist	2799; Translator
Logistics	0411; Embarkation Specialist
Marine corps community services (MCCS)	4133; PX
Meteorology and oceanography	6842; METOC Forecaster
Miscellaneous	8012; Career Planner
Music	5519; Musician
Personnel and administration	0151; Admin Clerk
Signals intelligence/ground electronic warfare	2611; Crypto Tech
Supply	3043; Warehouseman
Traffic Management	3112; Traffic Management Specialist
Training	0931; Trainer
Utilities	1141; Basic Hygiene Operator
Unidentified categories	
Multiple	0311/5811; Logistics and Martial Arts Instructor
Missing	0000; Platoon Sergeant
Unknown	13130; Expeditor
Total	

Belding et al., 2020; Martindale et al., 2023; Rowland et al., 2021

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ORIGINAL ARTICLE

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Keywords: blast; measurement; military; military occupational specialty; traumatic brain

Introduction

Despite advances in the conceptualization of blast exposure, the ideal way to measure blast exposure has not been established. A recent review[1] highlighted the measures currently available to characterize low-level blast (LLB) (overpressure from outgoing munitions) exposure, most of which are instruments of an individual's exposure occupational events. Though mating potential cumulative e overpressure across a military are largely restricted to quar

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**Please contact the corresponding author for a comprehensive list of publications from the present study.

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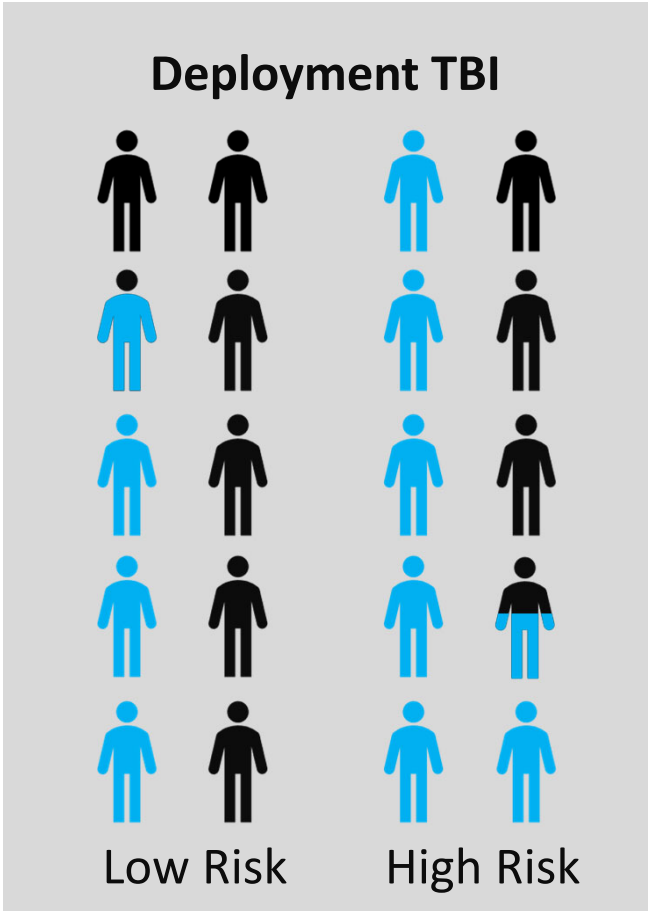
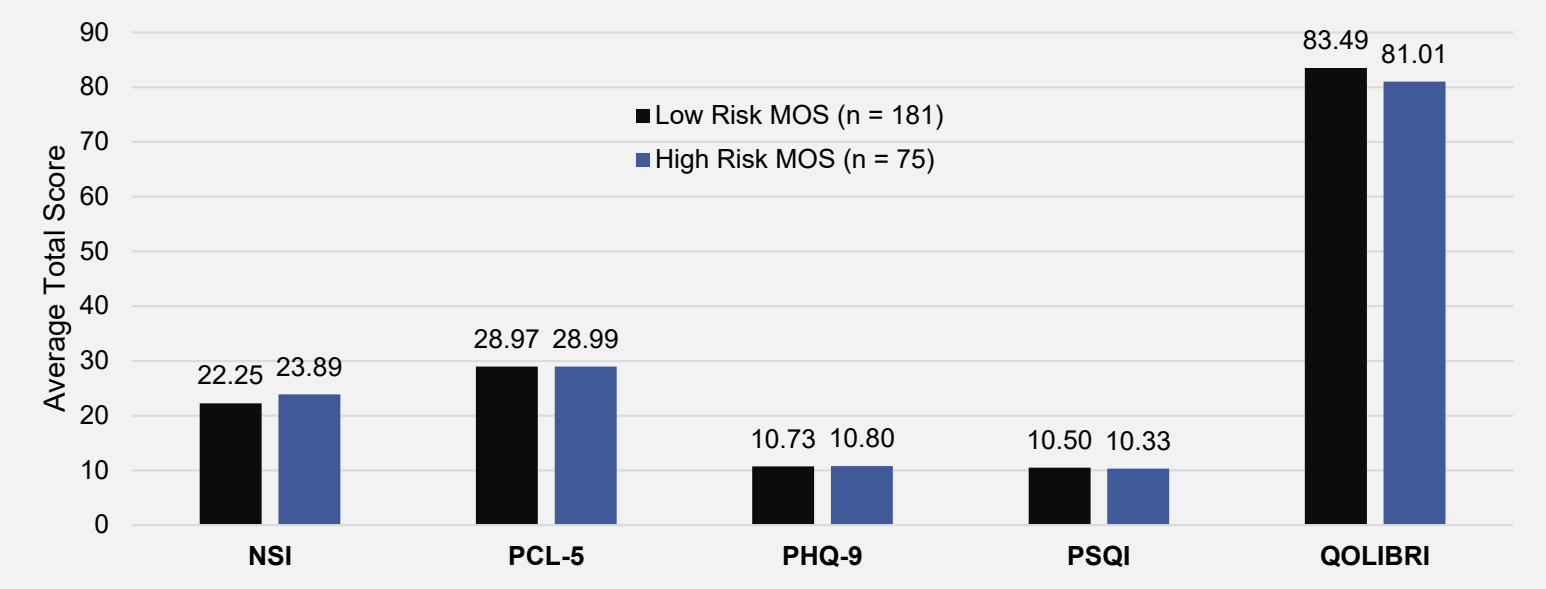
24% of low risk MOS
60% of high risk MOS



