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# The Boston Assessment of Traumatic Brain Injury-Lifetime Semistructured Interview for Assessment of TBI and Subconcussive Injury Among Female Survivors of Intimate Partner Violence: Evidence of Research Utility and Validity

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**Objective:** To adapt the Boston Assessment of TBI-Lifetime (BAT-L) interview specifically for female survivors of intimate partner violence (IPV), validate the adapted BAT-L/IPV, and report the prevalence of head injury. **Setting:** The BAT-L is the first validated instrument to diagnose traumatic brain injuries (TBIs) throughout the life span for post-9/11 veterans. The BAT-L/IPV was adapted to target diagnostic issues belonging exclusively to IPV while maintaining its life span approach. **Participants:** Community-dwelling convenience sample of 51 female survivors of IPV with subthreshold ($n = 10$) or full diagnostic criteria ($n = 41$) of posttraumatic stress disorder. **Design:** Standard TBI criteria were evaluated using a semistructured clinical interview. **Main Measures:** The BAT-L/IPV is compared with the Ohio State University TBI Identification Method (OSU-TBI-ID) scoring approach as the criterion standard. **Results:** Correspondence between the BAT-L/IPV and the OSU-TBI-ID score was excellent (Cohen $\kappa = 0.86$; Kendall $\tau$-b $= 0.89$). Sensitivity = 89.3% (95% CI, 81.2-97.4); specificity = 98.3% (95% CI, 95.0-100); positive predictive value = 98.0% (95% CI, 94.2-100); and negative predictive value = 90.6% (95% CI, 83.5-97.7). On the BAT-L/IPV, more than one-third (35.3%) of IPV survivors reported TBI secondary to an IPV-related assault, 76.5% reported IPV subconcussive head injury, 31.4% reported attempted strangulation, and 37.3% reported non-IPV TBI. **Conclusions:** The BAT-L/IPV performed well in diagnosing TBI in female IPV

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survivors as compared with the criterion standard. The prevalence of TBI was frequent; subconcussive head injury was pervasive. Greater awareness for head injury risk and increased diagnostic specificity of TBI in IPV survivors is needed. **Key words:** *Boston Assessment of Traumatic Brain Injury-Lifetime (BAT-L)*, *Boston Assessment of Traumatic Brain Injury-Lifetime/Intimate Partner Violence (BAT-L/IPV)*, *concussion*, *diagnosis*, *intimate partner violence (IPV)*, *mild traumatic brain injury (mTBI)*, *National Center for PTSD*, *Ohio State University TBI Identification Method (OSU-TBI-ID)*, *posttraumatic stress disorder (PTSD)*, *traumatic brain injury (TBI)*, *women*



INTIMATE PARTNER VIOLENCE (IPV) includes physical, psychological, and sexual violence by an intimate partner.[1] In the United States, 1 in 3 women (34%) experience physical IPV during their lifetime, with 1 in 4 women (23%) experiencing severe physical IPV (ie, hit with a fist or hard object, strangled, beaten, assaulted with a weapon).[2] Injuries to the head, neck, and face are most frequent (35%-94% of IPV survivors), conferring significant risk for both subconcussive injury and mild traumatic brain injury (mTBI).[3] Both men and women experience IPV, but women are more at risk for physical injury from assaults.[3] The prevalence of attempted strangulation among IPV survivors ranges from 10% to 80% depending on the sample.[4–7] Women are much more likely to be strangled by an intimate partner than men. The alarming prevalence of head injury and the varied types of injury that occur secondary to IPV (eg, subconcussive head injury, TBI, and potential anoxic events secondary to strangulation) require a sensitive assessment tool to assist in the diagnosis of injuries that occur in the context of IPV. Although the understanding of TBI and subacute injury in military and athletic populations has increased significantly,[8] there remains limited understanding and awareness of the symptoms of IPV-related TBI.[9] This lack of awareness regarding IPV-related TBI can be detrimental to the recognition, accurate diagnosis, recovery, and outcomes for IPV survivors.

Differences in TBI definitions, application of standard TBI diagnostic criteria, measurements, and methodology have resulted in a wide range of reported IPV-related head injury and TBI prevalence (28%-100%).[10–13] Differences in definition of TBI within the IPV literature have varied from any injury to the head or face regardless of severity/force of impact to documented TBI with some assessment of standard TBI diagnostic criteria (altered mental status [AMS], posttraumatic amnesia [PTA], and loss of consciousness [LOC]) at the time of the injury. Assessment instruments for TBI in IPV survivors range from screening measures to more comprehensive self-report questionnaires to clinician-administered structured and unstructured diagnostic interviews (eg, Glasgow Outcome Scale, Rivermead Postconcussion Symptoms Questionnaire, Brain Injury Screening Questionnaire, Ohio State University TBI Identification Method [OSU-TBI-ID], HELPS Screening Tool, and the Brain Injury Severity Assessment Interview).[14–20] With little exception,[19,20] these tools were designed to assess head injury resulting from a range of causes and do not specifically examine IPV-related injury.

