Department of Veterans Affairs
Rehabilitation Research & Development Service
Traumatic Brain Injury National Network Research Center

Deployment Trauma:
Insights from the TRACTS Cohort on the Effects of mTBI, Blast Exposure & Associated Comorbidities in OEF/OIF Veterans

HSR&D Cyberseminar
May 31, 2017

Regina McGlinchey, PhD
New England Geriatric Research Education and Clinical Center &
Translational Research Center for TBI and Stress Disorders

Mission:

- To conduct multidisciplinary, clinical research aimed at understanding the complex pathophysiology associated with co-occurring TBI and related stress disorders

- To develop effective treatment opportunities for OEF/ OIF/OND Veterans with multiple co-occurring conditions.

TRACTS is a VA Rehabilitation Research and Development Traumatic Brain Injury National Network Research Center (B9254-C)

TRACTS LONGITUDINAL COHORT STUDY:

Two sites:

- Boston (starting in 2010)
- Houston (starting in 2015)

Three study visits to date:

- Baseline
- Time 2 (~22 months, SD=7 months)
- Time 3 (5 years after Time 2)

Recruitment

- Majority of participants recruited through a full-time recruitment specialist who attends:
  - Yellow Ribbon events
  - Task Force meetings
  - Other events involving US Air National Guard, Marine and Marine Reserves, and Army and Army Reserve Units
- Remaining participants recruited through:
  - Flyers posted in the VA medical center
  - Word of mouth from other TRACTS participants

Inclusion Criteria

- Veteran of OEF/OIF (deployed at least one time to either Afghanistan or Iraq)
- Active duty Service Member (SM) not yet deployed to post-9/11 operation
- Age range 18-65 years at baseline visit

Exclusion Criteria

- History of neurological illness (Huntington's, Parkinson's, dementia, MS, etc)
- History of Seizure Disorders, unrelated to head injuries
- Current diagnosis of schizophrenia, bipolar or other psychotic disorder
- Severe depression or anxiety, current active homicidal and/or suicidal ideation with intent requiring crisis intervention
- Cognitive disorder due to general medical condition other than TBI
- Unstable psychological diagnosis that would interfere with accurate data collection, determined by consensus of at least two doctorate-level psychologists

Boston Site: Baseline Flow Diagram

Currently Tested: 543

Met Inclusion Criteria: 523

Certified Data: 481

Deployed to OIF/OEF/OND: 457

Boston Site: Time 2 Flow Diagram

Time 2 - Currently Tested: 291

Met Inclusion Criteria: 291

Certified Data: 264

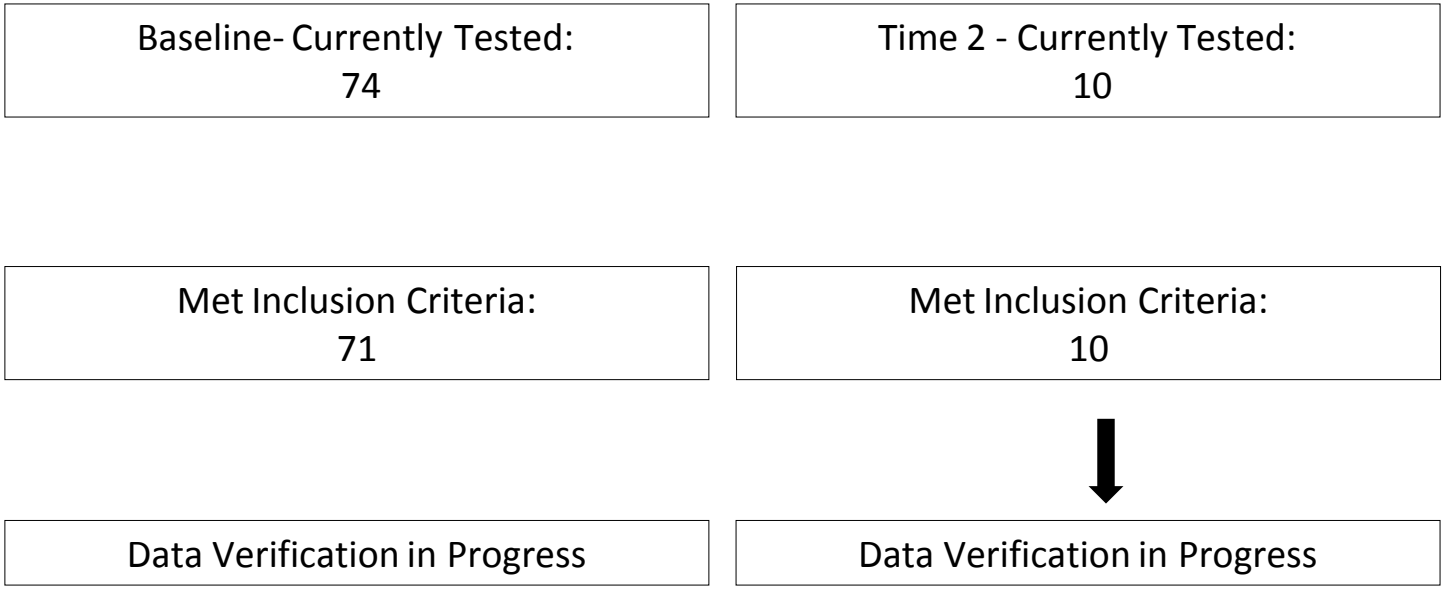
Deployed to OIF/OEF/OND: 248

Time 3 - Currently Tested: 14

Met Inclusion Criteria: 14

Data Verification in Progress

Houston Site: Baseline Flow Diagram



Poll Question:

Do you know what the definition of a mild traumatic brain injury is?

TRACTS Assessment Core

Medical/Biological	Neuropsych Domains	Affective/Psychosocial	Blast/TBI	Neuroanatomy S/F MRI
Blood Chemistry	Simple/Divided Attention	PTSD: CAPS & PCL-C	Boston Assessment of TBI-Lifetime	Cortical Volume
GWAS	Information Processing Speed	DSM-IV AXIS I: SCID	Ohio State University TBI ID	Cortical Thickness
Neuro-steroid	Executive Function	Traumatic Life Events Questionnaire	Neurobehavioral Symptom Inventory	Diffusion Tensor
	Declarative/Procedural Memory	Deployment Risk & Resiliency Inventory		Resting-State Networks
	Pre-morbid Function	Depression, Anxiety & Stress Scale-21		Functional Connectivity
	Perception	Pittsburgh Sleep Quality Index		Task-Based fMRI
	Symptom Validity	McGill Pain Questionnaire		
	Psychomotor Speed	Alcohol, Nicotine		
		Sickness Impact Profile		

J Head Trauma Rehabil
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The Boston Assessment of Traumatic Brain Injury–Lifetime (BAT-L) Semistructured Interview: Evidence of Research Utility and Validity

Catherine Brawn Fortier, PhD; Melissa M. Amick, PhD; Laura Grande, PhD; Susan McGlynn, PhD; Alexandra Kenna, PhD; Lindsay Morra, BA; Alexandra Clark, BA; William P. Milberg, PhD; Regina E. McGlinchey, PhD

Objective: Report the prevalence of lifetime and military-related traumatic brain injuries (TBIs) in Operation Enduring Freedom and Operation Iraqi Freedom (OEF/OIF) veterans and validate the Boston Assessment of TBI–Lifetime (BAT-L). **Setting:** The BAT-L is the first validated, postcombat, semistructured clinical interview to characterize head injuries and diagnose TBIs throughout the life span. **Participants:** Community-dwelling convenience sample of 131 OEF/OIF veterans. **Design:** TBI criteria (alteration of mental status, posttraumatic amnesia, and loss of consciousness) were evaluated for all possible TBIs, including a novel evaluation of blast exposure. **Main Measures:** BAT-L, Ohio State University TBI Identification Method (OSU-TBI-ID). **Results:** About 67% of veterans incurred a TBI in their lifetime. Almost 35% of veterans experienced at least 1 military-related TBI; all were mild in severity, 40% of them were due to blast, 50% were due to some other (ie, blunt) mechanism, and 10% were due to both types of injuries. Predeployment TBIs were frequent (45% of veterans). There was strong correspondence between the BAT-L and the OSU-TBI-ID (Cohen $\kappa = 0.89$; Kendall τ-b $= 0.95$). Interrater reliability of the BAT-L was strong (κs >0.80). **Conclusions:** The BAT-L is a valid instrument with which to assess TBI across a service member's lifetime and captures the varied and complex nature of brain injuries across OEF/OIF veterans' life span. **Key words:** *assessment, blast, OEF/OIF, traumatic brain injury (TBI), veterans*

Fortier, C. B., Amick, M. M., Grande, L., McGlynn, S., Kenna, A., Morra, L., . . . McGlinchey, R. E. (2014). The Boston Assessment of Traumatic Brain Injury-Lifetime (BAT-L) semistructured interview: evidence of research utility and validity. *J Head Trauma Rehabil, 29* (1), 89-98. doi: 10.1097/HTR.0b013e3182865859

Fortier, C. B., Amick, M. M., Kenna, A., Milberg, W. P., & McGlinchey, R. E. (2015). Correspondence of the Boston Assessment of Traumatic Brain Injury-Lifetime (BAT-L) clinical interview and the VA TBI screen. *J Head Trauma Rehabil, 30* (1), E1-7. doi: 10.1097/HTR.0000000000000008

TBI Severity is Rated According to DOD Criteria

Criteria	Mild	Moderate	Severe
Loss of Consciousness	0 - 30 minutes	>30 minutes and <24 hours	> 24 hours
Alteration of Mental Status	0 - 24 hours	>24 hours; severity based on other criteria	
Post Traumatic Amnesia	0 - 1 day	> 1 day and <7 days	> 7 days
Glascow Coma Scale	13 - 15	9 - 12	<9

TBI Severity (BAT-L) in Deployed TRACTS Participants (n=456)

	Deployment Blast	**Military "Other"**	**Pre-Deployment**	**Post-Deployment**
Mild	142 (31%) (27 with multiple)	123 (27%) (32 with multiple)	188 (41%) (70 with multiple)	35 (8%) (3 with multiple)
Moderate	2	3	11	1
Severe	1	0	2	1

Blast exposure in first 456 deployed TRACTS participants (BATL-Assessment)

	< 10 meters	11 – 25 meters	26-100 meters	Total Blast Exposures < 100 meters
Number of Service Members Exposed (%)	211 (46.3%)	213 (46.7%)	342 (75.0%)	380 (83.3%)
Mean Blasts per Service Member (SD)	3.0 (21.6)	3.3 (12.4)	27.9 (104.6)	34.2 (115.4)
Median Blasts per Service Member (IQR)	0 (0, 2)	0 (0, 2)	2 (1, 10)	4 (1, 18)
Range of Blasts per Service Member	0 – 416	0 – 204	0 – 999	0 – 1102

Robinson ME, Lindemer ER, Fonda JR, Milberg WP, McGlinchey RE, Salat DH. Close-range blast exposure is associated with altered functional connectivity in Veterans independent of concussion symptoms at time of exposure. Hum Brain Mapp. 2015 Mar;**36**(3):911-22.

Trotter BB, Robinson ME, Milberg WP, McGlinchey RE, Salat DH. Military blast exposure, ageing and white matter integrity. Brain : a journal of neurology. 2015 Jun 1.