38% of low risk MOS
65% of high risk MOS

Martindale et al., 2023

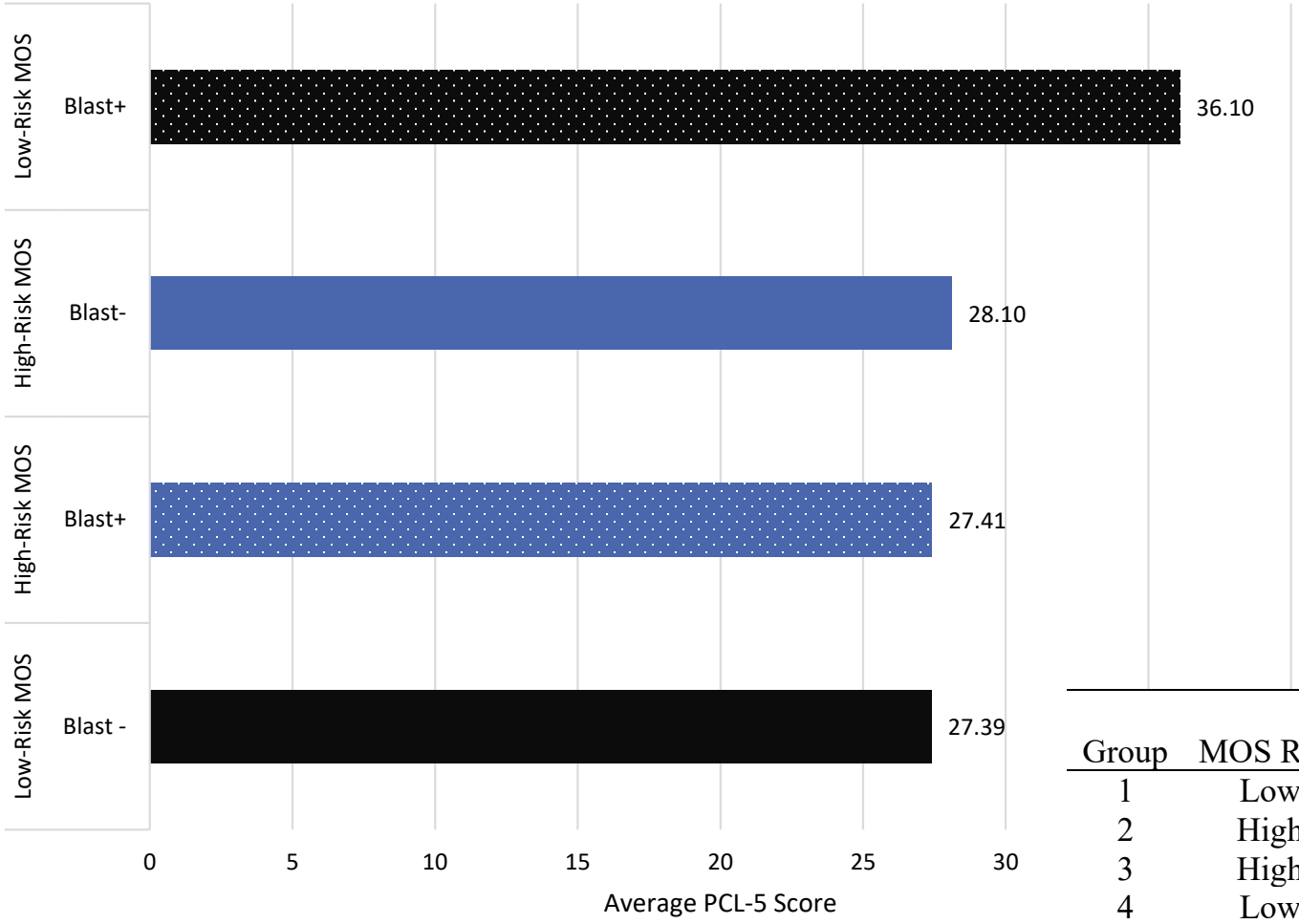
Results
Comparing MOS Risk Categories



Brain Health Outcomes	Low Risk MOS (*n* = 181)		High Risk MOS (*n* = 75)		*t*	*p*
	M	SD	*M*	SD		
NSI	22.25	15.81	23.89	14.66	-0.77	.440
PCL-5	28.97	18.94	28.99	17.58	-0.01	.996
PHQ-9	10.73	6.62	10.80	6.92	-0.08	.939