Valera and colleagues[19,20] developed a clinical interview specific to IPV. However, acute TBI diagnostic criteria at the time of the injury are not clearly differentiated from more general postconcussive, vestibular symptoms, or sensory changes and the validity of the interview has yet to be fully established. To our knowledge, none of the instruments used in the IPV literature to date have demonstrated validity in comparison with a criterion standard TBI assessment instrument in an IPV sample. Valid and reliable instruments for assessing TBI among IPV survivors are needed to advance this emerging area of research and practice. We adapted the Boston Assessment of TBI-Lifetime (BAT-L) to address the context and nature of head injury belonging exclusively to female IPV survivors (BAT-L/IPV) and support greater diagnostic accuracy of IPV-related injuries including subconcussive head injury, TBI, and potential anoxic injury secondary to strangulation.

The BAT-L is a semistructured clinical interview designed to assess TBI across the life span (including both military and civilian injuries) in post-9/11 veterans with excellent psychometric properties.[21] Similar to combat TBI, TBI acquired during IPV is especially challenging to diagnose because of the co-occurrence of psychological trauma at the time of injury. Psychological sequelae, including disorientation, confusion, and dissociation, that can occur during life-threatening situations/assault can be misperceived as TBI symptoms. A strength of the BAT-L is its ability to sensitively differentiate alterations in acute symptoms of TBI (AMS, PTA, and LOC) from other common physiological and psychological reactions to injury and trauma. The BAT-L/IPV was designed to help the examiner disentangle these frequently co-occurring psychological and physical symptoms by using probes targeting the unique and varied experiences of IPV survivors, including blunt force impact injuries and strangulation.[22–24] IPV assaults may be singular or repetitive. Injuries vary from subconcussive head injury to mild to moderate/severe TBIs. A comprehensive interview to address the complexity of injury belonging exclusively to IPV survivors is required.

This study compares TBI diagnostic score from the BAT-L/IPV with the scoring approach from the

well-validated OSU-TBI-ID. Prior research literature on moderate and severe TBIs has relied on medical records for accurate diagnosis of TBI. Ideally, IPV survivors would receive adequate medical attention immediately following head injury events and medical records could be used as a true gold standard. However, medical records are particularly inadequate for capturing a history of TBI among individuals with mTBIs and among IPV survivors because they are less likely to present for medical attention.[3,25,26] For example, Zieman et al.[3] demonstrated that only 21% of individuals with head trauma as a result of domestic violence sought medical attention at the time of injury. Reliance on medical record documentation of TBI, while less prone to retrospective recall bias, significantly underestimates a history of TBI. Furthermore, there is no specific biomarker for TBI. Neuroimaging techniques and neuropsychological assessment, although helpful for more severe TBI, have low positive predictive value and are not sensitive enough to accurately diagnose mTBI. Retrospective, validated, structured clinical interviews are the acknowledged standard for diagnosing remote mTBI,[27–29] particularly unwitnessed, undocumented, remote mTBIs that result from IPV.

The lack of available "gold standard" for the unwitnessed, undocumented, underreported head injuries is very similar to the nature of combat-related mTBI, which led us to apply the BAT-L forensic approach to IPV survivors. Past work has described the OSU-TBI-ID as the criterion standard in the field.[21,30–32] The OSU-TBI-ID is a TBI Common Data Element and is recommended by the National Institutes of Neurological Disorders and Stroke (NINDS) for measurement of lifetime TBI exposure.[33] It is freely available and has good-to-excellent interrater reliability, test-retest reliability, and predictive validity for number and severity of TBIs.[29,31] Despite these strengths, the OSU-TBI-ID is a relatively brief interview and is not specifically designed to address diagnostic challenges belonging exclusively to IPV. A more comprehensive tool with attention to the context and complexity of injury belonging exclusively to IPV survivors described earlier is required. In particular, the forensic approach of the BAT-L/IPV to differentiate traumatic response from neurological symptoms is needed given the high comorbidity of posttraumatic stress disorder (PTSD) common in this population. For the purposes of this validation study, we compare the diagnosis of TBI on the BAT-L/IPV with the OSU-TBI-ID scoring method as the criterion standard.

The primary aims of this study were to adapt the BAT-L interview specifically for female survivors of IPV and validate the newly adapted BAT-L/IPV using the OSU-TBI-ID scoring method as the criterion standard for TBI diagnosis. The secondary aim was to examine the prevalence of injury using the BAT-L/IPV. The prevalence of subconcussive head injury and TBI is provided for injuries occurring during IPV events. The prevalence of strangulation and LOC secondary to strangulation is also provided. Finally, the prevalence of non-IPV head injuries incurred across the life span is reported.

## METHODS

The data presented for this analysis are part of a larger study designed to examine subconcussive head injury and TBI and their impact on PTSD, psychiatric comorbidity, psychological distress, psychosocial functioning, neuropsychological functioning, and neuroimaging in a sample of female survivors of IPV.[34] The full study took approximately 12 hours over 2 testing days. Participants were offered remuneration for their time ($150 for day 1 and $125 for day 2). The study was conducted under the oversight of institutional review boards at University of Missouri St Louis Missouri Institute of Mental Health, Washington University, and VA Boston Healthcare System.

