

# Correlations Between the Neurobehavioral Symptom Inventory and Common Standard of Care Measures for Persistent Post-Concussive Symptoms

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**Background:** Many clinicians treating mild traumatic brain injury (mTBI) patients who report persistent post-concussive symptoms administer self-report questionnaires to capture concerns and symptoms.

While this may work well in clinics that address a few specific problems such as headache or sleep, time spent on administering questionnaires can become burdensome in multidisciplinary clinics due to the broad range of symptoms they must address.

This project examined the relationship between the Neurobehavioral Symptom Inventory (NSI)<sup>1</sup> and other commonly used symptom questionnaires for the mTBI population to see how well the NSI captures symptom-specific information, with the goal of using these findings to guide clinical decisions regarding questionnaire selection.

**Methods:** Questionnaires were obtained from the TBI Portal, which aggregates data from Fort Bragg, Fort Campbell, Fort Belvoir, Brooke Army Medical Center, and the National Intrepid Center of Excellence at Walter Reed Naval Military Medical Center between March 2009 and August 2019.

The overall dataset was limited to patients who had completed an NSI within a TBI clinic, which yielded a final sample of 16,336 NSIs. The NSI can be scored by a total score or four factor scores, derived by factor analyses from two military samples: Affective, Cognitive, Somatosensory, and Vestibular subscales.<sup>2,3</sup>

For comparison analysis, the NSI total score, a factor score, and/or an item score were correlated to a corresponding survey and/or item score using the Pearson's correlation coefficient.<sup>4</sup>

**Results:** An independent analysis assessed survey completion time to evaluate the "cost" of administering questionnaires. Survey duration was calculated from Wounded Ill and Injured Registry data via the TBI Portal. Patients spent an average of **1.5 minutes** on an individual questionnaire (n=3,110). Median completion time per session was **22 minutes**. 50% of patients spent between **11-min-45-sec and 39-min-30-sec on a session**, not including time for preparation, transition between surveys, or loading time.

**Table 1.** Pearson correlations of NSI scores to other questionnaires.

	PCL-5	PCL-M	PHQ-9	GAD-7	HIT-6	ISI	PSQI	ESS	ABC	DHI	AUDIT	WHOQOL-BREF Physical	WHOQOL-BREF Psychological	WHOQOL-BREF Social Relationships	WHOQOL-BREF Environment
n	3,709	9,150	5,957	6,369	8,277	2,126	5,581	5,751	1,577	4,283	656	2,649	2,644	2,652	2,637
NSI Total Score	0.81‡	0.82‡	0.83‡	0.78‡	0.70‡	0.56‡	0.61‡	0.37‡	-0.47‡	0.68‡	0.14‡	-0.46‡	-0.49‡	-0.45‡	-0.46‡
NSI Affective	0.81‡	0.81‡	0.82‡	0.79‡	0.60‡	0.61‡	0.66‡	0.37‡	-0.29‡	0.49‡	0.17‡	-0.53‡	-0.48‡	-0.48‡	-0.46‡
NSI Cognitive	0.66‡	0.71‡	0.72‡	0.67‡	0.55‡	0.44‡	0.50‡	0.34‡	-0.30‡	0.49‡	0.11‡	-0.43‡	-0.49‡	-0.40‡	-0.39‡
NSI Somatosensory	0.66‡	0.67‡	0.64‡	0.60‡	0.71‡	0.43‡	0.50‡	0.30‡	-0.47‡	0.66‡	0.07	-0.29‡	-0.32‡	-0.30‡	-0.34‡
NSI Vestibular	0.52‡	0.56‡	0.58‡	0.53‡	0.55‡	0.37‡	0.42‡	0.30‡	-0.58‡	0.72‡	0.03	-0.29‡	-0.32‡	-0.26‡	-0.30‡

‡ indicates a P-Value <0.01, † indicates a P-Value <0.001

**Table 2.** Pearson Correlations of Individual NSI Items to its corresponding questionnaire.

	PHQ-9	GAD-7	ESS	ISI	PSQI	HIT-6	AUDIT	ABC	DHI
n	5,957	6,369	5,751	2,126	5,581	8,277	656	1,577	4,283
NSI: Depressed	0.77‡						0.18‡		
NSI: Anxiety		0.81‡							
NSI: Fatigue			0.40‡						
NSI: Sleep Difficulty				0.64‡	0.71‡				
NSI: Headaches						0.80‡			
NSI: Balance								0.54‡	
NSI: Dizziness									0.66‡

\* indicates a P-Value <0.05, † indicates a P-Value <0.01, ‡ indicates a P-Value <0.001

**References:**

- Cicerone KD, Kalmar K. Persistent postconcussion syndrome: The structure of subjective complaints after mild traumatic brain injury. *Journal of Head Trauma Rehabilitation*. 1995;10(3):1-17.
- Meterko M, Baker E, Stolzmann KL, Hendricks AM, Cicerone KD, Lew HL. Psychometric assessment of the Neurobehavioral Symptom Inventory-22: The structure of persistent postconcussive symptoms following deployment-related mild traumatic brain injury among veterans. *Journal of Head Trauma Rehabilitation*. 2012;27(1):55-62.
- Vanderploeg RD, Silva MA, Soble JR, et al. The structure of postconcussion symptoms on the Neurobehavioral Symptom Inventory: A comparison of alternative models. *Journal of Head Trauma Rehabilitation*. 2015;30(1):1-11.
- Cohen J. A power primer. *Psychological bulletin*. 1992;112(1):155.
- Directive Type Memorandum 09-033: Policy Guidance for Management of Concussion/Mild Traumatic Brain Injury in the Deployed Setting. In:2010.
- DoD Instruction 6490.11: DoD Policy Guidance for Management of Mild Traumatic Brain Injury/Concussion in the Deployed Setting. In:2012.
- Warning Order 1 to Operation Order 19-51: Required Clinical Tools for Medical Personnel in the Assessment and Management of Traumatic Brain Injury. In:2019.

**Methods (continued):** The following were correlated with the NSI if they were collected on the same day as the NSI:

- Post-Traumatic Stress Disorder Checklist for DSM-5 (PCL-5)
- Post-Traumatic Stress Disorder Checklist Military Version (PCL-M)
- Patient Health Questionnaire (PHQ-9)
- Generalized Anxiety Disorder seven question survey (GAD-7)
- Headache Impact Test (HIT-6)
- Insomnia Severity Index (ISI)
- Pittsburgh Sleep Quality Index (PSQI)
- Epworth Sleepiness Scale (ESS)
- Activities-Specific Balance Confidence Scale (ABC)
- Dizziness Handicap Inventory (DHI)
- Alcohol Use Disorders Identification Test (AUDIT)
- World Health Organization Quality of Life Instrument-Abbreviated Version (WHOQOL-BREF)

**Discussion:** This project aimed to assist clinicians in decision making about the selection of a questionnaire battery by establishing the correlations between the NSI, a measure required by the Department of Defense for evaluation after traumatic brain injury (TBI)<sup>5-7</sup>, and other questionnaires commonly used in TBI.

Due to differences in patient populations and provider resources across military treatment facilities, there is no common battery that is "right" for every clinic. Clinicians can use this information to balance the time cost of administering questionnaires against additional variance within a symptom domain that may not be sufficiently captured by the NSI.

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