PSQI	10.50	4.28	10.33	4.23	0.28	.780
QOLIBRI	83.49	28.81	81.01	29.01	0.62	.533

*Unpublished

Results
Two-Way Interaction: PCL-5

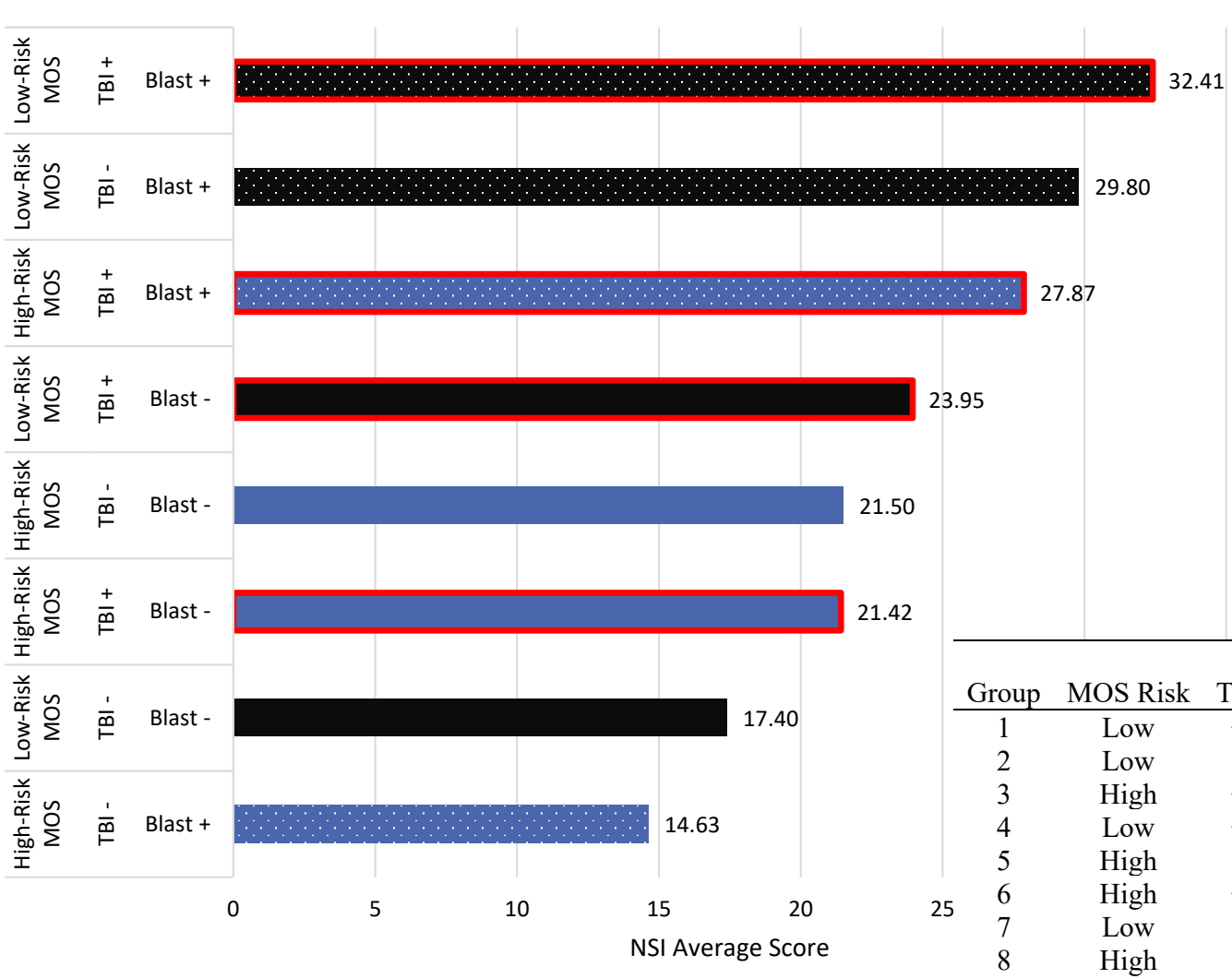


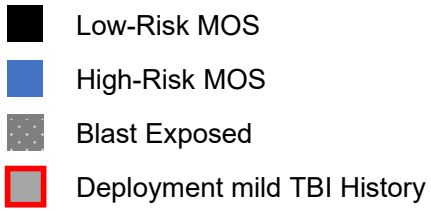
Group	MOS Risk	Blast	PCL-5 *M*	Group Contrasts 1	2	3	4
1	Low	+	36.10		•	•	•
2	High	-	28.10	•			
3	High	+	27.41	•			
4	Low	-	27.39	•			