### Participants

Participants were women who had experienced at least 1 IPV event in their lifetime and screened positive for probable PTSD.[35] Participants were recruited throughout greater St Louis, Missouri, via flyers sent to agencies that serve IPV survivors, hospitals, and online via social media platforms. Exclusion criteria included a history of neurological illness (eg, Huntington disease, Parkinson disease, dementia, multiple sclerosis), a history of seizure disorders unrelated to head injury(ies), current diagnosis of schizophrenia spectrum or other psychotic disorders, ineligibility for MRI, or current active homicidal and/or suicidal ideation with intent requiring crisis intervention (see Galovski et al[34] for more details). One the basis of these criteria, 78 women screened eligible. Of these, 27 were unable to participate due to inability to undergo MRI, 3 were excluded for negative PTSD screens, and 1 was excluded for active psychosis, resulting in a final sample of 51 participants.

### Procedure

As part of the larger test battery, participants underwent a lifetime trauma interview for IPV survivors,[36] the BAT-L/IPV semistructured interview for TBI, the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5),[37] the Verbal Medical Symptom Validity Test (MSVT),[38] and the Neurobehavioral Symptom Inventory (NSI).[39] The CAPS-5 was used to assess PTSD diagnosis and severity. The NSI was used to assess

neurobehavioral or postconcussive symptoms in the domains of physical, cognitive, affective, and sensory symptoms. The MSVT and the NSI-Validity 10 were used to measure engagement and exaggeration.

Interviews were conducted by masters-level clinical assessors. Clinical assessors received training in the administration of the BAT-L/IPV, which included review of the items and approach, review of sample interviews (audio recordings), practice administration of the interview with supervisors, ongoing individual supervision, and ongoing group supervision from the consensus team. All interviews were audiotaped for the purposes of supervision and reliability analyses.

### *Lifetime trauma interview*

Lifetime trauma exposure was assessed via a locally constructed interview.[36] This interview captured trauma history across the life span, a history of intimate relationships with a specific focus on IPV experiences, and injuries sustained during IPV assaults. Common causes of repetitive blows to the head within IPV relationships were queried.[36] These included potential primary blunt force injury resulting from IPV assaults (eg, hit/punched in the face with fist, weapons, or objects); potential secondary blunt force injury resulting from falls and shoves, striking head on ground, walls and/or furniture; and strangulation. These injuries were queried for the overall incidence of occurrence regardless of injury severity and are reported elsewhere.[34] Injuries that participants reported were severe enough to cause potential head injury or physiological disruption of consciousness or memory are detailed in the following text.

### *BAT-L/IPV semistructured interview for TBI*

The BAT-L was specifically adapted for use with IPV survivors to assess subconcussive head injury, TBI, and anoxic injury across the life span.[21] Injuries were systematically assessed in the context of IPV relationships rank ordered by the clinical assessor and participant from most violent (queried first) to least violent (queried last).

*Subconcussive head injury*: A subconcussive head injury was defined as a blow to the head that was severe enough to cause a potential head injury but did not meet diagnostic criteria for TBI.

*Traumatic brain injury*: A TBI was defined as a blow to the head severe enough to cause physiological disruption of consciousness and/or memory (AMS, PTA, LOC), and TBI severity was specified according to accepted TBI guidelines.[21,40]

*Strangulation*: Potential anoxic injury due to strangulation was assessed if the participant reported it was severe enough to cause any possible physiological disruption of consciousness and memory (AMS, PTA, LOC). Participants were further queried about occurrence and duration of LOC secondary to strangulation.

*BAT-L/IPV forensic approach*: To disentangle frequently co-occurring TBI and trauma symptoms, the BAT-L/IPV semistructured interview used a forensic, temporal approach to TBI assessment in which the patient was asked to describe, in detail, the events leading up to, during, and after the injury. Questions were asked in different formats; different sources were identified and queried to cross-check facts when possible; consistency of timeline was considered and queried when appropriate. The focus of questions was on the physical injury, accompanying symptoms, and the context in which the injury occurred to ground the participant in a medical framework to minimize emotional triggers more common to PTSD assessment. Through retelling of the events, with follow-up questions to identify evidence of impaired mental functioning, memory gaps, unresponsiveness, witness reports, psychological reaction/dissociation, and medical treatment, the interviewer assessed the primary acute markers of a TBI: AMS, PTA, and LOC.

Effort was made to establish a shared terminology as described by Vanderploeg et al[41] between the examiner and the participant through the use of examples and follow-up questions to ensure they understood the symptoms being queried. Effort was also made to distinguish altered consciousness from emotional responses by drawing comparisons between previous emotional events in which the patient did not sustain a blow to the head. This was particularly important in differentiating between trauma-related dissociation and AMS/PTA. Specific prompts guided the examiner in differentiating physiological disturbance of consciousness from postconcussive symptoms (eg, slowed thinking, vestibular symptoms). Although the BAT-L/IPV guided these distinctions, we note that diagnosis requires clinical judgment. Interviewer clinical expertise, training in TBI, and feedback from an experienced diagnostic consensus team were essential to successful interviewing.

