



Associations between traumatic brain injury from intimate partner violence and future psychosocial health risks in women

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ABSTRACT

Objective: The effects of traumatic brain injury (TBI) incurred during military service are widely studied; however, less is known about TBI resulting from intimate partner violence ("IPV-related TBI"). Women Veterans are at high risk for IPV, yet no research has examined future psychosocial health risks associated with IPV-related TBI history in this population.

Methods: We examined psychiatric and physical health outcomes, as well as IPV, in a sample of women Veterans who, at Time 1, reported IPV-related TBI with ($n = 13$) or without ($n = 20$) persistent symptoms; that is, symptoms such as memory problems, balance problems or dizziness, sensitivity to bright light, irritability, headaches, and sleep problems that began or got worse immediately following the IPV-related TBI and occurred within the past week. These women completed web-based surveys 18 months later (Time 2), which included validated measures of psychiatric and physical health symptoms as well as past-year IPV. We conducted linear regressions to model whether T1 IPV-related TBI with persistent symptoms predicted worse health outcomes at T2, in comparison to T1 IPV-related without persistent symptoms.

Results: Controlling for significant covariates (i.e., military sexual trauma; MST), IPV-related TBI with persistent symptoms at Time 1 was associated with significantly worse outcomes at Time 2 across all health outcome domains (sr^2 range: 0.12–0.37). After controlling for MST and probable posttraumatic stress disorder (PTSD) at Time 1, IPV-related TBI with persistent symptoms at Time 1 remained significantly associated with worse Time 2 symptoms of insomnia, depression, and physical health (sr^2 range: 0.12–0.25).

Conclusion: Women who experience IPV-related TBI with persistent symptoms are at higher risk for worse psychosocial health outcomes 18 months later. Findings necessitate screening IPV survivors for TBI with persistent symptoms and tailoring TBI and psychosocial interventions to reduce risk for ongoing health sequelae.

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1. Introduction

Traumatic brain injury (TBI) acquired in combat operations during military service has gained attention due to its complexity, frequency, and range of mental and physical impacts [1–3]. TBI is defined as an alteration in brain function, or other evidence of brain pathology, caused by an external force [4]. According to the Department of Defense, >380,000 U.S. Service Members have experienced TBI since 2000 [5]. TBI can be classified as mild, moderate, or severe. Mild TBIs, also known as concussions, are the most common type of TBI to occur in

military and civilian populations [6,7]. Although most individuals recover within weeks or a few months, there are a minority of individuals who do not fully recover (i.e., TBI with persistent symptoms), and that can lead to, or exacerbate, risk for harmful physical, psychological, and social health outcomes, including suicidality [8–13]. However, research on TBI among military populations has focused predominantly on men and deployment-related etiologies (e.g., blast exposure).

Since the Iraq and Afghanistan wars began, an unprecedented number of women have enlisted and served honorably in the military, with women representing 16.3% of active duty service members and 22.9% of new recruits [14]. Women constitute 12% of soldiers who served in Iraq and Afghanistan [15]. Given the combat exclusion policy has been lifted, it is probable that women service members will face increased exposure to deployment-related TBI [16]. While a growing literature sheds light

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on the incidence and correlates of deployment-related TBIs in populations of women Veterans [11,12,16,17], less is known about the physical and mental health consequences of non-deployment related TBI.

Intimate partner violence (IPV), including physical and sexual violence perpetrated by a past or current intimate partner, is an important risk factor for TBI in women Veterans [17,18]. Women Veterans are 1.6 times more likely to experience IPV during their lifetime compared to their peers who do not serve in the military and experience IPV at elevated rates across their lifetime, especially following separation from the military [19,20]. IPV behaviors resulting in TBI can include being beaten up; having one's head hit with a fist or hard object; or by being thrown down the stairs or off a porch [21]. In addition, strangulation-related anoxic/hypoxic brain injuries are commonly included in the IPV-related TBI literature [22]. Kwako and colleagues reported the occurrence of TBI (including from strangulation) among IPV survivors seeking emergency shelter or care in an emergency department to range from 30% to 74% [23]. The civilian literature clearly documents links between IPV, TBI, and posttraumatic effects [23–27], yet there has been little attention to this issue among women Veterans despite their documented high risk for IPV.

Two studies have examined TBI resulting from IPV (“IPV-related TBI”) and posttraumatic effects in women Veterans. In a cross-sectional mail survey of a random sample of Veterans Health Administration (VHA) patients, approximately 19% of the sample experienced a probable TBI from partner violence [28]. IPV-related TBI was associated with higher levels of posttraumatic stress disorder [PTSD] and depressive symptoms, even when adjusting for prior physical, sexual, and psychological IPV experiences. The second study was a cross-sectional investigation of IPV-related TBI and concurrent IPV-related PTSD symptoms among a sample of women Veteran IPV survivors [29]. Approximately 28% of this sample met criteria for IPV-related TBI history, and 12.5% met criteria for IPV-related TBI with persistent symptoms (i.e., symptoms that began or got worse immediately post-injury and occurred within the past week, such as dizziness, sensitivity to light, irritability, headaches, sleep, and/or memory disturbances). Women with persistent IPV-related TBI symptoms were nearly 6 times more likely to have probable PTSD compared those with no IPV-related TBI history. Thus, probable PTSD is a common health issue among this sample of women who experienced IPV-related TBI, and requires consideration

when examining health outcomes that may be associated with IPV-related TBI with persistent symptoms.