• = significant differences between means at $p < .05$

*Unpublished

Results
Three-Way Interactions: NSI



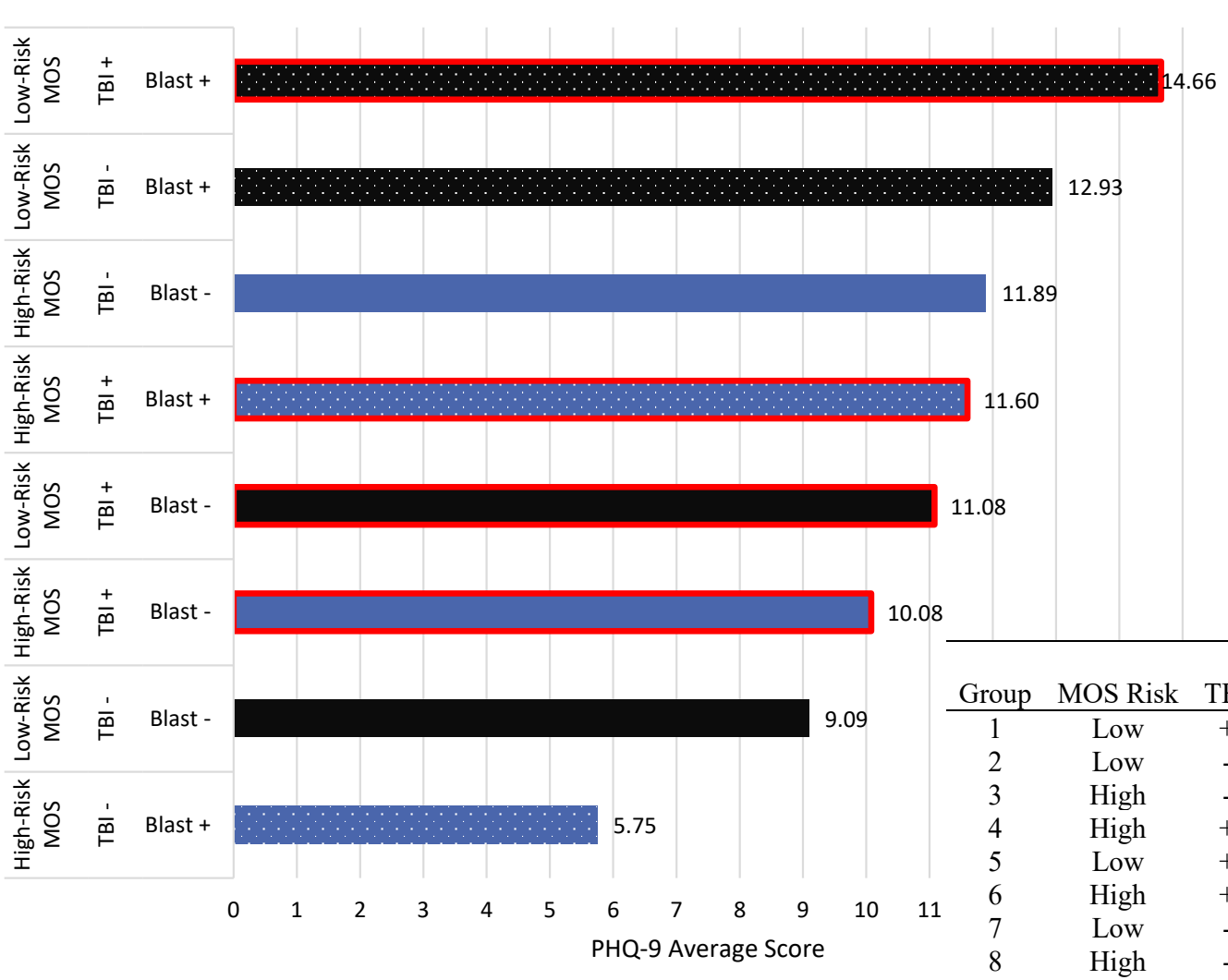


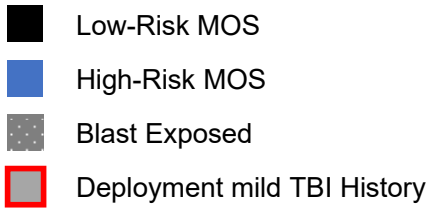
Group	MOS Risk	TBI	Blast	NSI *M*	Group Contrasts 1	2	3	4	5	6	7	8
1	Low	+	+	32.41				•	•	•	•	•
2	Low	-	+	29.80							•	•
3	High	+	+	27.87							•	•
4	Low	+	-	23.95	•						•	
5	High	-	-	21.50	•							
6	High	+	-	21.42	•							
7	Low	-	-	17.41	•	•	•	•				
8	High	-	+	14.63	•	•	•					