Each interview was reviewed by a consensus team including at least 3 doctoral-level psychologists (1 cognitive psychologist, 1 clinical neuropsychologist, and 1 clinical psychologist) with experience in TBI assessment to achieve a consensus diagnosis for TBI. The consensus team followed the principles of the Delphi method of consensus[42]:(1) presentation of standard information from the clinician administering the BAT-L/IPV; (2) initial independent decision of each team member; (3) discussion of diagnostic considerations and opinions; and (4) a final group decision. Diversity of opinions was encouraged during discussions. Disagreements were

rare, but if they occurred, then the majority decision ruled.

### *Head injury events*

Participants reported a mean of 2.8 (SD = 1.6) potential head injury events occurring across their life span, resulting in 115 head injury cases for analysis. Most reported injuries were remote, with an average time since head injury of 6.7 years (SD = 7.7).

### *Calculation of summary scores: OSU-TBI-ID scoring method*

We were unable to complete OSU-TBI-ID interview independently for this sample. Instead, we relied on independent raters' analysis of audio recordings of BAT-L/IPV interviews to score injuries on the basis of the OSU-TBI-ID methods and scoring as the criterion standard. Two independent raters (1 doctorate-level clinical neuropsychologist and 1 bachelors-level research assistant) blinded to the BAT-L/IPV diagnosis and not involved in the conduct of the study procedures used audio recordings of interviews to score each participant's possible head injuries using the OSU-TBI-ID. Each rater completed their review and scoring independently, recording them in separate files, which were later compared for interrater reliability. Disagreements were rare. Raters discussed disagreements and came to a mutual agreement on OSU-TBI-ID score.

### *Comparison of summary scores: OSU-TBI-ID and BAT-L/IPV*

To evaluate validity, TBI diagnosis was compared between the BAT-L/IPV and the OSU-TBI-ID scoring method following the methods described by Fortier et al.[21] To determine the agreement, BAT-L/IPV TBI severity for each of the 115 potential reported head injury events was converted to a scale comparable with the OSU-TBI-ID (see Table 1).

### Statistical analyses

Measures of validity were calculated using the OSU-TBI-ID scoring method as the criterion standard. To assess the ability of the BAT-L/IPV to accurately assess true positives and true negatives as compared with the criterion standard OSU-TBI-ID, sensitivity, specificity, and 95% CIs were calculated. For the purpose of further assessing predictive validity, head injury scores were dichotomized (0/1) for each instrument and positive and negative predictive values and CIs were calculated. Injuries classified as "possible TBI" or "mTBI" using the OSU-TBI-ID were considered positive for TBI, and those classified with "improbable TBI" were considered negative. For the BAT-L/IPV, injuries diagnosed with grade I, grade II, or grade III mTBI were considered positive for TBI and injuries diagnosed as no TBI were considered negative. To assess diagnostic agreement between the BAT-L/IPV and the OSU-TBI-ID, Cohen's $\kappa$ coefficient and Kendall's $\tau$-b coefficient were calculated for TBI diagnostic category (see Table 3) and positive/negative TBI (eg, dichotomized TBI Yes/No). Cohen's $\kappa$ coefficient was used to assess interrater reliability for independent rater scoring for the OSU-TBI-ID.

## RESULTS

### Participants

Demographic and clinical characteristics are presented in Table 2. Participants ranged in age from 18 to 45 years (mean = 32.6 years, SD = 7.1). Current PTSD was highly prevalent (80.4%; $n = 41$), with the remainder ($n = 10$) subthreshold for PTSD.[23] Participants were predominantly White (66.7%), with the remaining sample

**TABLE 1** *Diagnostic categories from the OSU-TBI-ID and the BAT-L*[a]

| OSU-TBI-ID diagnosis | OSU-TBI-ID criteria | BAT-L diagnosis | BAT-L TBI criteria |
|---|---|---|---|
| 1 (improbable TBI) | No AMS, PTA, or LOC | No TBI | No AMS, PTA, or LOC |
| 2 (possible TBI) | AMS or PTA but no LOC | Grade I mTBI | AMS or PTA <15 min but no LOC |
| 3 (mTBI) | LOC >0 but <30 min | Grade II or III mTBI | LOC >0 but <30 min, or AMS or PTA >15 min but <24 h |
| 4 (moderate TBI) | LOC between 30 min and 24 h | Moderate TBI | LOC between 30 min and 24 h, or AMS or PTA >24 h |
| 5 (severe TBI) | LOC >24 h | Severe TBI | LOC >24 h or PTA >7 d |

Abbreviations: AMS, altered mental status; BAT-L, Boston Assessment of TBI-Lifetime; LOC, loss of consciousness; mTBI, mild traumatic brain injury; OSU-TBI-ID, Ohio State University TBI Identification Method; PTA, posttraumatic amnesia; TBI, traumatic brain injury.