In summary, research to date has identified that women Veterans are a quickly growing population, are at an elevated risk for experiencing TBI secondary to IPV, and experience, at minimum, acute mental and physical health effects attributable to IPV-related TBI. However, it is unclear what role, if any, PTSD may play in explaining any long-term associations between TBI and future functioning. IPV-related TBI with persistent symptoms is strongly associated with concurrent probable PTSD [29]. Some studies with military populations show diminishing associations between TBI history and health symptoms after controlling for PTSD [30–32], while others demonstrate sustained associations between TBI and some health outcomes after controlling for PTSD [1,33,34]. This study builds on previous research and examines associations between IPV-related TBI with future mental and physical health symptoms among women Veterans who participated in the prior study on TBI with IPV survivors and participated in a follow-up survey 18 months later [29]. Based on the cross-sectional results within this sample for probable PTSD status [29], we expect that women with persistent IPV-related TBI, compared to women without persistent TBI symptoms, will report worse mental and physical health, as well as more frequent past-year IPV, at the 18-month follow-up assessment.

2. Methods

2.1. Participants and procedures

Data for this sub-study were drawn from a larger study that consisted of web-based surveys conducted in 2014 and 2016. The original study was planned as a cross-sectional assessment of women Veterans' preferences for IPV care [35] (i.e., Time 1), but was later expanded to assess health symptoms 18 months later (i.e., Time 2). Participants were members of the KnowledgePanel®, a probability-based, non-volunteer access survey panel of 55,000 U.S. adults, representative of 97% of U.S. households, maintained by GfK research firm [36]. Panel members were recruited through national random sampling. All KnowledgePanel® participants who identified as a woman and as a Veteran were eligible to participate in the Time 1 survey. Participant sample size and attrition from the Time 1 survey to inclusion in the present

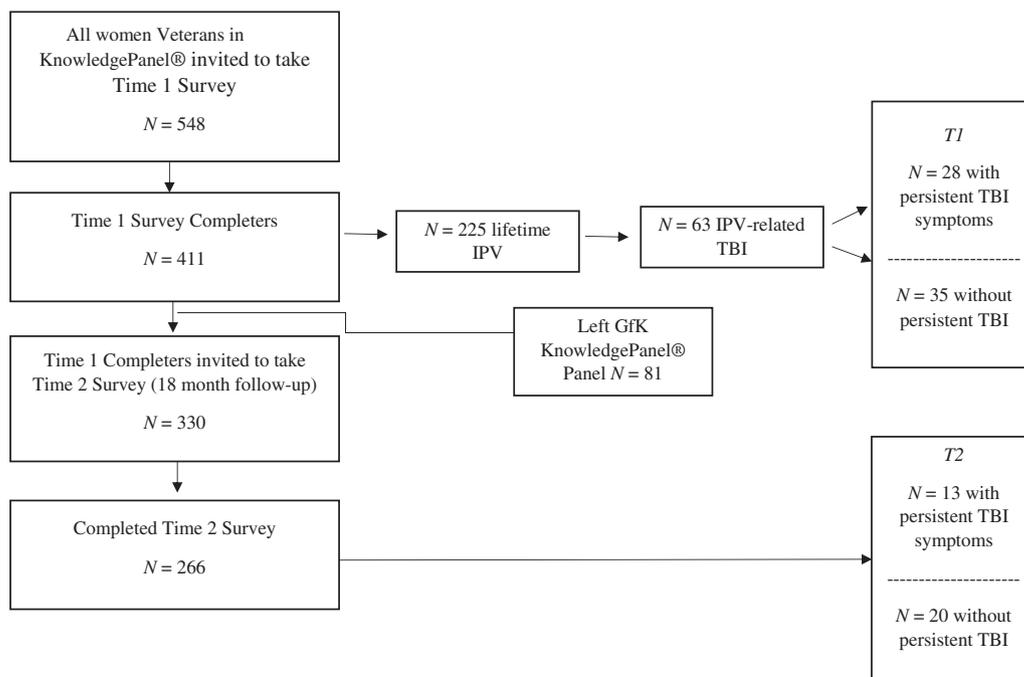


Fig. 1. Participant flow from parent study to inclusion in the present IPV-Related TBI sub-study.

study are shown in Fig. 1. As reported previously, 411 women veterans participated in an initial 30-min web-based survey (representing 75% of eligible women on the KnowledgePanel®, $n = 548$) [29,35]. All women who participated in the Time 1 survey who remained in the KnowledgePanel® were invited to participate in a follow-up survey 18 months later ($n = 330$), of whom 266 women completed the Time 2 60-min web-based survey (80.6% of eligible participants; 64.7% of Time 1 participants). There were no significant differences in demographic variables or Time 1 probable PTSD status among women who participated in the Time 2 survey compared to those who did not. With respect to history of IPV, at Time 1, 225 women reported lifetime IPV (54.8%). Among these IPV survivors, 63 women (28.1%) reported a history of IPV-related TBI history. Of these 63 women, 28 reported persistent TBI symptoms and 35 reported prior IPV-related TBI without persistent symptoms [29].

The present study focused on 18-month outcomes of those with a history of IPV-related TBI at Time 1. Thus, our sample of interest included those women who reported Time 1 (T1) TBI, with or without persistent symptoms, who participated in the Time 2 (T2) survey ($n = 33$: 13 women with persistent symptoms and 20 women without persistent symptoms). There were no significant differences in attrition ($n = 30$) in terms of demographic characteristics, IPV, or probable PTSD status between our two study groups: those with and without persistent TBI symptoms ($\chi^2(1) = 0.72, p = .453, \phi = 0.107$). Table 1 displays the demographic and military related characteristics for the current samples.

2.2. Measures

2.2.1. Time 1 variables

Probable IPV-related TBI with and without persistent symptoms was assessed using a modified version of the VA TBI screening tool [37], described in detail in the initial study [29]. Women were first considered to have experienced an IPV-related head event if they reported 1 of 7 events by an intimate partner (e.g., “Hit you in the head with an object, hand, or fist”, “Broken your teeth or jaw”, and “Strangled/choked you”). Women then met screening criteria for IPV-related TBI history if they reported that IPV-related head events were associated with loss of consciousness, altered consciousness (i.e., being dazed or confused), posttraumatic amnesia (i.e., not remembering events before or after the injury), concussion, or head injury. Consistent with prior research [29], women were considered to meet criteria for probable IPV-related TBI with *persistent* symptoms if they reported that one or more post-concussive symptoms began or got worse following the IPV-related head event and occurred within the past week (i.e., memory problems or lapses, balance problems or dizziness, sensitivity to bright light, irritability, headaches, and sleep problems). Only women who reported

probable IPV-related TBI history, with or without persistent symptoms, were included in this study.