Baseline Clinical Characteristics

	n	Total (n=456)	Military TBI (n=221)	No Military TBI (n=260)	P-value
PTSD, No. (%)	456	288 (63.2%)	170 (78.3%)	118 (49.4%)	<0.0001
Depressive DO, No. (%)	456	131 (28.7%)	80 (36.9%)	51 (21.3%)	0.0003
Major Depressive DO, No. (%)	456	118 (25.9%)	73 (33.6%)	45 (18.8%)	0.0003
Other Depressive DO, No. (%)	456	14 (3.1%)	8 (3.7%)	6 (2.5%)	0.4672
Anxiety Disorder, No. (%)	455	95 (20.9%)	50 (23.0%)	45 (18.8%)	0.2686
Panic Disorder, No. (%)	455	38 (8.4%)	26 (12.0%)	12 (5.0%)	0.0075
Social Phobia, No. (%)	455	27 (5.9%)	11 (5.1%)	16 (6.7%)	0.4559
Generalized Anxiety DO, No. (%)	455	37 (8.1%)	19 (8.8%)	18 (7.6%)	0.6420
Other Anxiety DO, No. (%)	455	25 (5.5%)	15 (6.9%)	10 (4.2%)	0.2050
Substance Use DO, No. (%)	456	74 (16.2%)	42 (19.4%)	32 (13.4%)	0.0844
Alcohol Abuse/Dependence, No.(%)	456	64 (14.1%)	36 (16.6%)	28 (11.8%)	0.1392
Other Abuse/Dependence, No (%)	456	16 (3.5%)	8 (3.7%)	8 (3.4%)	0.8441
Pain, No. (%)	410	291 (71.0%)	159 (83.3%)	132 (60.3%)	<0.0001
Sleep Disturbance, No. (%)	433	348 (80.4%)	180 (89.6%)	168 (72.4%)	<0.0001
Number of Psychiatric & Behavioral Conditions, mean	404	2.77 ± 1.48	3.27 ± 1.31	2.34 ± 1.48	<0.0001
3+ Comorbidities	404	232 (57.4%)	137 (73.7%)	95 (43.6%)	<0.0001

Journal of Traumatic Stress
February 2015, *28*, 25–33

ISTSS International Society for Traumatic Stress Studies

Deployment-Related Psychiatric and Behavioral Conditions and Their Association with Functional Disability in OEF/OIF/OND Veterans

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Understanding the factors that influence veterans' functional outcome after deployment is critical to provide appropriately targeted care. Mild traumatic brain injury (mTBI) and posttraumatic stress disorder (PTSD) have been related to disability, but other psychiatric and behavioral conditions are not as well examined. We investigated the impact of deployment-related psychiatric and behavioral conditions on disability among 255 OEF/OIF/OND service members and veterans. Structured clinical interviews assessed TBI and the psychiatric conditions of depression, PTSD, anxiety, and substance use. Self-report questionnaires assessed disability and the behavioral conditions of sleep disturbance and pain. Over 90% of participants had a psychiatric and/or behavioral condition, with approximately half presenting with $\geq$ 3 conditions. Exploratory factor analysis revealed 4 clinically relevant psychiatric and behavioral factors which accounted for 76.9% of the variance: (a) depression, PTSD, and military mTBI (deployment trauma factor); (b) pain and sleep (somatic factor); (c) anxiety disorders, other than PTSD (anxiety factor); and (d) substance abuse or dependence (substance use factor). Individuals with the conditions comprising the deployment trauma factor were more likely to be substantially disabled than individuals with depression and PTSD, but no military mTBI, $OR = 3.52$; 95% CI [1.09, 11.37]. Depression, PTSD, and a history of military mTBI may comprise an especially harmful combination associated with high risk for substantial disability.

Psychiatric and Behavioral Clusters (n=255)

	Factor 1	Factor 2	Factor 3	Factor 4
mTBI	**0.431**	0.349	-0.093	-0.532
Mood Disorder	**0.837**	-0.005	0.01	0.049
PTSD	**0.692**	0.405	0.153	-0.004
Pain	-0.001	**0.863**	-0.102	-0.02
Sleep	0.29	**0.592**	0.218	0.136
Alcohol Abuse/ Dependence	0.322	-0.05	**0.659**	-0.041
Other Abuse/ Dependence	-0.147	0.085	**0.833**	0.023
Anxiety Disorder	0.142	0.173	-0.053	**0.876**

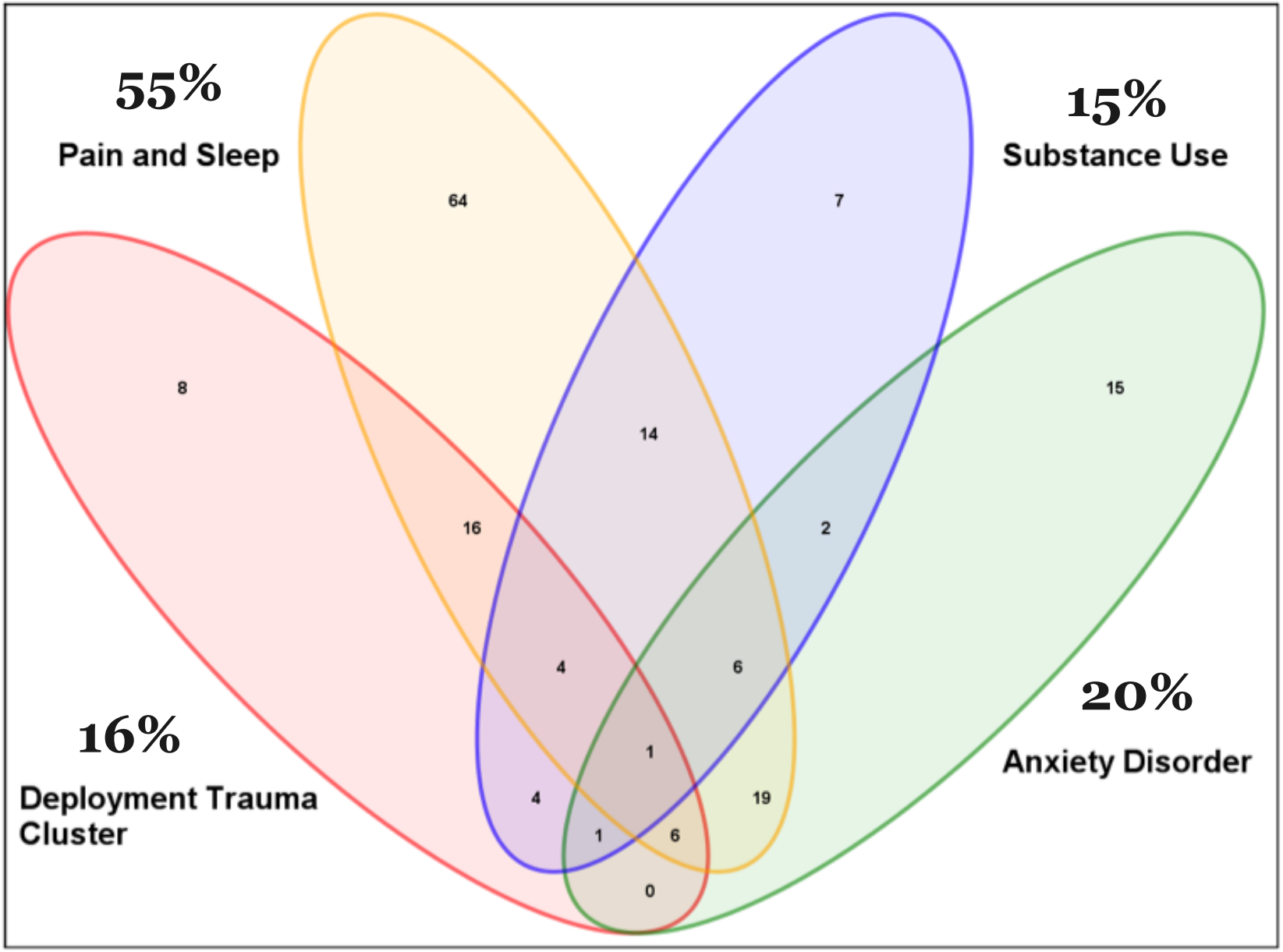
Deployment Trauma Phenotype

Pain/Sleep Factor

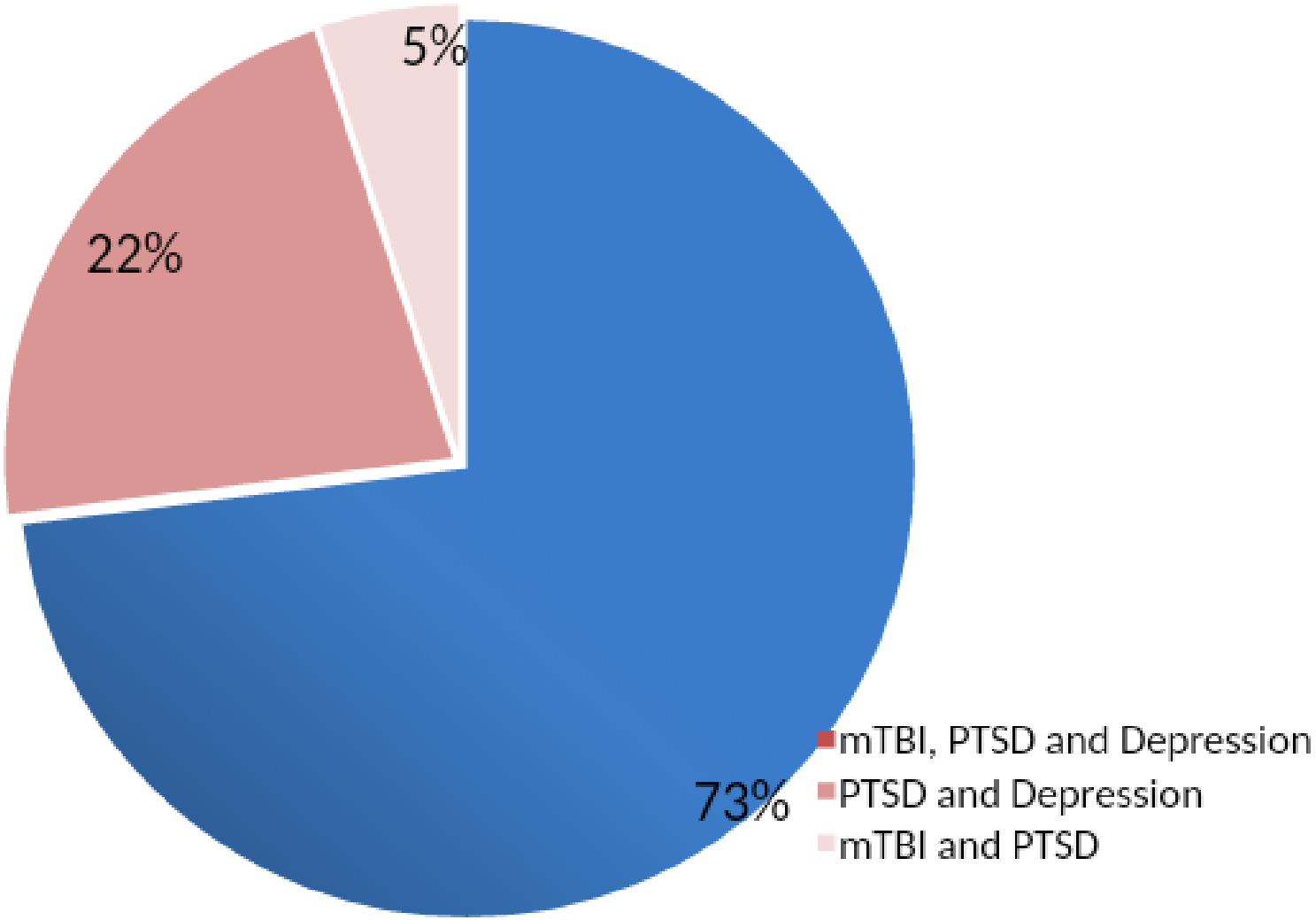
Substance Abuse Cluster

Anxiety Cluster

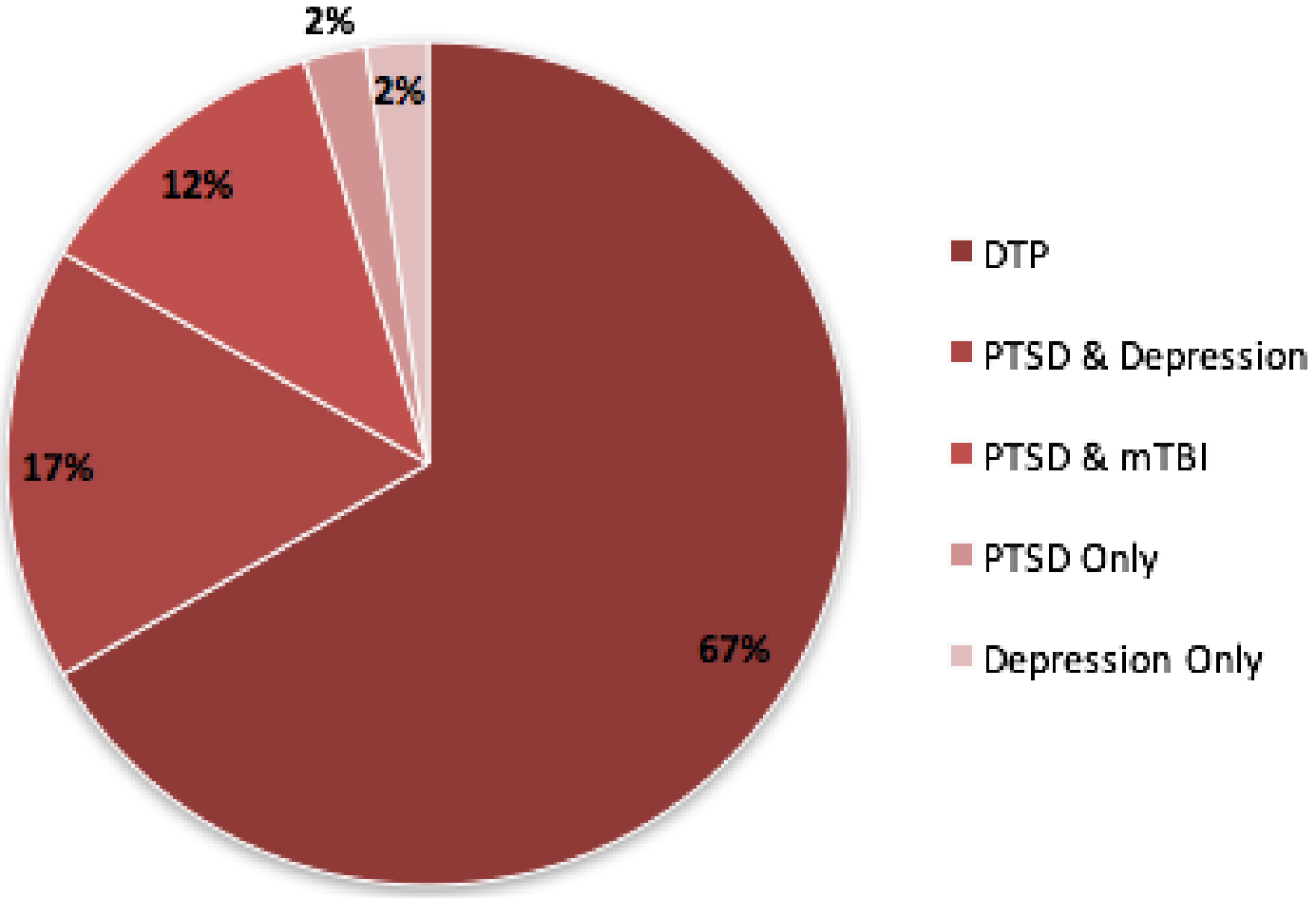
- **Psychiatric and Behavioral Clusters (n=255)**