[a]From Fortier et al.[21]

**TABLE 2** *Demographics and descriptive characteristics*

| Full sample ($N = 51$) | *n* (%)/*M* ± SD |
|---|---|
| *Age* | 32.6 ± 7.1 |
| *Education* | |
| High school/GED | 9 (17.6) |
| Some college credit/technical training | 20 (39.2) |
| Associate degree | 7 (13.7) |
| Bachelor's degree or higher | 15 (29.4) |
| *Race* | |
| White | 34 (66.7) |
| Black | 10 (19.6) |
| Mixed race/other | 7 (13.7) |
| *Non-IPV trauma exposure, total prevalence* | |
| Childhood trauma | |
| Sexual assault | 36 (70.6) |
| Physical assault | 24 (47.1) |
| Serious accident | 10 (19.6) |
| Exposure to toxic substance | 2 (3.9) |
| Witnessed sudden violent death | 9 (17.7) |
| Sudden, unexpected death of someone close | 15 (29.4) |
| Serious injury, harm, or death you caused | 1 (2.0) |
| Captivity | 4 (7.8) |
| Community violence | 4 (7.8) |
| Adult trauma | |
| Sexual assault | 23 (45.1) |
| Physical assault | 15 (29.4) |
| Serious accident | 26 (51.0) |
| Exposure to toxic substance | 6 (11.8) |
| Witnessed sudden violent death | 12 (23.5) |
| Sudden, unexpected death of someone close | 35 (68.7) |
| Serious injury, harm, or death you caused | 5 (9.8) |
| Captivity | 11 (21.6) |
| Community violence | 19 (39.2) |
| *IPV trauma exposure* | |
| Any IPV | 51 (100) |
| Physical | 48 (94.1) |
| Sexual | 36 (70.6) |
| Psychological | 49 (96.1) |
| Number of IPV relationships | 2.6 ± 1.4 |
| Percentage of adult life spent in IPV relationship | 50.0 ± 32.1 |
| Age at first IPV relationship experience | 19.1 ± 5.8 |
| *PTSD, current* | |
| PTSD diagnosis | 41 (80.4) |
| PTSD severity (CAPS-5) | 35.1 ± 7.1 |
| PTSD severity (PCL-5) | 48.7 ± 12.7 |
| *Comorbid psychiatric disorders, current* | |
| Major depressive disorder | 11 (21.6) |
| Panic disorder | 6 (11.8) |
| Alcohol use disorder | 9 (17.6) |
| Cannabis use disorder | 8 (15.7) |
| Opioid use disorder | 1 (2.0) |
| *Comorbid psychiatric disorders, current* | |
| Major depressive disorder | 11 (21.6) |
| Panic disorder | 6 (11.8) |
| *Neurobehavioral symptoms* | |
| NSI total score full sample ($n = 51$) | 30.0 ± 14.5 |
| NSI-Validity 10 score full sample ($n = 51$) | 9.47 ± 6.6 |
| NSI total score lifetime TBI+ ($n = 27$) | 31.6 ± 16.2 |
| NSI total score lifetime TBI− ($n = 24$) | 28.3 ± 12.6 |
| NSI total score lifetime IPV-related TBI+ ($n = 18$) | 30.5 ± 15.9 |
| NSI total score lifetime IPV-related TBI− ($n = 9$) | 33.8 ± 17.5 |
| *Validity* | |
| Passed MSVT ($n = 51$) | 98.0% |

Abbreviations: CAPS-5, Clinician-Administered PTSD Scale for DSM-5; GED, General Educational Development; IPV, intimate partner violence; MSVT, Verbal Multiple Symptom Validity Test; NSI, Neurobehavioral Symptom Inventory; PTSD, posttraumatic stress disorder.

identifying as Black (19.6%) and mixed or other race (13.7%). Thirty percent had either a bachelor's or advanced degree. Almost 40% reported less than $15 000 in annual household income, and 30% reported an annual household income between $15 000 and $35 000.

Participants reported high rates of trauma exposure in addition to IPV (see Table 2). Childhood sexual (70.6%) and physical (47.1%) assaults were highly prevalent. Most women (80%) reported non-IPV sexual violence in adulthood, and more than half reported non-IPV physical violence in adulthood. Within IPV relationships, all women reported psychological/emotional violence, nearly all reported physical violence (96.1%), and 72.6% reported sexual violence.

Neurobehavioral symptoms were elevated overall in the sample and did not differ by TBI status (see Table 2; lifetime TBI: $t_{49} = -0.81$, $P = .42$; IPV-related TBI $t_{25} = 0.49$, $P = .63$).[43] Three participants fell below the suggested cutoff score for the NSI Validity-10 scale ($\geq 23$),[44] a screen for possible symptom exaggeration. However, each of these women passed the more stringent MSVT, indicating appropriate engagement.

### Correspondence between raters for OSU-TBI-ID scoring method

Interrater reliability for OSU-TBI-ID scores by independent raters was excellent, with a substantial

**TABLE 3** *Comparison of TBI diagnosis: OSU-TBI-ID scoring method as compared with the BAT-L in 115 head injury cases*

| | BAT-L score | | |
|---|---|---|---|
| **OSU-TBI-ID score** | **1 (no TBI)** | **2 (grade I mTBI)** | **3 (grade II and III mTBI)** |
| 1 (improbable TBI) | 58 | 1 | 0 |
| 2 (possible TBI) | 5 | 23 | 1 |
| 3 (mTBI) | 1 | 2 | 24 |

Abbreviations: BAT-L, Boston Assessment of TBI-Lifetime; OSU-TBI-ID, mTBI, mild traumatic brain injury; Ohio State University TBI Identification Method; TBI, traumatic brain injury.



association (Cohen $\kappa = 0.89$) between individual raters' diagnoses.