Demographic and military characteristics (age, race/ethnicity, employment status, income, educational level, and military branch) were self-reported on the survey and were considered as potential covariates. Military sexual trauma (MST) was assessed using VHA’s screener, which consist of two dichotomous (yes/no) questions: harassment (i.e., “When you were in the military, did you ever receive unwanted, threatening or repeated sexual attention (for example, touching, cornering, pressure for sexual favors, or inappropriate verbal remarks, etc.?”), and military sexual assault (i.e., “When you were in the military, did you have sexual contact against your will or when you were unable to say no (for example, after being forced or threatened or to avoid other consequences?”). Endorsement of either item was considered positive for MST history. History of combat exposure was assessed with a dichotomous (yes/no) question (“During any of your deployments, did you have any exposure to combat (for example, you fired a weapon, were under fire, or saw people who were injured or killed in battle?”). Demographic and military variables were considered for inclusion as covariates in the models if they were significantly associated with T2 outcomes.

Additional potential T1 covariates. Lifetime IPV experiences were assessed at T1 using the modified Humiliate/Afraid/Rape/Kick (HARK) tool [38]. The HARK includes 4 dichotomous (Yes/No) items assessing lifetime IPV experiences (emotional mistreatment, fear, sexual aggression, and physical violence). The HARK was summed to create an index between 0 and 4 forms of lifetime IPV (Cronbach’s $\alpha = 0.79$). This index was used to describe IPV experiences at T1 and evaluate T1 IPV as a potential covariate in the models. The PCL-5 is a 20-item self-report measure that assesses current DSM-5 [39] PTSD symptom severity. The items were anchored to Veterans’ IPV at T1. A cut-off score of 33 was used to determine probable T1 PTSD (yes/no) [40]. The PCL-5 has demonstrated good internal consistency ($\alpha = 0.96$), test-retest reliability ($r = 0.84$), and convergent and discriminant validity in previous research [40]. The probable PTSD variable was examined as a covariate in the final regression model. In the present study, the internal consistency of the PCL-5 at T1 was excellent, $\alpha = 0.98$.

2.2.2. Time 2 psychosocial health variables

PTSD symptoms were assessed using the PCL-5 [41], as described above for T1, with two exceptions. First, the items were anchored to experiences of any traumatic event. Second, responses were summed to create a total score, with higher scores indicating greater levels of PTSD symptoms. The internal consistency of the PCL-5 at T2 was excellent, $\alpha = 0.98$.

Depressive symptoms were assessed using the 10-item version of original Center for Epidemiological Studies-Depression Scale (CES-D-10) [42]. Participants were asked to evaluate a series of depressive symptoms (e.g., feeling sad, blue, and hopeless) they may have

Table 1.
Demographic and military-related characteristics among women with IPV-related TBI with and without persistent symptoms.

Variable	IPV-related TBI with persistent symptoms ($n = 13$)	IPV-related TBI without persistent symptoms ($n = 20$)	χ^2/t
Demographic and military-related variables			
Age (M, SD)	45.85 (15.17)	51.35 (11.71)	1.17, $p = .249, d = 0.41$
Race (% non-White)	61.5% (8)	40.0% (8)	1.46, $p = .296, \phi = 0.211$
College graduate (% Yes)	23.1% (3)	40.0% (8)	1.02, $p = .456, \phi = 0.175$
Married/cohabitating (% Yes)	53.8% (7)	50.0% (10)	0.05, $p = 1.00, \phi = 0.038$
Branch (% Yes)			3.05, $p = .385, \text{Cramér's } V = 0.304$
Army	38.5% (5)	55.0% (11)	
Navy	23.1% (3)	30.0% (6)	
Air Force	30.8% (4)	15.0% (3)	
Marines	7.7% (1)	0% (0)	
MST (% Yes)*	84.6% (11)	45.0% (9)	5.18, $p = .032, \phi = 0.396$
Combat Exposure (% Yes)	30.8% (4)	15.0% (3)	1.17, $p = .393, \phi = 0.188$

* $p < .05$; MST = Military Sexual Trauma.

experienced over the past week. This measure has demonstrated acceptable convergent and concurrent validity [42,43]. Responses were summed to create a total score, with higher scores indicating higher levels of depression symptoms. Cronbach's alpha for the CES-D-10 was excellent, $\alpha = 0.94$.

Insomnia symptoms were assessed using the Insomnia Severity Index (ISI) [44], a seven-item measure assessing current (e.g., within the last two weeks) sleep difficulties. Respondents were asked to rate the nature (e.g., difficulty falling or staying asleep, waking up too early) and symptoms (e.g., dis/satisfaction or worry due to sleep problems) of their current sleep problems using a Likert-type scale (range of 0–4). Scores were summed, with higher scores indicating higher levels of sleep difficulties. The ISI is a valid and sensitive measure for detecting perceived sleep difficulties [44]. The internal consistency of the ISI in the present study was excellent, $\alpha = 0.91$.

Anxiety symptoms were measured using the Anxiety subscale of the Depression Anxiety Stress Scale (DASS) [45]. The anxiety subscale has 14 items which assess autonomic, skeletal muscle effects, situational anxiety, and anxious affect over the past week. Participants were asked to rate these items on a scale of 1 (“Did not apply to me at all”) to 4 (“Applied to me very much, or most of the time”). Scores were summed, with higher scores indicating higher anxiety symptoms. The DASS has been shown to have high internal consistency and discriminant validity in a variety of settings [45,46]. The internal consistency of the anxiety scale of the DASS in the present study was excellent, $\alpha = 0.95$.