Deployment Trauma Phenotype Associated with Substantial Disability (WHODAS overall score of ≥45 =22; 73%=16/22)



Current Total TRACTS n=435
Deployment Trauma Phenotype Associated with Substantial Disability
(WHODAS overall score of ≥45 =42; 67%=28/42)



J Head Trauma Rehabil
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The Deployment Trauma Phenotype and Employment Status in Veterans of the Wars in Iraq and Afghanistan

Melissa M. Amick, PhD; Mark Meterko, PhD; Catherine B. Fortier, PhD; Jennifer R. Fonda, PhD; William P. Milberg, PhD; Regina E. McGlinchey, PhD

Objectives: To determine the prevalence of comorbid mild traumatic brain injury (mTBI), posttraumatic stress disorder (PTSD), and depression, termed the deployment trauma phenotype (DTP), and its constituent diagnoses' impact on unemployment status in a national cohort of veterans. **Setting:** Retrospective analysis of the comprehensive TBI evaluation, a Veterans Affairs-wide protocol for assessing TBI, employment status, and psychiatric impressions. **Participants:** The final data set consisted of 48 821 veterans. **Main Outcomes and Measures:** Frequency of mTBI, PTSD, and depression in isolation and combinations and their association with unemployment status. **Results:** Age- and education-adjusted risk ratios (RRs) showed that the mTBI-only group was the least likely to be unemployed, RR = 0.65 (0.59–0.71). By contrast, the greatest likelihood of unemployment was associated with membership in the DTP group, RR = 1.45 (1.36–1.56), and the comorbid PTSD and depression group, RR = 1.39 (1.27–1.52). Furthermore, the DTP was nearly 3 times more prevalent (16.4%) in this sample compared with comorbid PTSD and depression (5.7%), indicating that the DTP conveys risk for unemployment to a significantly greater number of individuals. **Conclusions and Relevance:** The comorbid and interactive conditions of PTSD, depression, and mTBI, rather than mTBI in isolation, were linked to significant risk for unemployment in this veteran cohort. These findings suggest that multifaceted assessments and interventions to improve postdeployment reintegration are needed. **Key words:** *depression, employment, mTBI, PTSD, veterans*

Sample Selection

Steps 5-6 ruled out individuals with possible poor effort on the assessment (based on an embedded measure of impression management on the NSI-22.

1 Total Comprehensive TBI Evaluation Medical Records (CTBIE) (Q4FY09 – Q4FY13) 86,140

2 LOC, PTA and/or AMS is documented to permit classification per VA/DoD TBI criteria?

→ Missing data excluded (n=20,083; 23.3%)

Yes (n=66,057; 76.7%)

3 CTBIE clinician indicated presence or absence of TBI diagnosis ?

→ No (n=673; 1.0%)

Yes (n=65,384; 99.0%)

4 Did CTBIE clinician and VA/DoD criteria agree regarding subject's TBI status?

Yes (n=56,024; 85.7%)

→ No (n=9,630; 14.3%)

5 Among those with definitive TBI status determination, did subject also have sufficient NSI data to compute VALIDITY10 index?

Yes (n=56,015; >99%)

→ No (n=9; < 0.02%)

6 Did subject pass VALIDITY10 screening (score was below threshold indicative of likely impression management)?

Yes (n=48,821; 87.2%)

→ No (n=7,194; 12.8%)

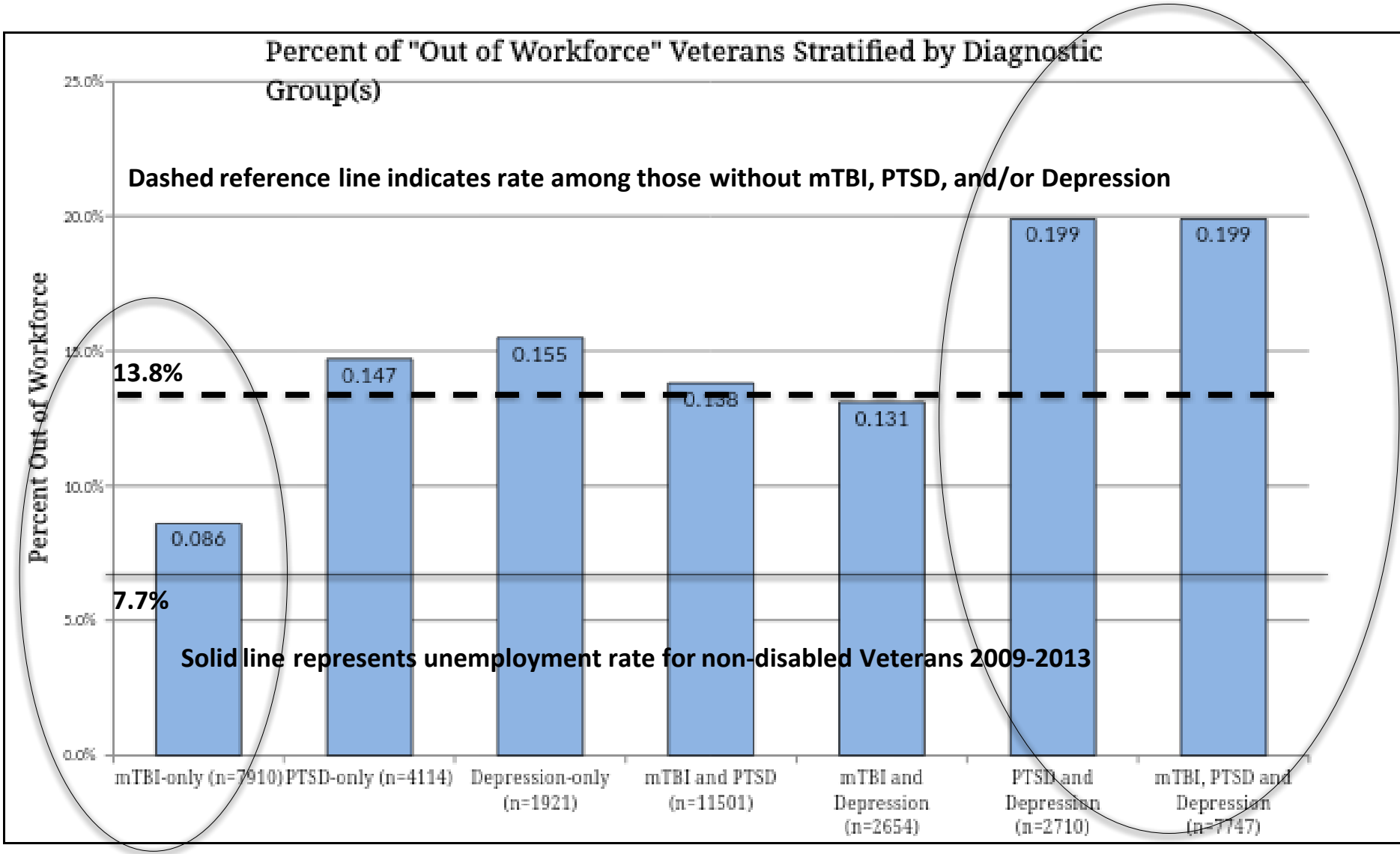
CTBIE	VA/DoD		Total
	Yes (1)	No (0)	
Yes (1)	**40,294** **61.6%**	863 1.3%	41,157 63.0%
No (0)	8,497 13.0%	**15,730** **24.1%**	24,227 37.0%
Total	48,791 74.6%	16,593 25.4%	**65,384** **100%**

Table 1: *Veteran Demographic and Clinical Characterization*

Age (years)	
Mean	33.97
Median	31.00
Std. Dev.	8.56
Gender (%)	
Male:	94.25%
Female:	5.75%
Marital Status (%)	
Married/Partnered	49.89%
Single (Never Married)	27.64%
Divorced/Separated	22.26%
Widowed	0.21%
Education Level (%)	
HS or Less	62.57%
Some Post-HS	31.87%
BA or More	5.56%
Clinical Diagnoses	
No Diagnoses	18.72%
mTBI- only	16.60%
PTSD-only	8.72%
Depression-only	4.08%
mTBI and PTSD	24.25%
mTBI and Depression	5.57%
PTSD and Depression	5.68%
mTBI, PTSD, and Depression	16.37%

Neurobehavioral Symptom Inventory-22

No mTBI, PTSD or Depression	30.21 (15.57)
mTBI-only	27.91 (13.61)
PTSD-only	33.04 (13.73)
Depression-only	33.95 (13.59)
mTBI and PTSD	36.52 (12.92)
mTBI and Depression	35.89 (12.81)
PTSD and Depression	37.94 (13.33)
mTBI, PTSD and Depression (DTP)	40.58 (12.32)


Percent of "Out of Workforce" Veterans Stratified by Diagnostic Group(s)
Dashed reference line indicates rate among those without mTBI, PTSD, and/or Depression
Solid line represents unemployment rate for non-disabled Veterans 2009-2013
13.8%
7.7%
Percent Out of Workforce
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.086
0.147
0.155
0.138
0.131
0.199
0.199
mTBI-only (n=7910)
PTSD-only (n=4114)
Depression-only (n=1921)
mTBI and PTSD (n=11501)
mTBI and Depression (n=2654)
PTSD and Depression (n=2710)
mTBI, PTSD and Depression (n=7747)

Conclusions:

- In an epidemiological sample screened for impression management, DTP prevalence was almost identical to our laboratory-based findings (16.4% vs 16.9%).

- Mild TBI in isolation was associated with the lowest risk of unemployment and the fewest neurobehavioral symptoms.

- Comorbid PTSD and Depression with mTBI (DTP) were linked with the highest risk for unemployment across all age strata except those over 50 and the most neurobehavioral symptoms.

Poll question:

True/False:
Symptoms at the time of acute concussion are directly linked to the long-term consequences of that injury.