### Correspondence between the BAT-L/IPV and the OSU-TBI-ID scoring method

The BAT-L/IPV demonstrated high diagnostic agreement with the OSU-TBI-ID. Sensitivity was 89.3% (95% CI, 81.2-97.4) and specificity was 98.3% (95% CI, 95.0-100). Both Cohen $\kappa$ and Kendall $\tau$-b coefficients indicated strong consistency between the BAT-L/IPV and the OSU-TBI-ID for TBI diagnosis (Cohen $\kappa = 0.86$; Kendall $\tau$-b $= 0.89$; see Table 3).

After dichotomizing TBI scores (positive TBI/negative TBI), 43.4% ($n = 50$) of 115 reported possible head injury events met for positive TBI diagnosis on both instruments, whereas 50.4% ($n = 58$) were negative for TBI diagnosis on both instruments. The remaining 7 possible head injury events showed disagreement for TBI diagnosis: 5.2% ($n = 6$) were classified as having "no TBI" on the BAT-L/IPV but "possible TBI" or "mTBI" on the OSU-TBI-ID and 0.9% ($n = 1$) were classified with a "grade I mTBI" or higher on the BAT-L/IPV but "improbable TBI" on the OSU-TBI-ID. Positive and negative predictive values were high (98.0%: 95% CI, 94.2-100; 90.6%: 95% CI, 83.5-97.7, respectively). Both Cohen $\kappa$ and Kendall's $\tau$-b coefficients indicated strong consistency for positive/negative TBI diagnosis (Cohen $\kappa = 0.88$; Kendall $\tau$-b $= 0.88$).

Diagnostic disagreements between the 2 instruments were rare. The largest discrepancy involved 5 individuals classified with "possible TBI" according to the OSU-TBI-ID but classified as "no TBI" on the BAT-L/IPV. One individual was categorized as having an "improbable TBI" on the OSU-TBI-ID but classified as "grade I mTBI" on the BAT-L/IPV. Another individual was classified with "mTBI" on the OSU-TBI-ID but "no TBI" on the BAT-L/IPV (see Table 3). These disagreements were a result of either insufficient diagnostic information collected by the clinical assessor, potential anoxic event and TBI occurring during the same assault, co-occurring substance use, possible dissociation during assault, or medical comorbidities that clouded the etiology of symptoms (see Supplemental Digital Content Table 1, available at: http://links.lww.com/JHTR/A456). The clinical assessor and consensus team determined that the symptoms reported could not definitively be related to TBI, given confounding factors (eg, dissociation). Two additional discrepancies were not in fact diagnostic disagreements, per se. Two individuals were classified with "mTBI" according to the OSU-TBI-ID but were rated "grade I mTBI" on the BAT-L/IPV (both instruments coded them as mTBI, but severity differed). Finally, one discrepancy was due to a difference in measurement criteria between the instruments. A TBI can be graded as more severe on the BAT-L/IPV (eg, grade II or III mTBI) on the basis of any of the 3 acute TBI symptoms, whereas LOC is required on the OSU-TBI-ID to be classified as a "definite mTBI" (see Table 1). AMS and/or PTA only (no LOC) are captured as a "possible TBI" on the OSU-TBI-ID. This injury involved AMS and/or PTA lasting more than 15 minutes without LOC (consistent with a grade II mTBI on the BAT-L/IPV) that was defined as a "possible TBI" on the OSU-TBI-ID.

### IPV Boston Assessment of TBI-Lifetime (BAT-L/IPV)

The majority of participants (76.5%; $n = 39$; mean $= 1.8$, SD $= 0.9$) reported IPV-related blunt force subconcussive head injury that did not meet criteria for TBI but was identified by the participant as potentially severe enough to cause physiological disruption of consciousness and memory (AMS, PTA, LOC). Approximately one-third of the sample experienced a blunt force injury secondary to IPV that met diagnostic criteria for TBI (35.3%; $n = 18$; mean incidence of TBI secondary to IPV $= 1.3$, SD $= 0.8$). The prevalence of strangulation described as potentially severe enough to cause physiological disruption of consciousness and memory was 31.4% ($n = 16$), of which 7.8% ($n = 4$) resulted in LOC.

Across the life span, the prevalence of non-IPV subconcussive head injury potentially severe enough to

cause physiological disruption of consciousness and memory was 58.8% ($n = 30$; mean = 1.9, SD = 1.1). More than one-third of the sample (37.3%) reported a lifetime history of 1 or more non-IPV TBIs ($n = 19$; mean lifetime non-IPV TBIs = 1.5, SD = 0.8).