Physical health symptoms were measured using the Patient Health Questionnaire (PHQ-15) [47], a well-validated, continuous measure of physical health symptoms. Participants rated how bothered (0= “Not bothered at all”, 1= “Bothered a little”, 2= “Bothered a lot”) they were over the past 4-weeks due to various somatic symptoms (e.g., stomach pain, headaches, dizziness). Scores were summed, with higher scores indicating higher levels of physical health symptoms. The internal consistency of the PHQ-15 in the present study was excellent, $\alpha = 0.88$.

Past-year IPV experiences were assessed at T2 using the Revised Conflict Tactics Scales (CTS-2) [48]. Three subscales measuring IPV behaviors were included in this study: psychological aggression (sample item: “shouted at me”), physical IPV (sample item: “punched or hit me with something that could hurt”), and sexual IPV (sample item: “used force to make me have sex”). The past-year frequency of each form of IPV is assessed on a 7-point scale (*never* to *>20 times*). Items are summed using the midpoints of the response categories to create subscale frequency totals [48]. Overall IPV exposure was calculated for

the present study, as well as frequency of each of the three forms of IPV. Cronbach's α values for CTS-2 scales were excellent (physical = 0.95, sexual = 0.92, psychological = 0.93).

2.3. Data analysis

Only three participants had missing data, which included one to two missing items on three T2 measures. The total missing data represented fewer than 10% of the measure's items. We therefore computed scales based on all available data for the entire sample. Bivariate (Pearson) correlations were explored among all T1 and T2 variables of interest. Associations between demographic and military-related variables (e.g., MST and combat exposure) and T2 psychological and physical outcomes were evaluated to determine whether to adjust for these variables. Next, T2 outcomes were regressed on persistent and non-persistent IPV-related TBI symptoms while controlling for significant demographic and military-related covariates. Finally, given that literature suggests PTSD symptoms are an important factor linking TBI to some prospective health outcomes [32], we assessed whether the association between persistent and non-persistent IPV-related TBI symptoms and T2 psychological and physical outcomes remained while controlling for T1 probable PTSD status. Specifically, we regressed T2 psychological and physical outcomes on persistent and non-persistent IPV-related TBI while controlling for T1 probable PTSD (and significant demographic and military-related covariates). The Benjamini-Hochberg method was used to correct for multiple testing [49].

3. Results

3.1. Bivariate associations

Table 2 presents descriptive information and correlations among all primary study variables. The positive point-biserial correlations between IPV-related TBI with persistent symptoms and T2 outcomes indicates that, at the bivariate level, women with IPV-related TBI with persistent symptoms at T1 reported significantly higher (worse) T2 psychological and physical outcomes than did women without persistent IPV-related TBI symptoms. Overall, T1 demographic and military variables were not strongly associated with T2 outcomes, except for MST, which was significantly and positively associated with T2 PTSD, insomnia, and anxiety symptoms. MST was therefore included as a covariate in subsequent analyses.

Table 2.
Bivariate associations among primary study variables (N = 33).

	% (N) or M (SD)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. IPV-related TBI w/persistent symptoms	39.4% (13)	–0.21	–0.07	0.40*	0.19	0.21	0.49*	0.48*	0.58*	0.74*	0.47*	0.57*	0.46*	0.47*	0.43*	0.44*
2. Age	49.18 (13.24)	–	0.40*	–0.04	–0.16	0.05	–0.21	0.01	–0.06	–0.07	–0.06	–0.26	–0.11	–0.05	–0.13	–0.14
3. T1 IPV	3.30 (0.88)	–	–	0.21	–0.10	–0.27	0.08	0.27	0.12	0.25	0.10	0.19	0.04	0.15	–0.04	–0.01
4. MST	60.6% (20)	–	–	–	0.27	0.29	0.52*	0.41*	0.30	0.46*	0.44*	0.31	0.28	0.24	0.28	0.28
5. Combat	21.2% (7)	–	–	–	–	0.24	0.34	0.18	0.24	0.21	0.25	0.07	0.34	0.26	0.35	0.36*
6. Race: Non-White	48.5% (16)	–	–	–	–	–	0.34	0.09	0.05	0.24	0.06	0.04	–0.15	–0.27	0.09	–0.05
7. Probable T1 PTSD	39.4% (13)	–	–	–	–	–	–	0.64*	0.57*	0.68*	0.67*	0.55*	0.35*	0.23	0.38*	0.42*
8. T2 PTSD symptoms	23.18 (21.65)	–	–	–	–	–	–	–	0.83*	0.59*	0.83*	0.58*	0.49*	0.54*	0.44*	0.41*
9. T2 Depression symptoms	20.36 (13.67)	–	–	–	–	–	–	–	–	0.66*	0.81*	0.60*	0.39*	0.45*	0.35	0.31
10. T2 Insomnia symptoms	10.61 (6.35)	–	–	–	–	–	–	–	–	–	0.51*	0.68*	0.27	0.28	0.23	0.26
11. T2 Anxiety symptoms	8.91 (9.67)	–	–	–	–	–	–	–	–	–	–	0.67*	0.58*	0.60*	0.55*	0.53*
12. T2 Physical health symptoms	11.28 (6.83)	–	–	–	–	–	–	–	–	–	–	–	0.32	0.39*	0.27	0.27
13. T2 Total Past-Year IPV	41.18 (97.47)	–	–	–	–	–	–	–	–	–	–	–	–	0.94*	0.98*	0.97*
14. T2 Past-Year Psychological IPV	18.18 (36.12)	–	–	–	–	–	–	–	–	–	–	–	–	–	0.87*	0.84*
15. T2 Past-Year Physical IPV	13.15 (37.59)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.98*
16. T2 Past-Year Sexual IPV	9.85 (27.44)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

* $p < .05$; TBI w/persistent symptoms = IPV-related Traumatic Brain Injury with persistent symptoms; IPV = Intimate Partner Violence; MST = Military Sexual Trauma, Combat = Combat exposure; PTSD = Posttraumatic Stress Disorder.