Neurobehavioral Symptom Inventory (NSI)

- Feeling Dizzy
- Loss of balance
- Poor coordination, clumsy
- Headaches
- Nausea e.g. vomiting
- Vision problems, blurring trouble seeing
- Sensitivity to light
- Hearing difficulty
- Sensitivity to noise
- Numbness/tingling on parts of body
- Change in taste and/or smell
- Loss of appetite or increased appetite
- Poor concentration, can't pay attention, easily distracted
- Forgetfulness, can't remember things
- Difficulty making decisions
- Slowed thinking, difficulty getting organized, can't finish things
- Fatigue, loss of energy, getting tired easily, drowsiness
- Difficulty falling or staying asleep
- Feeling anxious or tense
- Feeling depressed or sad
- Irritability, easily annoyed
- Poor frustration tolerance, feeling easily overwhelmed by things

Analyses

- Cross-sectional and longitudinal analyses:
  - Hierarchical and multivariate regression
  - K-fold cross-validation analyses of hierarchical regressions
- Structural equation model of the direct and indirect effect of mTBI on NSI

Cross-Sectional and Longitudinal Sample Sizes

Current TRACTS Data Repository: N=500

Met TRACTS Inclusion Criteria: N=476

Deployed to OIF/OEF: N=452

Passed MSVT Symptom Validity Measure: N=400

No History of Moderate/Severe TBI N=388

Passed Validity-10 PCS Exaggeration Measure: N=379

Completed All Assessments and Questionnaires: N=351

Final Cross-Sectional Sample

Eligible for Follow-Up Visit: N=322

Returned for Follow-up Visit: N=222 (69% retention)

Data Available in Repository: N=176

Passed Symptom Validity Measures: N=169

No TBI between Baseline and Follow-Up: N=167

Completed All Assessments and Questionnaires: N=160

Final Longitudinal Sample

Demographic and Clinical Characteristics

Age (years), mean (SD)	32.1 (8.5)	32.7 (8.5)
Males	320 (91.2%)	164 (88.2%)
Race		
Black, No. (%)	27 (7.7%)	13 (7.0%)
Hispanic, No. (%)	54 (15.4 %)	32 (17.2%)
White, No. (%)	264 (75.2 %)	138 (74.2%)
Education, mean (SD), years	14.0 (2.0)	14.1 (2.0)
Military related mTBI	151 (43.0%)	71 (38.2%)
Time (years) between military mTBI &visit, mean (SD)	5.7 (4.4)	5.4 (3.9)
PTSD, No. (%)	206 (58.7%)	110 (59.1%)
Mood Disorder, No. (%)	84 (23.9%)	40 (21.5%)
Anxiety Disorder, No. (%)	72 (20.5%)	34 (18.3%)
Sleep Impairment, No. (%)	272 (77.5%)	135 (72.6%)
Pain, No. (%)	239 (68.1%)	127 (68.2%)
Substance Abuse, No. (%)	54 (15.4%)	31 (16.7%)

Hierarchical Regression: Cross-sectional and Longitudinal Analysis

I. Cross-sectional Model (n=351)			
Demographics	0.0225	0.0309	0.0123
Psychological/Behavioral	0.5337	0.5457 / **0.5148**	<.0001
Military mTBI	0.5479	0.5608 / **0.0151**	0.0007
II. Longitudinal Model (n=186)			
Demographics	0.0146	0.0305	0.1293
Psychological/Behavioral	0.2785	0.3136 / **0.2831**	<.0001
Military mTBI	0.2755	0.3147 / **0.0011**	0.6040

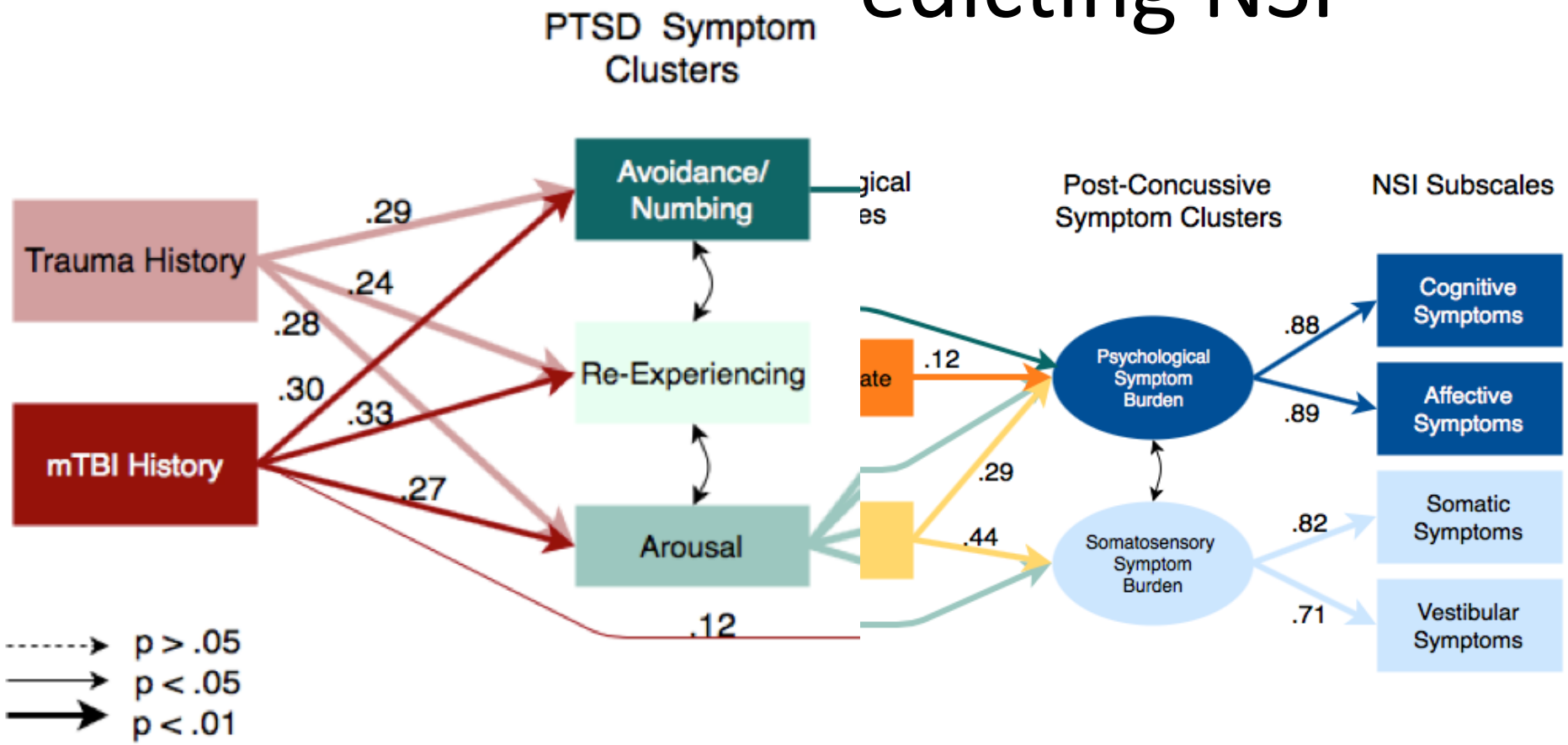
- **Psychological and behavioral conditions** contribute between **28-51%** of the variability of NSI beyond what is attributable to demographic predictors.
- **mTBI** explains **1% or less** of the additional variance of NSI beyond what is attributable to demographics and psychological/behavioral predictors.

K-Fold Cross-Validation of Hierarchical Regression Analysis

I. Cross-sectional Model (n=351)				
Psychological/Behavioral	0.5457 / 0.5148	0.5286 / 0.4171	0.0322	0.0082
Military mTBI	0.5608 / 0.0151	0.5254 / 0.0099	0.0354	0.0052
II. Longitudinal Model (n=186)				
Psychological/Behavioral	0.3136 / 0.2831	0.2030 / 0.1898	0.1175	0.0548
Military mTBI	0.3147 / 0.0011	0.2110 / 0.0137	0.1037	0.0148

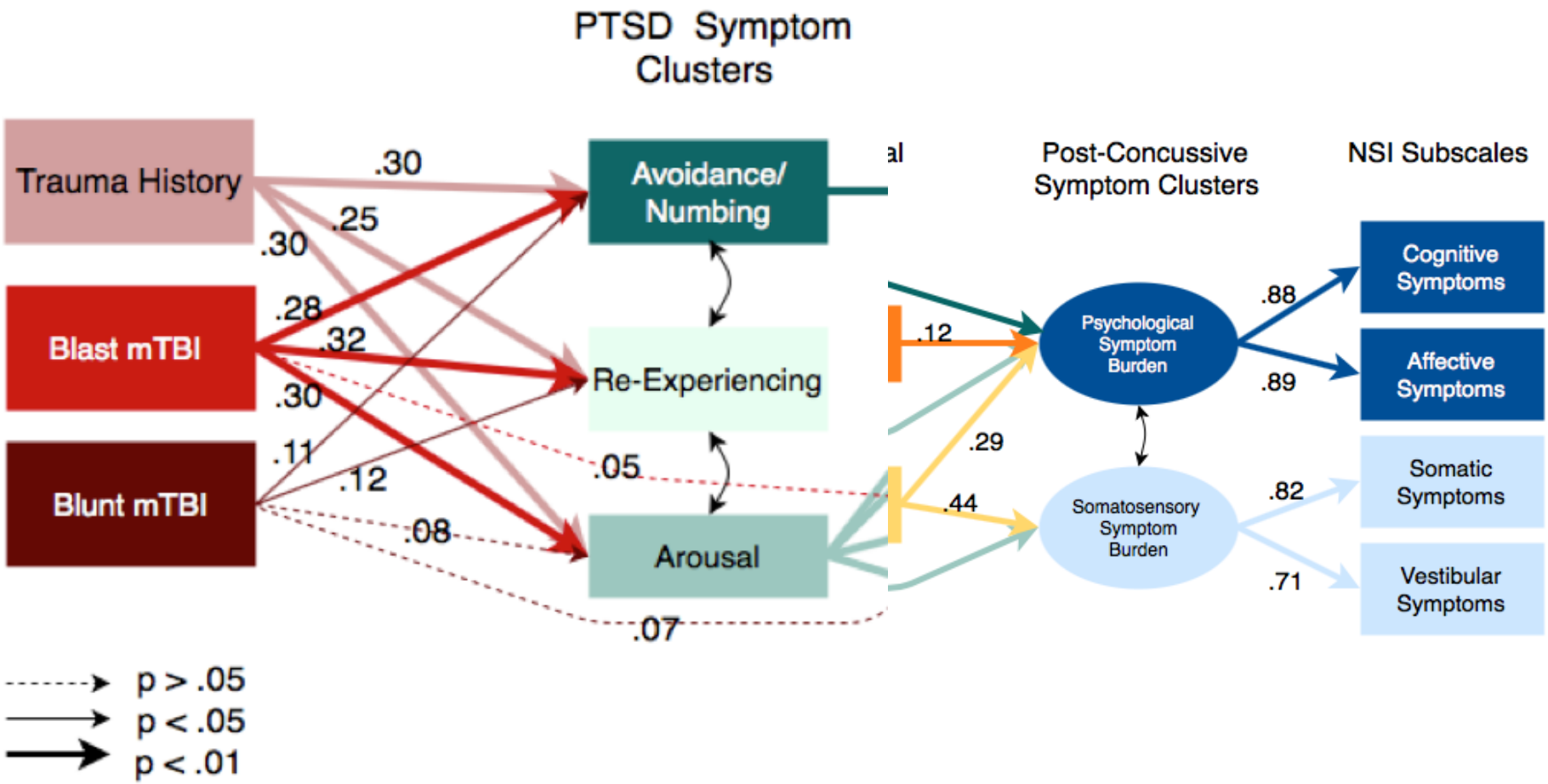
- Cross-Validation analyses support the generalability of these findings

edicting NSI



- **mTBI** does **not** have a **significant direct effect** on NSI scores
- The relationship between **mTBI and NSI** scores is indirect and **mediated by PTSD symptom clusters**

Path Analysis Predicting NSI: Blast vs. Bunt mTBI



The causal path to PTSD symptoms derives from mTBI related to blast exposure not blunt injury

Conclusions

- A history of concussion is a negligible predictor of long-term NBS reporting compared to the substantial predictive ability of psychological and behavioral-related conditions in this veteran sample
  - Long-term NBS reporting more likely a reflection of these co-morbidities rather than of concussion itself
- Co-occurring conditions such as PTSD and chronic pain, *and not the head injury itself,* lead to high NBS endorsement on the NSI
  - However, mTBI may play a role in the development or exacerbation of conditions such as PTSD and chronic pain and, thus, indirectly increase NBS

PTSD Symptom Trajectory Analysis

- Measure: Clinician Administered PTSD Scale (CAPS) at Baseline and Follow-Up (1-2 years apart)
- Change groups determined by **Reliable Change Index**
  - Determines cutoff for change that is unlikely to be due to simple measurement unreliability (Jacobson & Traux 1991)
  - Changes could be due to stressors, interventions or natural disease progression

# PTSD Diagnosis Over Time
N=249

Follow Up PTSD Diagnosis		Yes	No	Total
	Yes	118 (47 %)	16 (6%)	134 (54%)
	No	38 (15%)	77 (31%)	115 (46%)
	Total	156 (63%)	93 (37%)	249

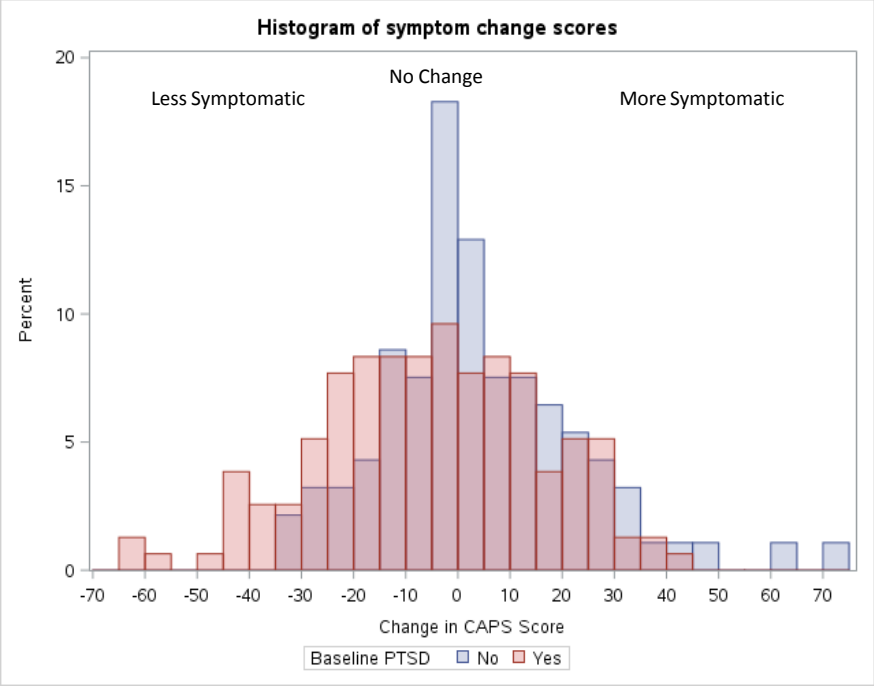
-78% of participants had concurrence between baseline and follow up diagnoses

-Of the 16 participants who were newly diagnosed with PTSD at follow up, 4 (25%) had been redeployed or reported a traumatic life event between baseline and follow-up

-Of the 38, 13 (33%) retained a “partial PTSD” diagnosis at Time 2.