### Severity of TBIs (BAT-L/IPV)

All TBIs secondary to IPV were mild (see Figure 1). Of these, 30.4% ($n = 7$; mean = 1.0, SD = 0.0) were mild grade I injuries indicating no LOC, and AMS and PTA less than 15 minutes in duration. More than half ($n = 12$; mean = 1.5, SD = 0.8) were mild grade II injuries, indicating there was brief LOC associated with the event (<5 minutes' duration) or PTA and/or AMS of more than 15 minutes. Four participants experienced a grade III mTBI, indicating LOC of 5 to 30 minutes or PTA and/or AMS of more than 24 hours. All non-IPV TBIs were mild in nature and similarly distributed among grade I, II, and III injuries.

## DISCUSSION

The BAT-L/IPV demonstrates excellent diagnostic consistency with the criterion standard OSU-TBI-ID scoring method, indicating the BAT-L/IPV is an effective instrument for diagnosing TBI in populations with a history of IPV. The BAT-L was successfully adapted to create the BAT-L/IPV, a retrospective tool with which to probe, characterize, and diagnose an individual's lifetime and IPV-related exposure to TBI. The BAT-L/IPV is a more detailed, comprehensive semistructured interview designed specifically to characterize and diagnose head injuries that occur in the IPV context. Injuries are identified and assessed by IPV relationship to assist recall, beginning with the most physically violent relationship. The BAT-L/IPV adopts a forensic approach to head injury assessment and collects additional contextual information to assist the examiner in differentiating symptom etiology (eg, TBI, trauma, neurobehavioral/postconcussive, strangulation) using a detailed timeline approach and forensic cueing to improve diagnostic accuracy.

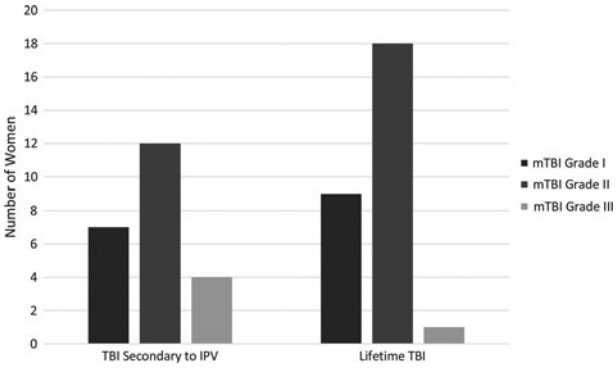


**Figure 1.** BAT-L/IPV consensus diagnosis of TBI secondary to IPV and lifetime TBI by severity in 51 female survivors of IPV. The number of women who sustained a grade I mTBI, grade II mTBI, and grade III mTBI is reported. All injuries were mild in nature. BAT-L indicates Boston Assessment of TBI-Lifetime; TBI, traumatic brain injury; IPV, intimate partner violence; mTBI, mild traumatic brain injury.

Disagreements between the BAT-L/IPV and the OSU-TBI-ID were infrequent. Overall, the BAT-L/IPV was more conservative in diagnosing TBI largely due to its attention to differentiating AMS from PCS and other factors that may better explain reported acute symptoms. These factors included strangulation, substance use, dissociation, and fainting that co-occurred at the time of the possible TBI. These co-occurring factors clouded the etiology of symptoms and as a result could not be ruled out as possible causes of AMS, PTA, and/or LOC. The BAT-L/IPV takes an a priori conservative diagnostic approach such that if there are other co-occurring etiologies that can explain potential acute TBI symptoms, the injury is considered negative for TBI. Specifically, the interview is designed to have higher specificity to accurately diagnose TBI and rule out associated symptoms unrelated to TBI. The very high specificity observed indicates that the BAT-L/IPV met this goal. The BAT-L/IPV is a detailed diagnostic interview, not a screening tool. Therefore, it is not designed to catch all potential head injuries and its slightly lower sensitivity is expected and acceptable. The positive predictive value of the BAT-L/IPV was nearly perfect, indicating that the BAT-L/IPV performs similarly to the criterion standard OSU-TBI-ID in accurately diagnosing individuals positive for TBI and performs well in ruling out individuals negative for TBI. In summary, the BAT-L/IPV is less sensitive but more specific than the OSU-TBI-ID in terms of TBI diagnosis.

The lack of available "gold standard" diagnosis for the often unwitnessed, undocumented, underreported head injuries common to IPV poses particular challenges for validation of TBI interviews, such as the BAT-L/IPV. Medical records are particularly inadequate for capturing TBI diagnosis among individuals with mTBIs and among IPV survivors because they are less likely to seek medical attention.[3,25,26] There is no biomarker for TBI. Neuroradiological techniques available for more severe TBI are not sensitive enough for mTBI. Therefore, validation studies are limited in terms of diagnostic data available for comparison. Because of the lack of more definitive data, retrospective, validated, semistructured clinical interviews are the acknowledged standard for diagnosing remote mTBI.[27–29] Further limiting our assessment of validity, we were unable to complete OSU-TBI-ID interview independently for this sample. Instead, we relied on independent raters analysis of recorded BAT-L/IPV interviews to score injuries on the basis of the OSU-TBI-ID methods and scoring system.

Therefore, subsequent research is needed to further examine the validity and reliability of the BAT-L/IPV. Specifically, the BAT-L/IPV should be compared with an independently administered criterion standard clinical interview to further establish validity and test-retest and interrater reliability should be established.