3.2. Regressions controlling for significant demographic and military-related covariates

Next, we regressed T2 outcomes on persistent and non-persistent IPV-related TBI symptoms, while controlling for MST. Results are shown in Table 3. When controlling for MST history, women with persistent IPV-related TBI symptoms reported higher (worse) levels of each outcome at T2 than did women without persistent symptoms. Squared semi-partial correlations indicate the unique effects attributed to each predictor. Specifically, having persistent IPV-related TBI symptoms was associated with increased symptoms of: PTSD ($sr^2 = 0.119$), depression ($sr^2 = 0.253$), insomnia ($sr^2 = 0.365$), anxiety ($sr^2 = 0.105$), and physical health problems ($sr^2 = 0.238$), compared to not having persistent IPV-related TBI symptoms. In addition, having persistent IPV-related TBI symptoms were associated with increased levels of total past-year IPV experiences ($sr^2 = 0.147$), as well as each subtype of IPV (i.e., psychological: $sr^2 = 0.163$, physical: $sr^2 = 0.120$, and sexual: $sr^2 = 0.128$), compared to women who did not have persistent IPV-related TBI symptoms. MST was not significantly associated with any T2 outcome when IPV-related TBI with persistent symptoms status was included in the model.

3.3. Regressions controlling for significant time 1 covariates

Finally, to determine whether differences among those with and without persistent IPV-related TBI symptoms remained when controlling for T1 probable PTSD status, we regressed T2 outcomes on persistent and non-persistent IPV-related TBI symptoms, while controlling for both T1 probable PTSD status and MST. Results are shown in Table

Table 3.

Linear regressions predicting Time 2 outcomes from Time 1 TBI status, controlling for Military Sexual Trauma (MST).

T2 outcome	β	t	p	sr^2
<i>PTSD Symptoms (F = 6.01, p = .006, Adjusted R² = 0.238)</i>				
MST ^a	0.26	1.54	0.133	0.057
TBI w/persistent symptoms ^b	0.38	2.24	0.033	0.119
<i>Depression Symptoms (F = 7.90, p = .002, Adjusted R² = 0.301)</i>				
MST	0.09	0.54	0.596	0.006
TBI w/persistent symptoms	0.55	3.40	0.002	0.253
<i>Insomnia Symptoms (F = 20.08, p < .001, Adjusted R² = 0.544)</i>				
MST	0.19	1.50	0.145	0.032
TBI w/persistent symptoms	0.66	5.06	<0.001	0.365
<i>Anxiety Symptoms (F = 6.26, p = .005, Adjusted R² = 0.247)</i>				
MST	0.30	1.77	0.087	0.073
TBI w/persistent symptoms	0.35	2.11	0.043	0.105
<i>Physical Health Symptoms (F = 7.45, p = .002, Adjusted R² = 0.287)</i>				
MST	0.10	0.59	0.557	0.008
TBI w/persistent symptoms	0.53	3.27	0.003	0.238
<i>Total Past-Year IPV (F = 4.31, p = .023, Adjusted R² = 0.172)</i>				
MST	0.11	0.63	0.536	0.010
TBI w/persistent symptoms	0.42	2.39	0.023	0.147
<i>Past-Year Psychological IPV (F = 4.27, p = .023, Adjusted R² = 0.170)</i>				
MST	0.07	0.38	0.706	0.003
TBI w/persistent symptoms	0.44	2.51	0.018	0.163
<i>Past-Year Physical IPV (F = 3.66, p = .038, Adjusted R² = 0.143)</i>				
MST	0.13	0.71	0.482	0.014
TBI w/persistent symptoms	0.38	2.11	0.043	0.120
<i>Past-Year Sexual IPV (F = 3.94, p = .030, Adjusted R² = 0.155)</i>				
MST	0.13	0.72	0.475	0.014
TBI w/persistent symptoms	0.39	2.20	0.035	0.128

Bolded results are significant at $p < .05$. sr^2 refers to the squared semi-partial correlation. PTSD = Posttraumatic Stress Disorder; MST = Military Sexual Trauma; TBI = Traumatic Brain Injury; IPV = Intimate Partner Violence.

^a Reference = No history of MST.

^b Reference = IPV-related TBI without persistent symptoms.

4. With respect to the mental and physical health outcomes, whereas MST was not significantly associated with T2 outcomes, probable T1 PTSD was significantly associated with each mental health outcome at T2. In the presence of these variables, the presence of persistent IPV-related TBI symptoms remained significantly and uniquely associated with higher symptoms of depression ($sr^2 = 0.124$), insomnia ($sr^2 = 0.201$), and physical health problems ($sr^2 = 0.253$), but was not significantly associated with symptoms of PTSD ($sr^2 = 0.031$) or anxiety ($sr^2 = 0.021$). In addition, women who reported persistent IPV-related TBI symptoms at T1 reported significantly higher past-year psychological IPV at T2 ($sr^2 = 0.150$). However, the presence of persistent IPV-related TBI symptoms was not significantly associated with levels of T2 physical ($sr^2 = 0.069$), sexual ($sr^2 = 0.067$), or overall T2 IPV ($sr^2 = 0.101$), though the latter approached significance ($p = .06$), likely driven by the significant psychological IPV result.

4. Discussions

This study furthers our understanding of the psychosocial health correlates of IPV-related TBI. In our sample of women Veterans, we found that women who reported IPV-related TBI with persistent

Table 4.

Linear regressions predicting Time 2 outcomes from Time 1 TBI status, controlling for Military Sexual Trauma (MST) and Time 1 probable PTSD status.