• = significant differences between means at $p < .05$

*Unpublished

Results
Three-Way Interactions: PHQ-9



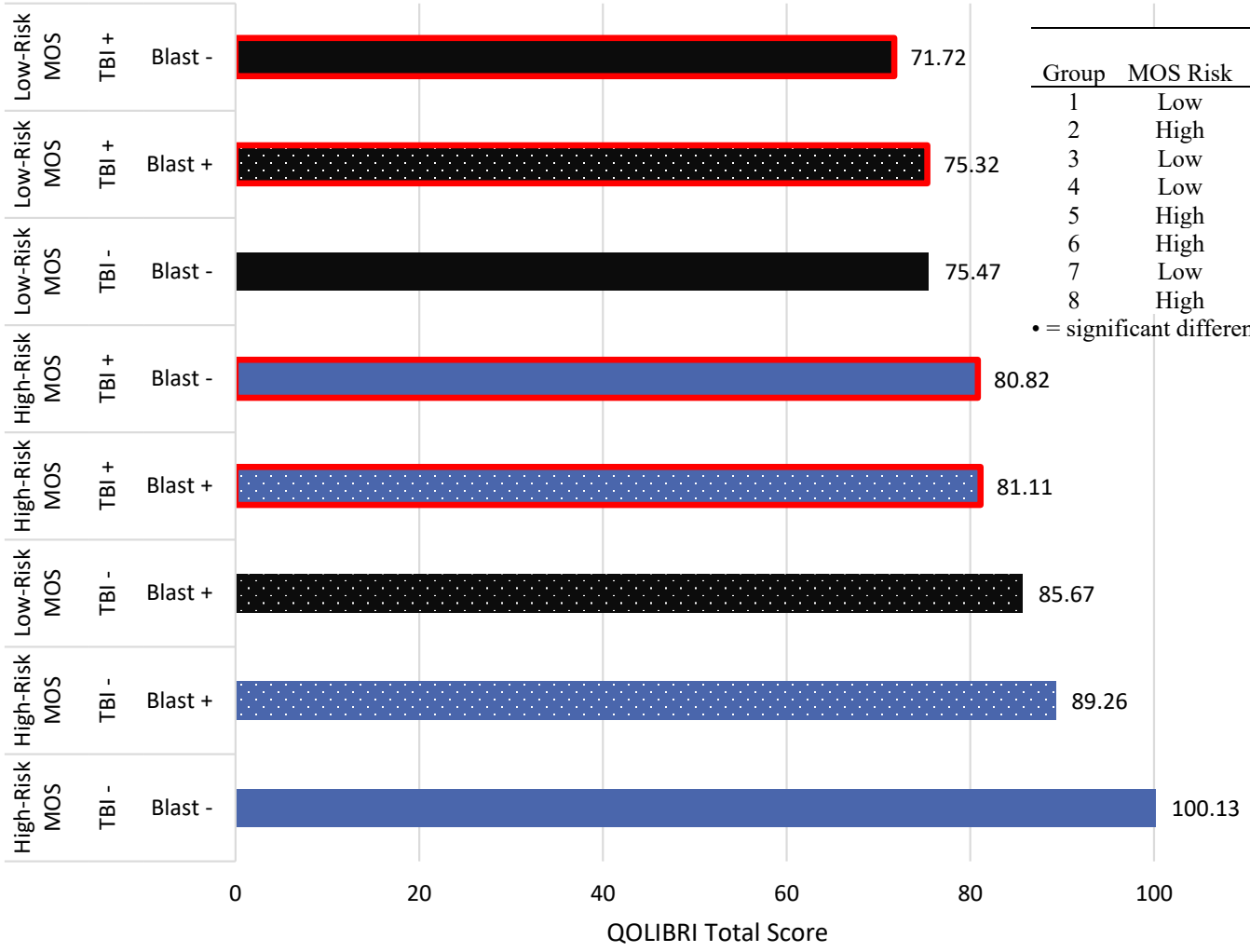


Group	MOS Risk	TBI	Blast	PHQ-9 *M*	Group Contrasts 1	2	3	4	5	6	7	8
1	Low	+	+	14.66					•	•	•	•
2	Low	-	+	12.93							•	•
3	High	-	-	11.89								•
4	High	+	+	11.60							•	•
5	Low	+	-	11.08	•							•
6	High	+	-	10.08	•							
7	Low	-	-	9.09	•	•		•				
8	High	-	+	5.75	•	•	•	•	•			