Just over one-third of our sample experienced a TBI secondary to IPV, all of which were mild in severity. The prevalence of IPV-related TBI (35%) is lower than many previous studies that reported a TBI prevalence ranging from 28% to 100%.[10–13] This difference is not surprising, considering that prior reports of TBI and head injury from IPV have relied primarily on screening measures, self-report questionnaires, and unstructured diagnostic interviews.[14–20] Our results do, however, replicate a high prevalence of IPV-related blunt force subconcussive head injury (77%). Importantly, the BAT-L/IPV instructs participants to report only those injuries they felt were severe enough to cause physiological disruption of consciousness and memory or "potentially result in a head injury." As reported previously in our sample, self-report of any injury involving the head regardless of severity was 94%.[34] As predicted, when TBI diagnostic criteria were carefully applied using the BAT-L/IPV, the prevalence of TBI was much lower than the prevalence of head injury. Despite the lower prevalence of TBI found in this sample compared with prior studies, the prevalence of TBI secondary to IPV was still substantial and the occurrence of subconcussive head injury was pervasive. Accurate assessment of these injuries is critical to improve health-related outcomes in women survivors of IPV.

TBIs occurring in a traumatic situation are challenging to diagnose. Disentangling psychological and physiological (eg, AMS, PTA, LOC) responses to injury requires a detailed forensic approach and sound clinical training and judgment. The BAT-L/IPV explicitly guides the interviewer in assessing and differentiating between these overlapping symptoms of trauma and TBI. It is possible that previous studies used instruments that lack specificity to sufficiently disentangle psychological response from acute TBI symptoms, thus contributing to a higher prevalence of IPV-related TBI. It is critical to consistently apply accepted definitions of acute TBI symptoms in diagnosis. Acute TBI symptoms of AMS, PTA, and LOC must be disentangled not only from psychological symptoms (eg, anxiety, fear, dissociation) but also from neurobehavioral or postconcussive symptoms (dizziness, slowed thinking, "seeing stars," or other nonspecific symptoms that do not necessarily entail acute alteration of consciousness). TBI assessment measures that incorporate a detailed account and timeline of injury, other possible contributing etiologies (eg, concurrent substance use, anoxia, dissociation), and forensic cueing will improve diagnostic accuracy.

Strangulation is a prevalent form of IPV that presents significant health risks.[6,45] Strangulation by intimate partners was prevalent in our sample, providing additional evidence that female survivors of IPV are at risk for anoxic brain injury in addition to blunt force injury.[10] There may be significant long-term consequences of strangulation injuries due to vascular compromise and potential cell death depending on duration of lack of blood flow.

In our sample, lifetime history of non-IPV TBI was also highly prevalent. More than one-third of the sample experienced 1 or more lifetime TBIs unrelated to IPV, all of which were mild. The majority of non-IPV head injuries occurred during childhood or young adulthood and were most often caused by sports injury, falls, or motor vehicle accidents. In addition to assaults incurred during IPV, this sample reported high rates of exposures to traumatic events during childhood and adulthood. The complexity of the sample's trauma history is consistent with that observed in the larger IPV population. Disentangling the acute neurobiological effects of TBI from the acute psychiatric sequelae is critical to accurate diagnosis and optimal approach to intervention.

## LIMITATIONS

First, this study represents a convenience sample. Participants volunteered to participate in a research study about IPV. It is possible that IPV survivors who participate in research may differ from those who do not. Our sample was predominantly White women aged 18 to 45 years drawn from an urban area with low socioeconomic status; therefore, gender, age, and racial diversity must be considered as limitations. Women were required to screen positive for PTSD and therefore may not be representative of IPV survivors more generally. We believe our sample to be representative of IPV survivors, given the documented prevalence of mental health diagnoses, particularly PTSD,[46–48] among women with a history of IPV; however, selection bias must be considered. Second, the BAT-L/IPV is based on self-report and therefore subject to recollection bias and/or underreporting of symptoms due to stigma. However, symptom validity testing indicated intact engagement and validity scales were unrelated to TBI diagnosis in this sample. Finally, the OSU-TBI-ID scores were obtained by independent, blinded reviewers using audio recordings of BAT-L/IPV interviews to score head injuries using the OSU-TBI-ID method, rather than conducting an independent interview using the OSU-TBI-ID. This is a limitation to the reported criterion validity.

## CONCLUSION

The BAT-L has been adapted to characterize and diagnose subconcussive head injury and TBI in

female IPV survivors while maintaining its life span approach. The BAT-L/IPV showed excellent correspondence with the criterion standard OSU-TBI-ID scoring method. To our knowledge, the BAT-L/IPV is the first validated semistructured clinical interview designed specifically to characterize head injuries and diagnose TBIs in IPV survivors. The high prevalence of IPV-related TBI, IPV-related subconcussive head injury, and IPV strangulation-induced anoxic brain injury found in this study demonstrate and reinforce the importance of comprehensive, validated assessment of TBI with carefully applied diagnostic criteria to establish prevalence of injury in female survivors of IPV.



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