T2 outcome	β	t	p	sr^2
<i>PTSD Symptoms (F = 7.71, p = .001, Adjusted R² = 0.386)</i>				
MST ^a	0.65	0.39	0.699	0.003
Probable T1 PTSD ^b	0.50	2.87	0.008	0.158
TBI w/persistent symptoms ^c	0.21	1.28	0.211	0.031
<i>Depression Symptoms (F = 7.81, p = .001, Adjusted R² = 0.390)</i>				
MST	-0.07	-0.43	0.673	0.004
Probable T1 PTSD	0.40	2.31	0.028	0.102
TBI w/persistent symptoms	0.41	2.55	0.016	0.124
<i>Insomnia Symptoms (F = 19.77, p < .001, Adjusted R² = 0.638)</i>				
MST	0.04	0.31	0.756	0.001
Probable T1 PTSD	0.40	2.96	0.006	0.099
TBI w/persistent symptoms	0.52	4.21	<0.001	0.201
<i>Anxiety Symptoms (F = 8.99, p < .001, Adjusted R² = 0.428)</i>				
MST	0.08	0.52	0.607	0.004
Probable T1 PTSD	0.55	3.24	0.003	0.187
TBI w/persistent symptoms	0.17	1.08	0.290	0.021
<i>Physical Health Symptoms (F = 6.99, p < .001, Adjusted R² = 0.360)</i>				
MST	-0.05	-0.29	0.774	0.002
Probable T1 PTSD	0.37	2.10	0.045	0.088
TBI w/persistent symptoms	0.40	2.45	0.021	0.120
<i>Total Past-Year IPV (F = 2.98, p = .048, Adjusted R² = 0.156)</i>				
MST	0.06	0.29	0.775	0.002
Probable T1 PTSD	0.14	0.68	0.504	0.012
TBI w/persistent symptoms	0.37	1.96	0.060	0.101
<i>Past-Year Psychological IPV (F = 2.77, p = .060, Adjusted R² = 0.142)</i>				
MST	0.08	0.42	0.679	0.005
Probable T1 PTSD	-0.04	-0.18	0.855	0.001
TBI w/persistent symptoms	0.453	2.37	0.025	0.150
<i>Past-Year Physical IPV (F = 2.77, p = .060, Adjusted R² = 0.143)</i>				
MST	0.05	0.24	0.813	0.002
Probable T1 PTSD	0.21	1.00	0.325	0.027
TBI w/persistent symptoms	0.31	1.60	0.119	0.069
<i>Past-Year Sexual IPV (F = 3.23, p = .037, Adjusted R² = 0.173)</i>				
MST	0.03	0.14	0.889	0.001
Probable T1 PTSD	0.26	1.28	0.211	0.042
TBI w/persistent symptoms	0.30	1.61	0.119	0.067

Bolded results are significant at $p < .05$. sr^2 refers to the squared semi-partial correlation. PTSD = Posttraumatic Stress Disorder; T1 = Time 1; MST = military sexual trauma; TBI = Traumatic Brain Injury; IPV = Intimate Partner Violence.

^a Reference = No history of MST.

^b Reference = Probable PTSD Status at T1.

^c Reference = IPV-related TBI without persistent symptoms.

symptoms at T1 reported higher mental and physical health difficulties, as well as more recent IPV, at T2 compared to women with IPV-related TBI without persistent symptoms. When adjusting for the contributions of MST and T1 probable PTSD, IPV-related TBI with persistent symptoms continued to be associated with more severe symptoms of depression, insomnia, and physical health problems 1.5 years later. To our knowledge, this is the first examination of whether persistent IPV-related TBI symptoms are associated with women's future psychosocial health and relationship experiences. Results extend prior work by furthering our understanding of the health impacts of IPV in an understudied yet rapidly growing population—women Veterans—while accounting for possible confounding factors [50–53].

Previous literature among populations of women with IPV-related TBI demonstrates associations between TBI with physical health conditions (e.g., gastrointestinal disorders) and psychiatric symptoms (e.g., affective and mood disorders) [27]. The current study furthers this knowledge base by demonstrating worse health status across domains of depression, sleep, and physical health among women Veterans experiencing IPV-related TBI with persistent symptoms, while accounting for potential confounding factors, such as MST and PTSD. Understanding the relationship between IPV-related TBI and health symptoms is important for providers who see women that present with these issues (e.g., depressive symptoms, chronic pain, sleep disturbances). Awareness of IPV-related TBI with persistent symptoms and its association with future physical and mental health may cue providers to inquire about IPV-related TBI with persistent symptoms among women who experience recent or past IPV. TBI screening tools, such as the one used in this study, and a more comprehensive IPV-related TBI evaluation that captures context, allows patients to detail head and other bodily injuries, and includes a checklist for documenting immediate and current post-injury symptoms, could be developed for women who experience IPV. Discussion of such symptoms would help providers better understand women's current physical and mental health needs to inform diagnosis and course of treatment. It is possible that some of the associations observed between T1 IPV-related TBI with persistent symptoms represent non-recovery from the TBI. It is also possible that persistent symptoms following TBI may contribute to other behaviors or experiences that maintain or exacerbate depressive symptoms, insomnia and physical health problems. That associations between IPV-related TBI with persistent symptoms continues to be associated with some T2 psychosocial problems after adjusting for T1 PTSD suggests that PTSD symptoms are not necessarily mediating the associations observed. This finding is consistent with research suggesting that an association independent of PTSD exists for deployment-related TBI and health symptoms among women veterans [33].

When adjusting for MST, a known predictor of past-year IPV among women Veterans [51–53], persistent IPV-related TBI symptoms were associated with higher overall past-year IPV, as well as each type of IPV (physical, sexual, and psychological). When controlling for T1 PTSD, however, persistent IPV-related TBI symptoms continued to be associated with increased levels of T2 psychological IPV experiences, but not with T2 physical or sexual IPV experiences. IPV-related TBI and PTSD have both been independently implicated in increasing risk for IPV experiences among women [28,54–56]. It is possible that the presence of TBI history alone, rather than the distinction between those with and without persistent symptoms, influences future physical and sexual IPV risk. It is also possible that an unmeasured variable, such as avoidance coping [57] may mediate associations between both health variables and past-year IPV, which may explain the lack of significance between persistent IPV-related TBI and IPV victimization in the adjusted model. Given that IPV-related TBI remained marginally associated with overall IPV experiences in the adjusted model, it is also possible that our small sample size precluded detection of associations in the adjusted model.