• = significant differences between means at $p < .05$

*Unpublished

Results
Three-Way Interactions: QOLBRI



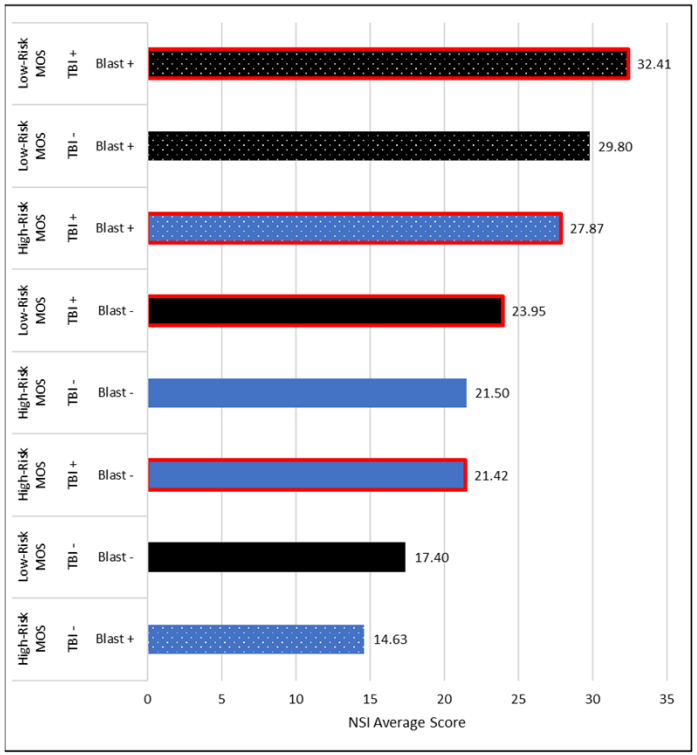
Group	MOS Risk	TBI	Blast	QOLIBRI *M*	Group Contrasts 1	2	3	4	5	6	7	8
1	Low	+	+	71.72							•	•
2	High	+	+	75.32							•	•
3	Low	-	+	75.47								•
4	Low	+	-	80.82								
5	High	-	-	81.11								
6	High	+	-	85.67								
7	Low	-	-	89.26	•	•						
8	High	-	+	100.13	•	•	•					

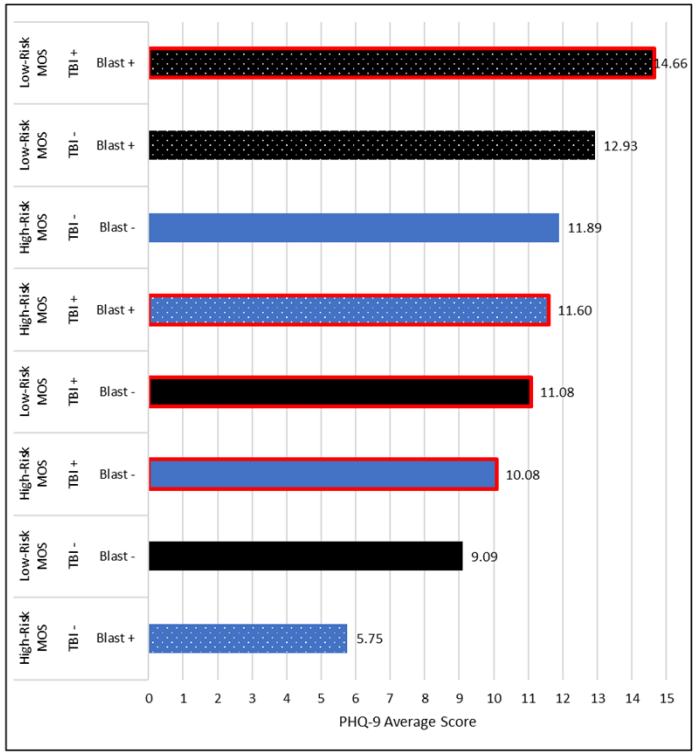
• = significant differences between means at $p < .05$

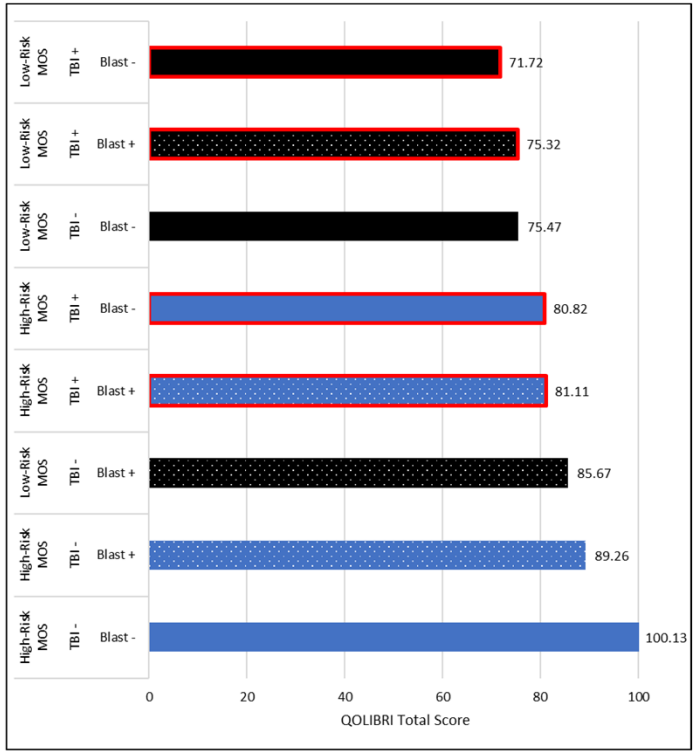
Low-Risk MOS
High-Risk MOS
Blast Exposed
Deployment mild TBI History