Positive PTSD Diagnosis at Baseline (N=156)

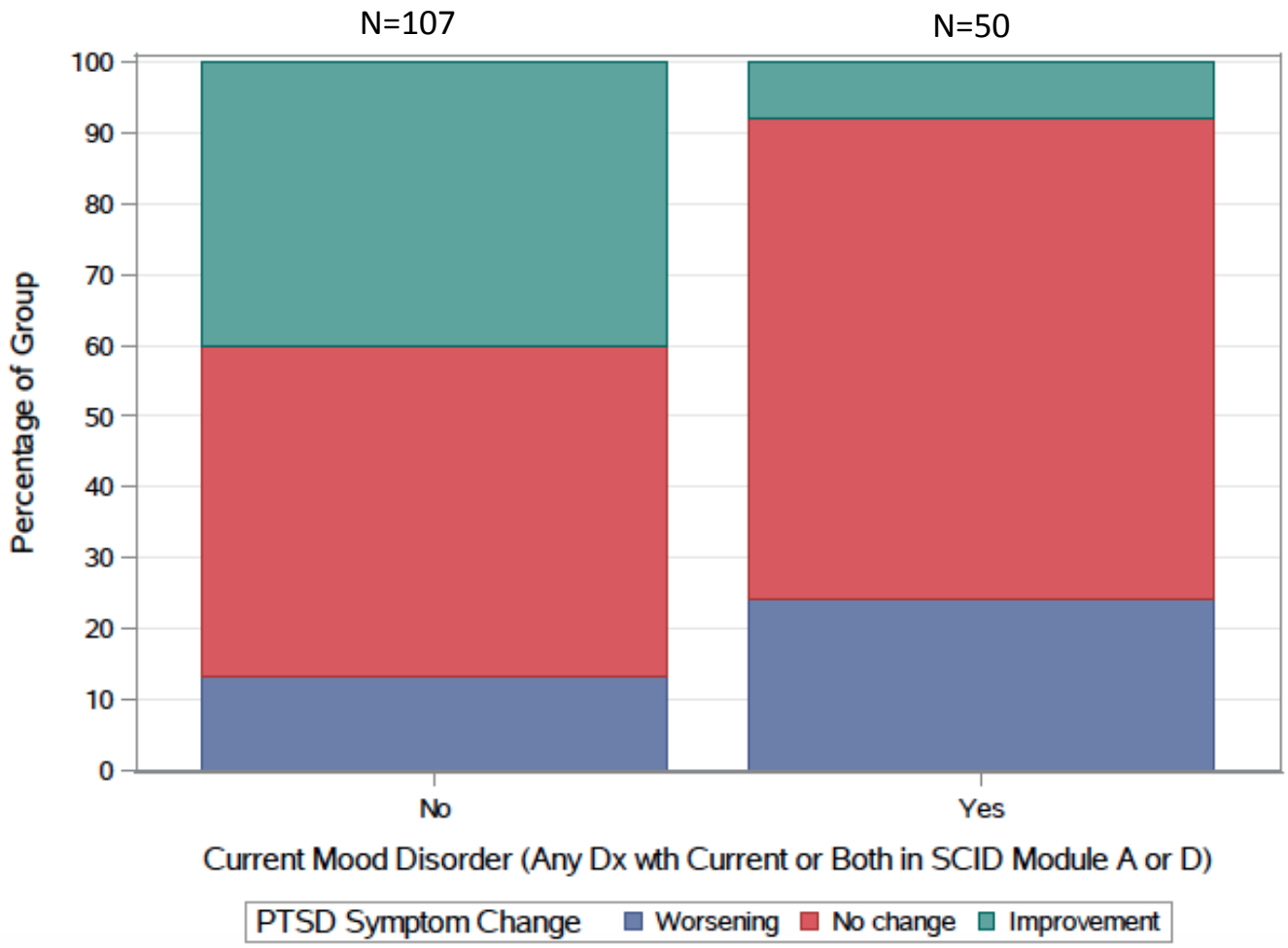
N (%)	47 (30%)	84 (54%)	25 (16%)
Baseline CAPS Score Mean (SD)	69 (17)	69 (19)	58 (12)
Follow Up CAPS Score Mean (SD)	38 (18)	67 (21)	84 (14)



No Positive PTSD Diagnosis at Baseline (N=93)

N (%)	10 (11%)	62 (67%)	21 (22%)
Baseline CAPS Score Mean (SD)	35 (12)	20 (15)	19 (11)
Follow Up CAPS Score Mean (SD)	9 (7)	19 (15)	49 (18)

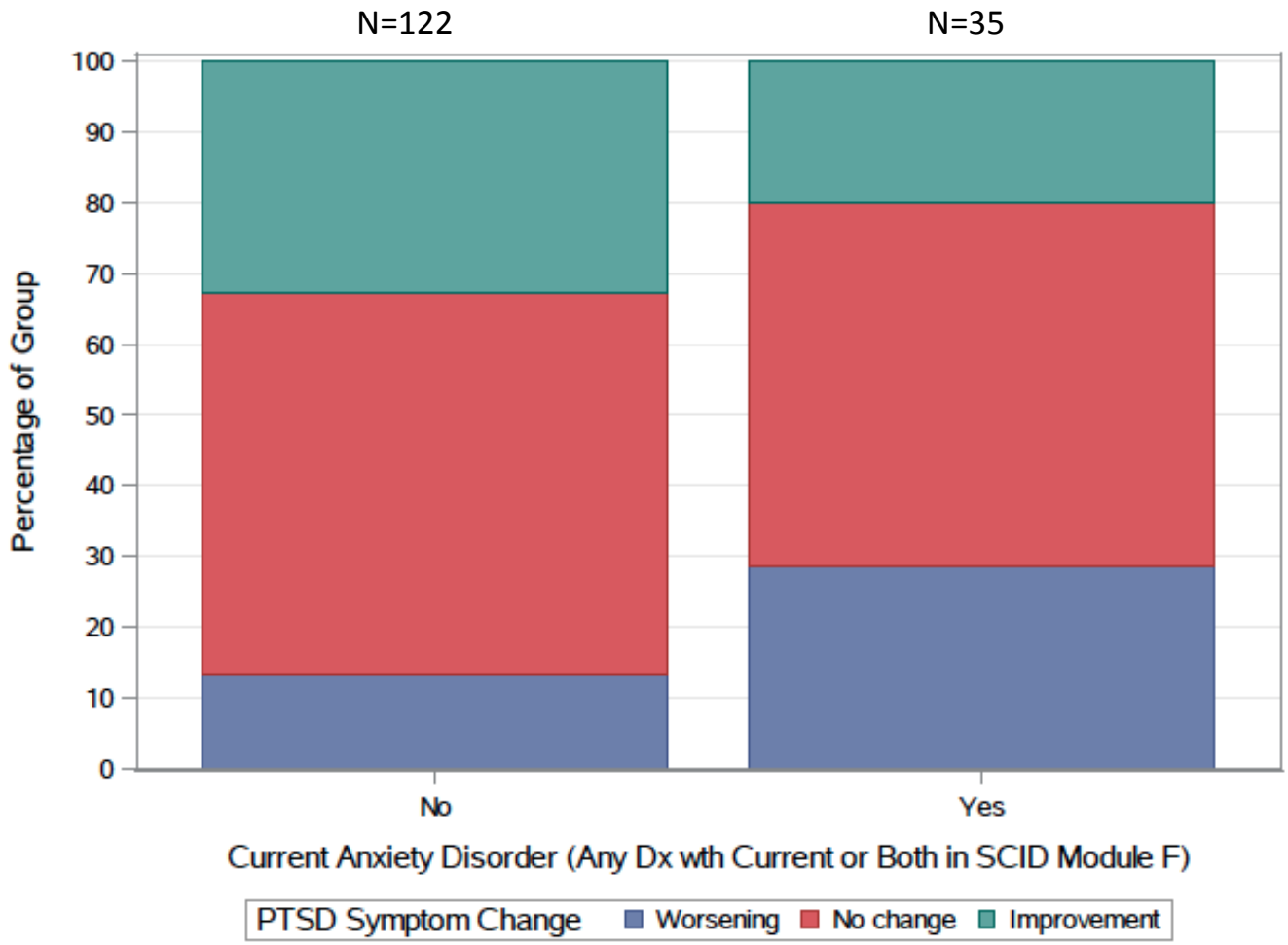
Comorbidities: Mood Disorders



Participants with **PTSD** who had or developed a **comorbid mood disorder** had**:**

- **0.2 times** the chance of PTSD symptoms **improving** between baseline and follow up
- **1.8 times** the risk of PTSD symptoms **worsening** between baseline and follow up

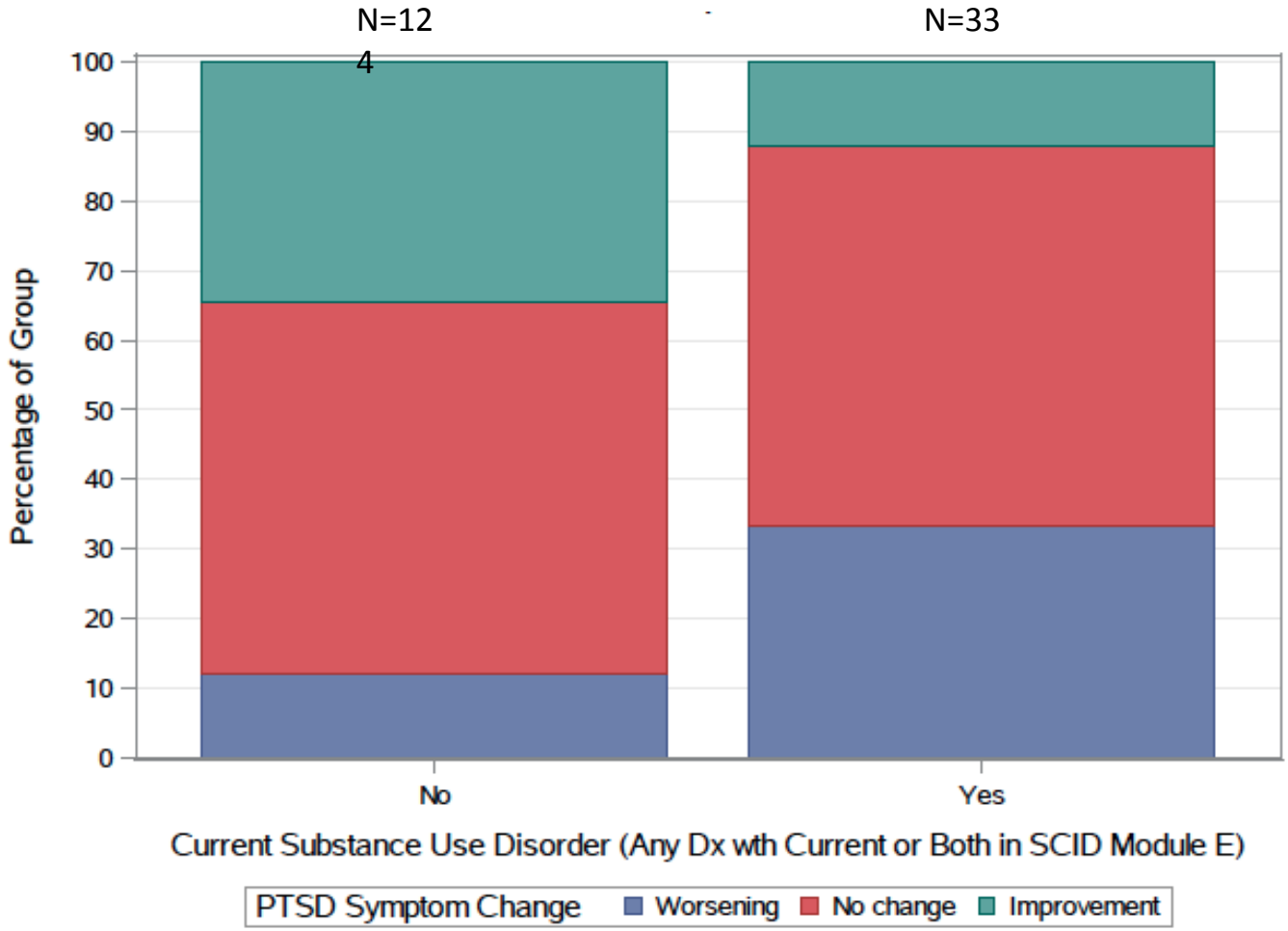
Comorbidities: Anxiety Disorders



Participants with **PTSD** who had or developed a **comorbid anxiety disorder** had**:**