Findings from these studies underscore the importance of implementing case finding (i.e., inquiry based on symptom profiles or

clinical suspicion) or routine screening practices (i.e., screen all women who report lifetime IPV) for IPV-related TBI in women seen in mental health and primary care clinics. Failure to detect IPV-related TBI with persistent symptoms precludes access to appropriate care, perpetuates misdiagnosis, and prolongs suffering in women experiencing IPV [58]. Some healthcare settings, including VHA, screen for IPV based on national recommendations [59]; however, this is not universal. Furthermore, current healthcare-based screenings for IPV do not include items that assess for TBI stemming from IPV. This lack of crossover between IPV and TBI detection is equally apparent in TBI screeners, as existing screeners typically do not assess for IPV as an etiology of head injury [60]. IPV-related TBI screens should include prompts relevant to events that can result in TBI in this population (e.g., “Has a partner ever hit you in the head with an object, hand, or fist?”), allow for safe and private disclosure of IPV experiences, and should be easy to administer by IPV-knowledgeable staff [60]. The current study's findings extend support for the potential validity of the modified VA TBI screening tool for use in detecting IPV-related TBI history with and without current symptoms. Based on the results of the present study, assessing for the persistence of symptoms could be critical, given the suggested associations of IPV-related TBI with negative psychological and physical health. It is important that IPV-related TBI screening and follow-up conversations are trauma-informed, and when appropriate, include referrals for further assessment and intervention [22].

The data suggest that it may be important that women presenting with an IPV-related TBI, particularly those with persistent symptoms, also be evaluated for additional psychological distress and physical health concerns which may warrant treatment. To date, there is no multimodal intervention that addresses the complexity of IPV-related TBIs and all commonly co-occurring mental health (e.g., depression, PTSD) or physical health (e.g., chronic pain, nausea) symptoms [61]. However, there may be opportunities to integrate existing evidence-based therapies that have been found to be effective in treating PTSD and depression in the IPV population with interventions targeting the sequelae of TBI. For instance, some current interventions appropriate for IPV survivors with comorbid psychiatric distress (e.g., depression and PTSD) include a host of cognitive behavioral therapies, psychoeducation, and referrals to IPV community-based organizations [62,63]. Furthermore, effective mental health treatments can have the added benefit of improving women's sleep and overall physical health [63]. Psychoeducation on post-concussive symptoms and resource provision are also part of interventions for TBI [64,65]. For the women Veteran population, there are specialized services available in VHA to address IPV and TBI, including comprehensive TBI evaluation programs that are increasingly addressing TBI from IPV [66], and interventions for IPV in development that are personalized, patient-centered [67], and lend themselves to addressing follow-up care pertaining to IPV-related TBI.

This study has several limitations. The small sample size limited our power to observe significant associations between IPV-related TBI status and some of the outcome variables in the models adjusting for both MST and T1 PTSD, particularly given the modest effect sizes of IPV-related TBI status on some of these constructs. Moreover, the small sample size precluded us from evaluating the interactions between IPV-related TBI, MST, and health outcomes. Replication among larger samples is needed. This study only assessed IPV-related TBI at T1. It is unknown whether women may have experienced additional TBIs or other injuries prior to T1 or between the T1 and T2 surveys. Moreover, we were not able to determine the severity of TBIs reported in this sample. Women who suffered moderate or severe TBIs (as opposed to mild) may be more likely to experience persistent symptoms. More detailed information, including severity of TBIs as well as frequency of head blows and other physical injuries, is important to examine in future research. Use of semi-structured interviews, such as the Boston Assessment of Traumatic Brain Injury-Lifetime and the Brain Injury Severity Assessment Interview, could be useful in this regard [68,69].

Given the small sample size, we were unable to differentiate between probable TBIs resulting from blows to the head versus strangulation-related anoxic/hypoxic injuries. Although strangulation is commonly considered a source of brain injuries in the IPV literature [22,70], we recognize that it is not typically considered a source of TBI in other clinical and research contexts.

With the exception of PTSD and IPV-related TBI screeners, the T1 survey did not include other measures of psychosocial health. Thus, the physical and mental health symptoms examined in this study were assessed only at T2. We therefore could not examine the potential effects of T1 physical and mental health symptoms on T2 outcomes. Associations should not be considered causal. All data was collected via self-report. Although all the outcome measures are validated, the reliance on self-report measures for all of the variables examined in this study raises concerns of shared-method variance. The TBI screener is a modified version of the VHA screener for deployment-related TBI [37]. The psychometric properties of the IPV-related TBI tool used in the current study have not been evaluated. As such, these head injuries should be considered probable IPV-related TBIs. Future research should include more comprehensive and multi-source assessments, including clinical TBI and psychiatric interviews conducted by a trained professional. Findings should be replicated with samples of women in the community and clinical/help-seeking settings.

4.1. Conclusions

IPV-related TBI is a complex and pervasive public health problem impacting numerous women. Understanding the mental and physical distress that accompanies an IPV-related TBI with persistent symptoms can inform screening procedures, interventions, and linkages to comprehensive follow-up care across health and social services. Given that IPV-related TBI is often a “silent injury”, it is critical for providers be knowledgeable of this treatable health issue.

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Declaration of Competing Interest

The authors have no disclosures or conflicts of interest to report.