*Unpublished

Results
Three-Way Interactions







Low-Risk MOS High-Risk MOS Blast Exposed Deployment TBI History

*Unpublished

MOS Blast Risk Summary

Individuals in low-risk MOS may be more vulnerable to long-term psychological effects of blast exposure

Is distress tolerance an explanatory factor?

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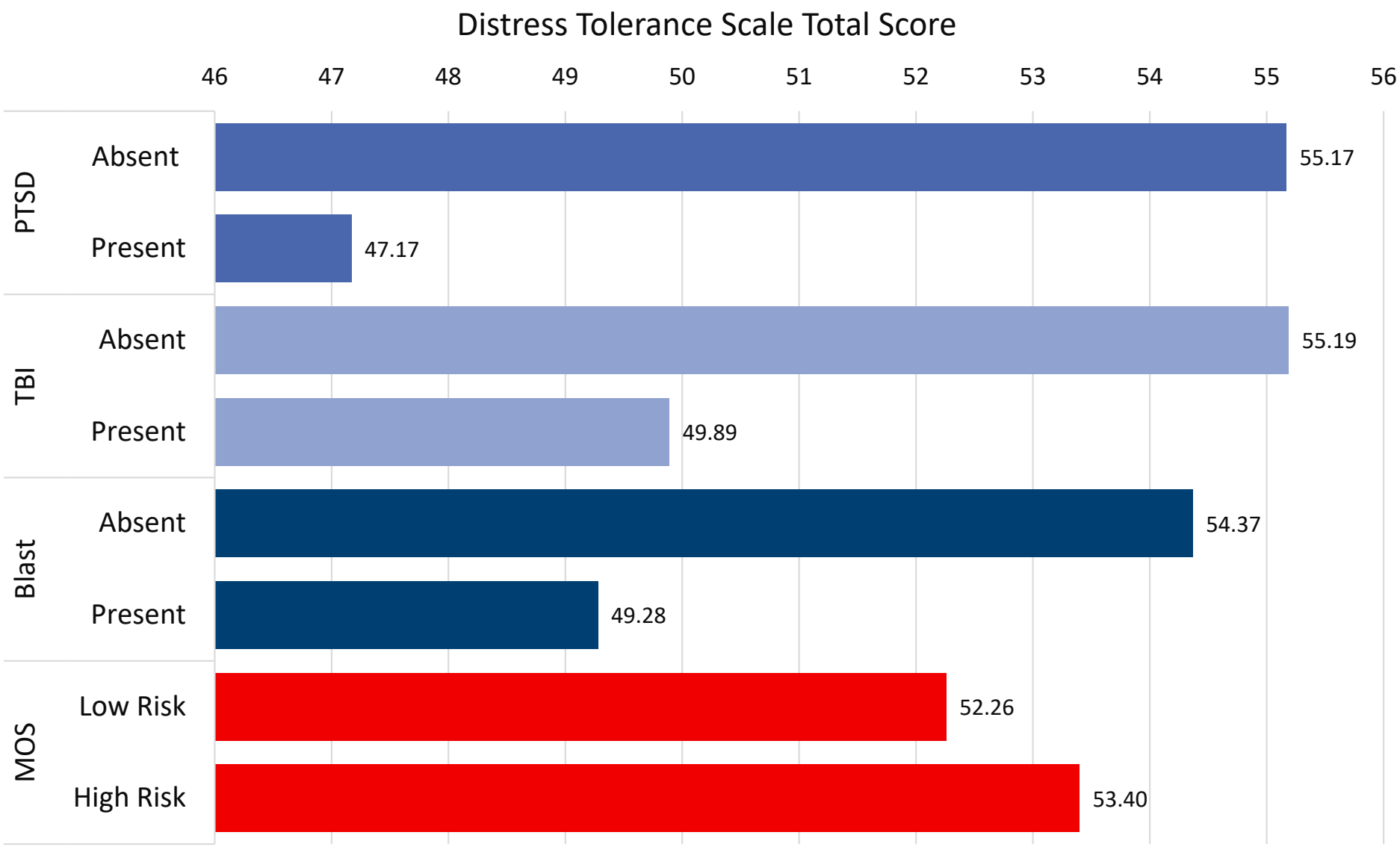

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Wrap-Up

Training	Preparation to experience stressful/injurious events
Policy	Implementation of policies over time may reduce poor outcomes for high risk MOS
Awareness	Greater recovery for high risk MOS may be a result of earlier identification and treatment of blast injuries