- **0.6 times** the chance of PTSD symptoms **improving** between baseline and follow up
- **2.2 times** the risk of PTSD symptoms **worsening** between baseline and follow up

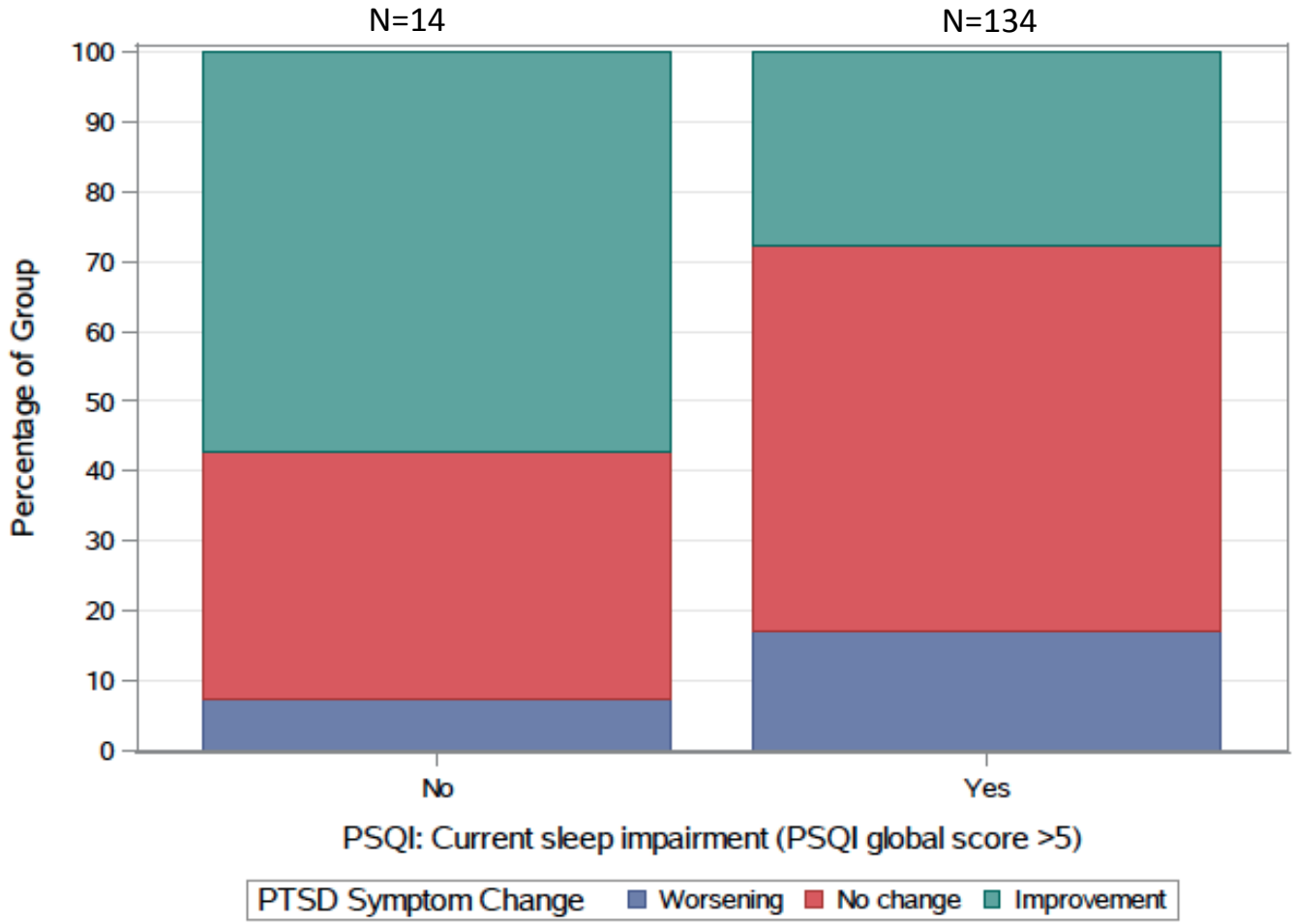
Comorbidities: Substance Use Disorders



Participants with **PTSD** who had or developed a **comorbid substance use disorder** had**:**

- **0.3 times** the chance of PTSD symptoms **improving** between baseline and follow up
- **2.8 times** the risk of PTSD symptoms **worsening** between baseline and follow up

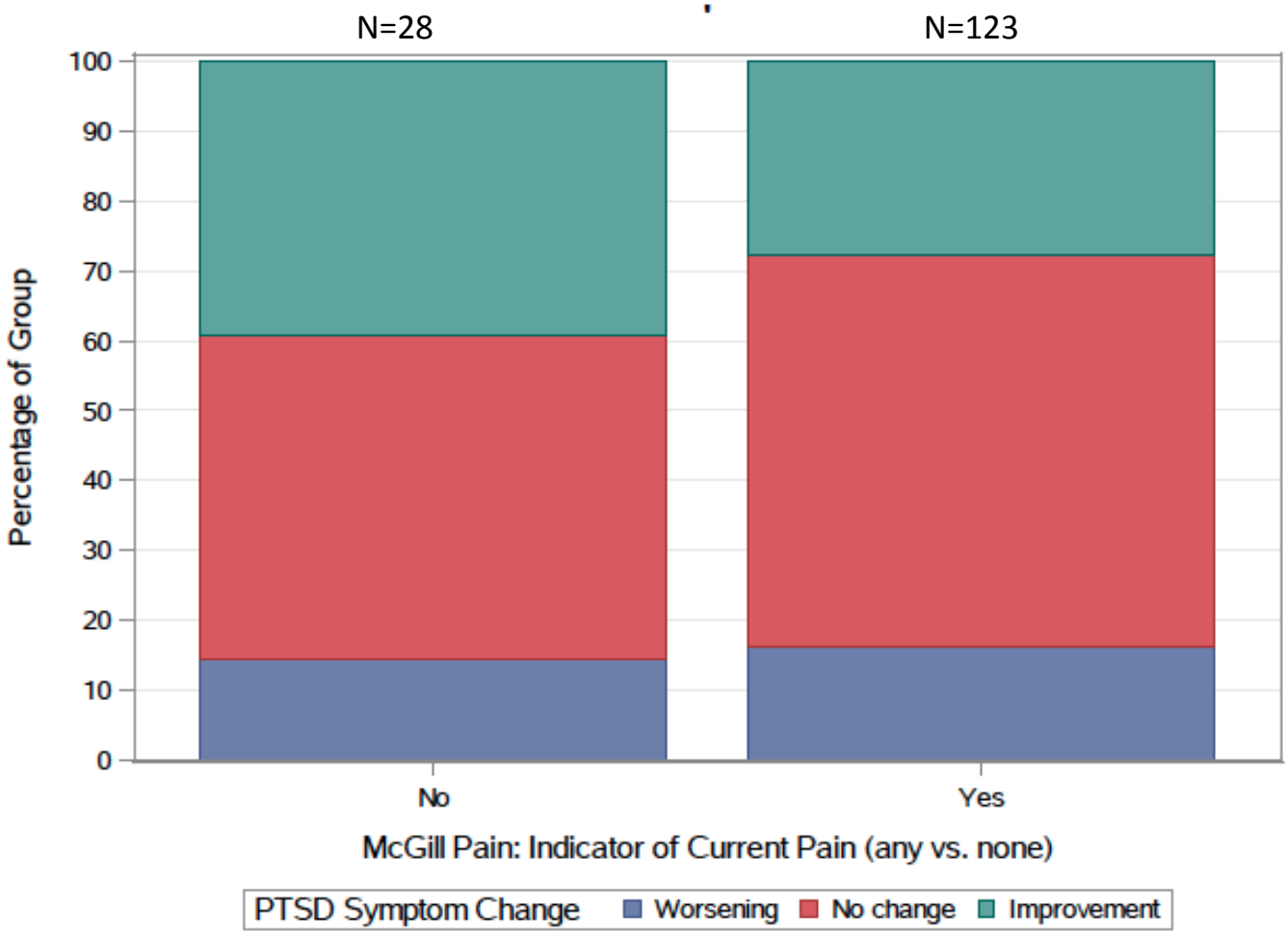
Comorbidities: Sleep Impairment



Participants with **PTSD** who had or developed a **comorbid sleep impairment** had**:**

- **0.5 times** the chance of PTSD symptoms **improving** between baseline and follow up
- **2.4 times** the risk of PTSD symptoms **worsening** between baseline and follow up

Comorbidities: Pain

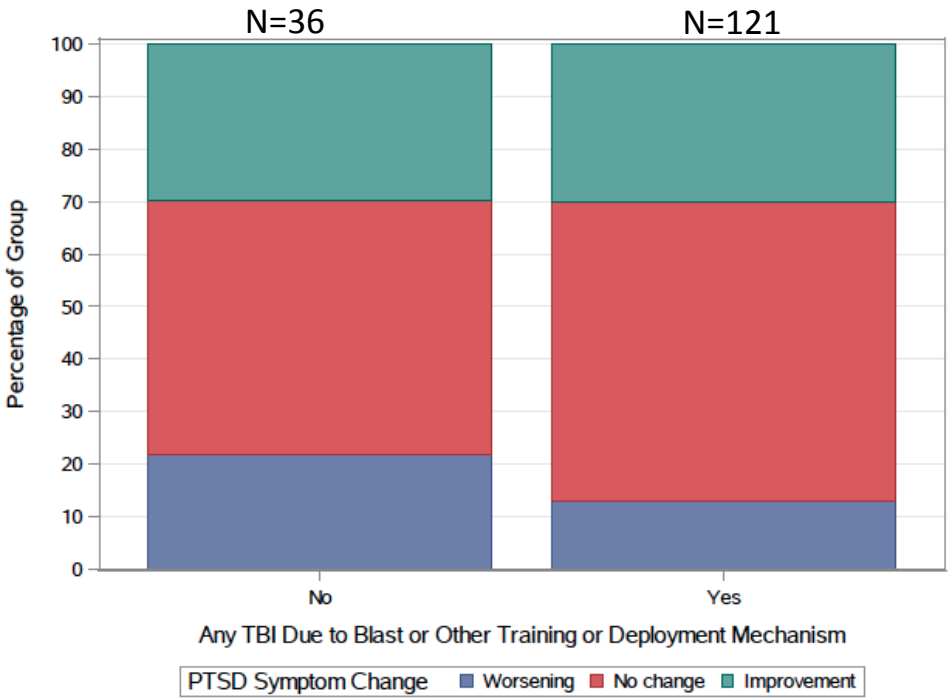


Participants with **PTSD** who had or developed a **comorbid pain** had**:**

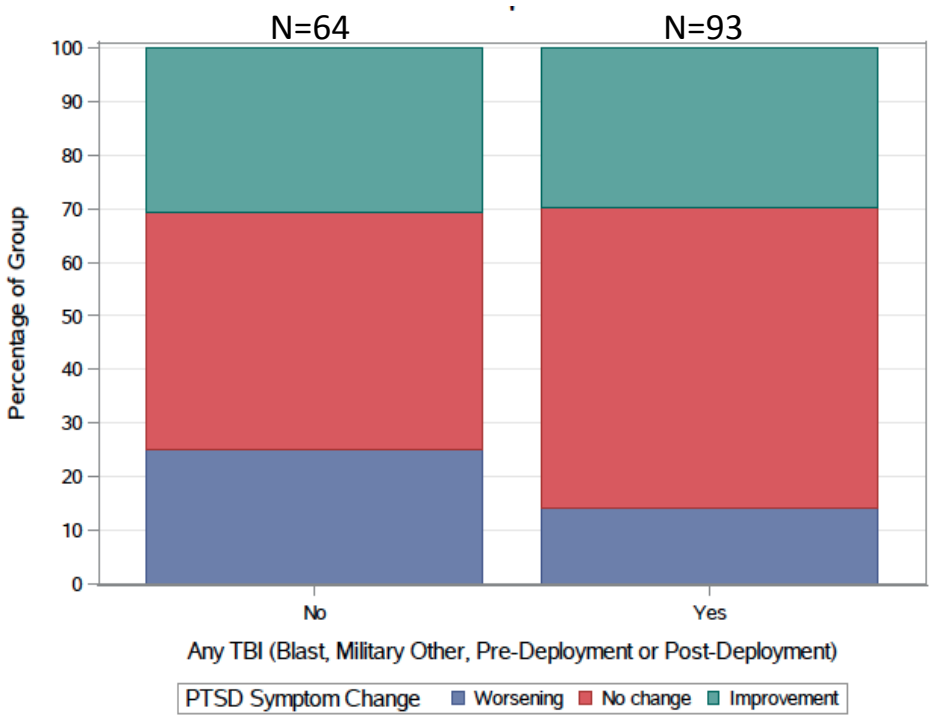
- **0.7 times** the chance of PTSD symptoms **improving** between baseline and follow up
- **1.1 times** the risk of PTSD symptoms **worsening** between baseline and follow up

Comorbidities: mTBI

Lifetime mTBI

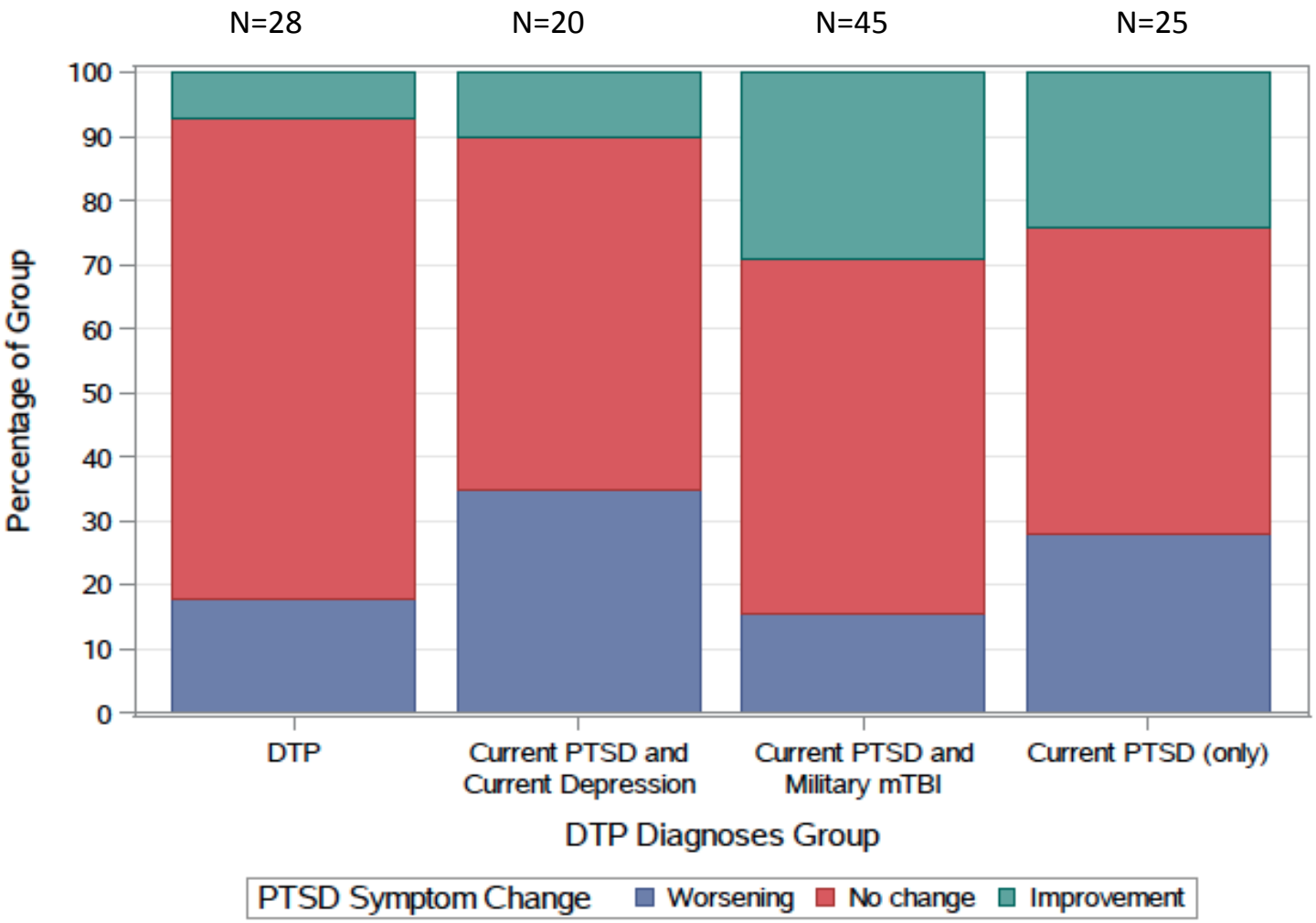


Military-related mTBI



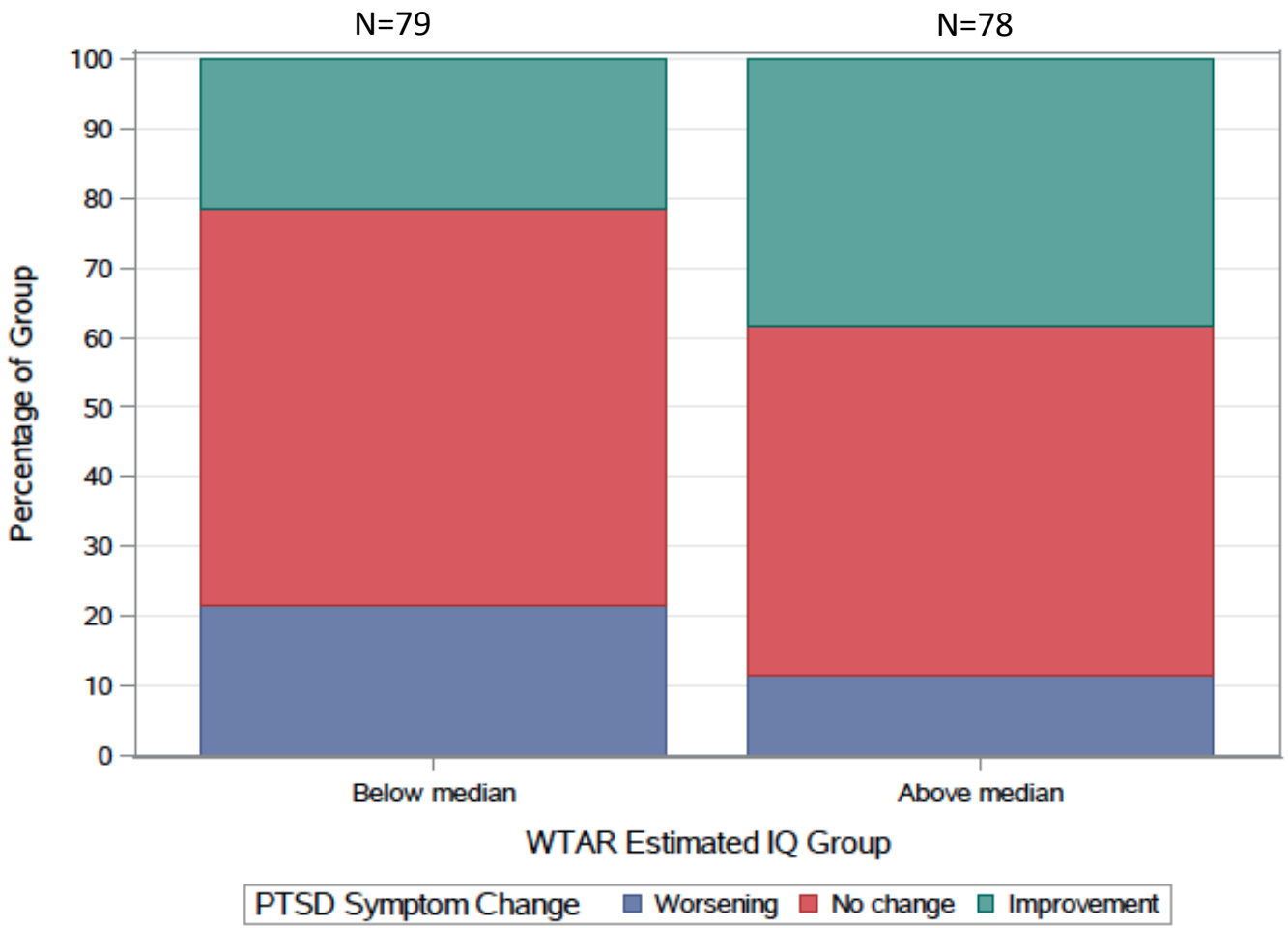
Comorbid mild TBI did not reduce chance of symptoms improving or increase chance of symptoms worsening in participants with PTSD.

Deployment Trauma Phenotype (PTSD Diagnosis at baseline and Time 2 n=118)



- Participants with the **Deployment Trauma Phenotype** had the **lowest probability** of symptom improvement compared to other combinations of comorbidities.
- DTP less “worsening” rate reflects overall higher PTSD symptoms (ceiling effect).

Demographic Factors: WTAR Estimated IQ

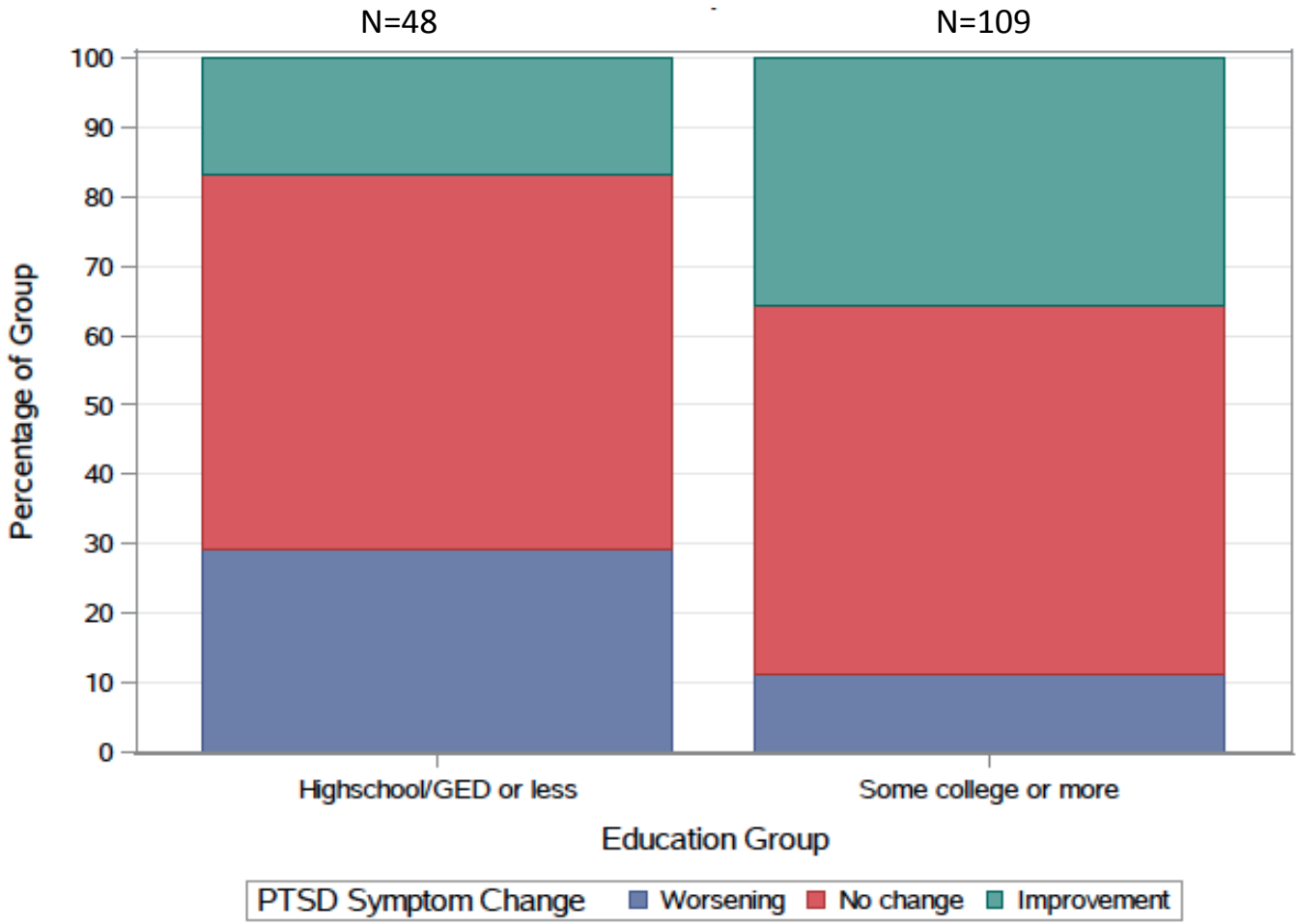


Participants with **PTSD** who had a **below median** (103) estimated IQ had**:**

- **0.6 times** the chance of PTSD symptoms **improving** between baseline and follow up
- **1.9 times** the risk of PTSD symptoms **worsening** between baseline and follow up

Compared with participants with PTSD and above median estimated IQ.