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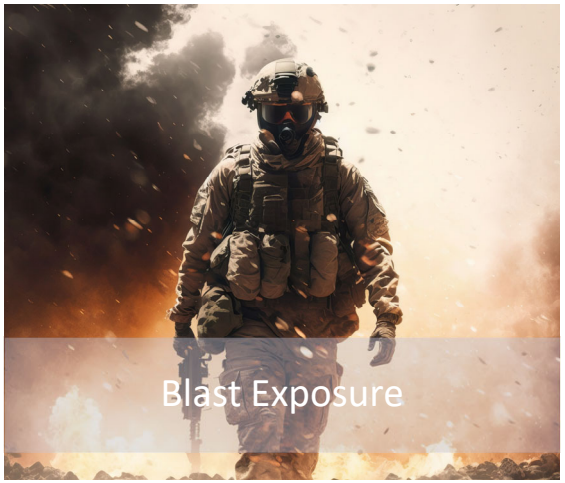

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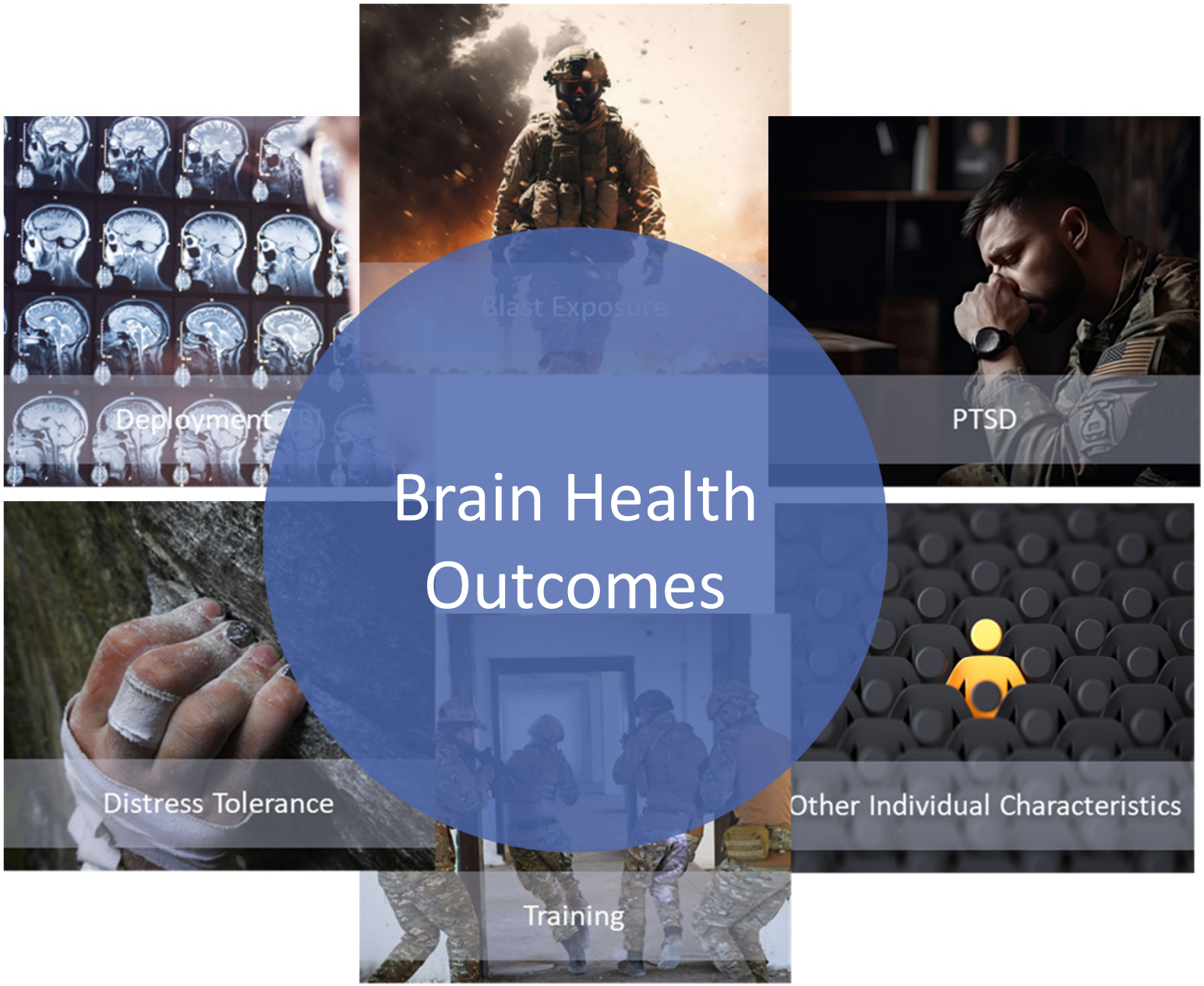

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MID-ATLANTIC MIRECC POST DEPLOYMENT MENTAL HEALTH

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