Demographic Factors: Education

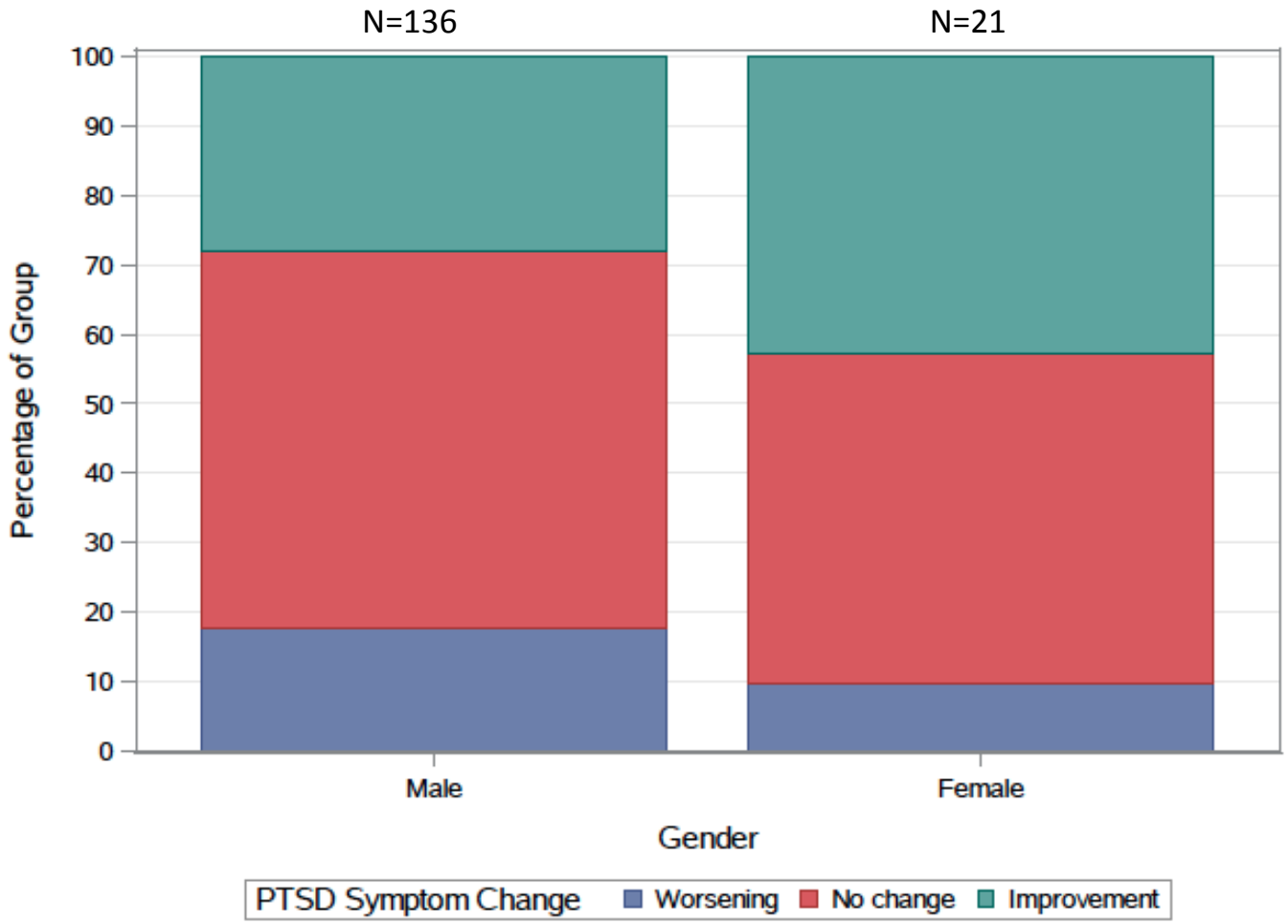


Participants with **PTSD** who **a high school or below education** or less had**:**

- **0.5 times** the chance of PTSD symptoms **improving** between baseline and follow up
- **2.6 times** the risk of PTSD symptoms **worsening** between baseline and follow up

Compared with participants with PTSD and some college or more.

Demographic Factors: Gender

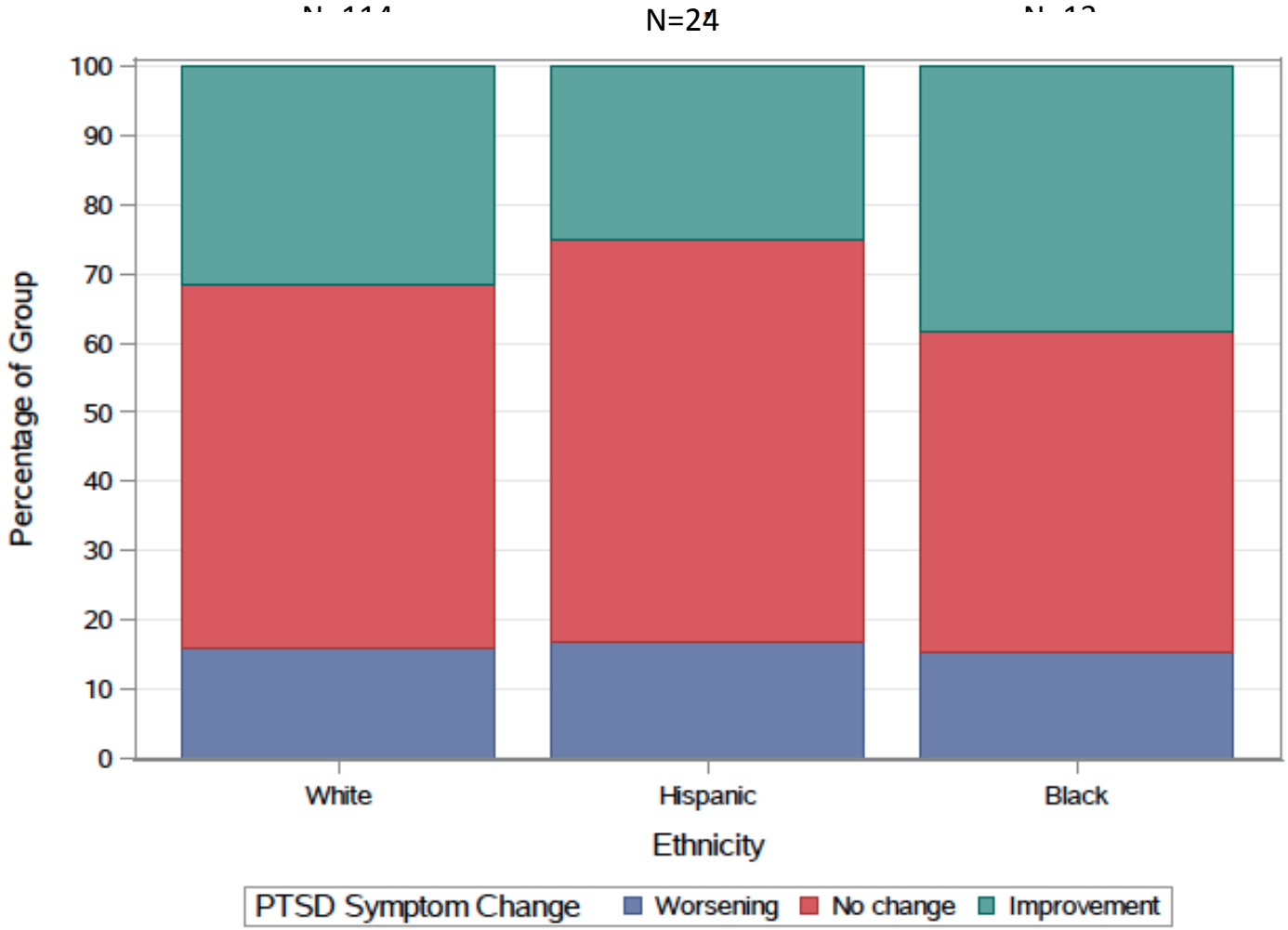


Male participants with **PTSD** had**:**

- **0.7 times** the chance of PTSD symptoms **improving** between baseline and follow up
- **1.8 times** the risk of PTSD symptoms **worsening** between baseline and follow up

Compared with female participants

Demographic Factors: Ethnicity



Rates of symptom improvement and worsening were similar between White, Black and Hispanic participants

Conclusions

- The effect of most comorbidities on PTSD is to worsen PTSD severity over time and limit the level of improvement.
- There is some evidence that factors such as education and estimated IQ can have a moderating effect.

Overall Conclusions

- Mild TBI alone should not be expected to have a negative outcome. Attributing “PCS” to mTBI in this group is as likely to lead to negative or iatrogenic effects than it is to appropriate treatment.
- When mTBI is occurs under psychologically traumatic circumstances, or is accompanied by other trauma related psychological diagnoses (e.g., PTSD, depression, pain, sleep), it is more likely to have significant clinical implications.
- The Deployment Trauma Phenotype may be a

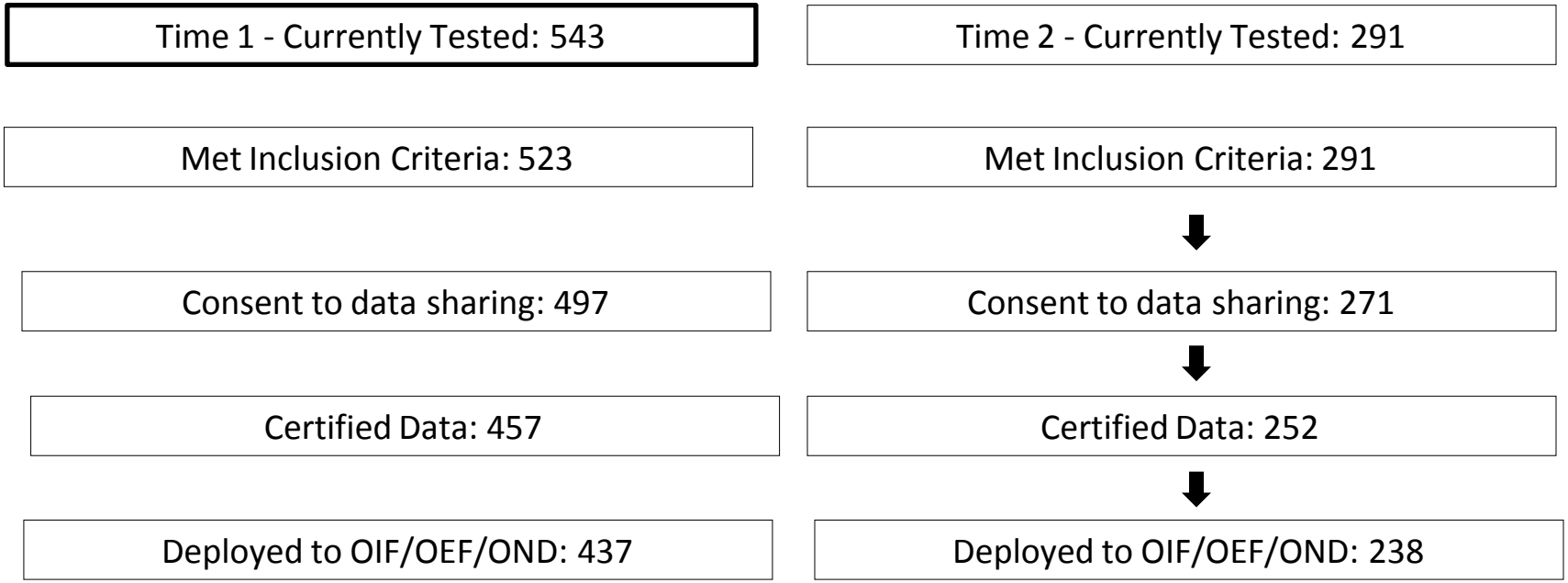
VA BOSTON HEALTHCARE SYSTEM

https://www.researchgate.net/project/Translational-Research-Center-for-Traumatic-Brain-Injury-and-Stress-Disorders-TRACTS

https://heartbrain.hms.harvard.edu/

TRACTS DATA REPOSITORY

Tracts Data Repository

- Data warehouse established in 2012
- Goal is to share data with VA and non-VA investigators who share scientific interests of TRACTS
  - Available to all investigators who obtain specific permissions to use the data
  - Includes data for the subset of participants who consented to share their data

Data Repository Flow Diagram