References

- [1] Hoge CW, McGurk D, Thomas JL, Cox AL, Engel CC, Castro CA. Mild traumatic brain injury in U.S. soldiers returning from Iraq. *New England Journal of Medicine* 2008;359(5):453–63. <https://doi.org/10.1056/NEJMoa072972>. Hoge CW, McGurk D, Thomas JL, Cox AL, Engel CC, & Castro CA. Mild traumatic brain injury in U.S. Soldiers returning from Iraq. *New England Journal of Medicine* 2008;359(5):453–463. doi: 10.1056/NEJMoa072972.
- [2] Seal KH, Bertenthal D, Samuelson K, Maguen S, Kumar S, Vasterling JJ. Association between mild traumatic brain injury and mental health problems and self-reported cognitive dysfunction in Iraq and Afghanistan veterans. *J Rehabil Res Dev* 2016;53:185–98. Seal KH, Bertenthal D, Samuelson K, Maguen S, Kumar S, & Vasterling JJ. Association between mild traumatic brain injury and mental health problems and self-reported cognitive dysfunction in Iraq and Afghanistan Veterans. *Journal of Rehabilitation Research and Development* 2016;53:185–198.
- [3] Vasterling JJ, Brailey K, Proctor SP, Kane R, Heeren T, Franz M. Neuropsychological outcomes of mild traumatic brain injury, post-traumatic stress disorder and depression in Iraq-deployed US Army soldiers. *Br J Psychiatry* 2012;201:186–92. Vasterling JJ, Brailey K, Proctor SP, Kane R, Heeren T, Franz M. Neuropsychological outcomes of mild traumatic brain injury, post-traumatic stress disorder and depression in Iraq-deployed US Army soldiers. *British Journal of Psychiatry* 2012;201:186–192.
- [4] Department of Defense. VA/DoD clinical practice guideline for the Management of Concussion- Mild Traumatic Brain Injury; 2016. Department of Defense. VA/DoD Clinical Practice Guideline for the Management of Concussion- Mild Traumatic Brain Injury. 2016.
- [5] Defense and Veterans Brain Injury Center. DoD Worldwide Numbers for TBI. Accessed August 2018;29:2018. Defense and Veterans Brain Injury Center. DoD Worldwide Numbers for TBI 2018; Accessed August 29, 2018.
- [6] Cassidy JD, Carroll L, Peloso P, Borg J, Von Holst H, Holm L, et al. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of Rehabil Med* 2004;36:28–60. Cassidy JD, Carroll L, Peloso P, Borg J, Von Holst H, Holm L, ... Coronado V. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of Rehabil Med* 2004;36:28–60.
- [7] Frieden TR. Report to congress on traumatic brain injury in the United States: understanding the public health problem among current and former military personnel; 2013. Frieden TR. Report to Congress on Traumatic Brain Injury in the United States: Understanding the Public Health Problem among Current and Former Military Personnel. 2013.
- [8] Amara JH, Stolzmann KL, Iverson KM, Pogoda TK. Predictors of employment status in male and female post-9/11 veterans evaluated for traumatic brain injury. *J Head Trauma Rehabil* 2019;34:11–20. Amara JH, Stolzmann KL, Iverson KM, Pogoda TK. Predictors of employment status in male and female post-9/11 veterans evaluated for traumatic brain injury. *J Head Trauma Rehabil* 2019;34:11–20.
- [9] Carlson KF, Nelson D, Orazem RJ, Nugent S, Cifu DX, Sayer NA. Psychiatric diagnoses among Iraq and Afghanistan war veterans screened for deployment-related traumatic brain injury. *J Trauma Stress* 2010;23:17–24. <https://doi.org/10.1002/jts.20483>. Carlson KF, Nelson D, Orazem RJ, Nugent S, Cifu DX, & Sayer NA. Psychiatric diagnoses among Iraq and Afghanistan war veterans screened for deployment-related traumatic brain injury. *J Trauma Stress* 2010;23:17–24. doi: 10.1002/jts.20483.
- [10] Daneshvar DH, Riley DO, Nowinski CJ, McKee AC, Stern RA, Cantu RC. Long-term consequences: effects on normal development profile after concussion. *Phys Med Rehabil Clin N Am* 2011;22:683–700. <https://doi.org/10.1016/j.pmr.2011.08.009>. Daneshvar DH, Riley DO, Nowinski CJ, McKee AC, Stern RA, & Cantu RC. Long-term consequences: Effects on normal development profile after concussion. *Phys Med Rehabil Clin N Am* 2011;22:683–700. doi: 10.1016/j.pmr.2011.08.009.
- [11] Gradus JL, Wisco BE, Luciano MT, Iverson KM, Marx BP, Street AE. Traumatic brain injury and suicidal ideation among U.S. operation enduring freedom and operation Iraqi freedom veterans. *J Trauma Stress* 2015;28:361–5. <https://doi.org/10.1002/jts.22021>. Gradus JL, Wisco BE, Luciano MT, Iverson KM, Marx BP, & Street AE. Traumatic brain injury and suicidal ideation among U.S. Operation Enduring Freedom and Operation Iraqi Freedom veterans. *J Trauma Stress* 2015;28:361–5. doi: 10.1002/jts.22021.
- [12] Lippa SM, Fonda JR, Fortier CB, Amick MA, Kenna A, Milberg WP, et al. Deployment-related psychiatric and behavioral conditions and their association with functional disability in OEF/OIF/OND veterans. *J Trauma Stress* 2015;28:25–33. <https://doi.org/10.1002/jts.21979>. Lippa SM, Fonda JR, Fortier CB, Amick MA, Kenna A, Milberg WP, & McGlinchey R E. Deployment-related psychiatric and behavioral conditions and their association with functional disability in OEF/OIF/OND Veterans. *J Trauma Stress* 2015;28:25–33. doi: 10.1002/jts.21979.
- [13] Yee M, Janulewicz P, Seichepine D, Sullivan K, Proctor S, Kregel M. Multiple mild traumatic brain injuries are associated with increased rates of health symptoms and gulf war illness in a cohort of 1990–1991 Gulf War veterans. *Brain Sci* 2017;7:79. <https://doi.org/10.3390/brainsci7070079>. Yee M, Janulewicz P, Seichepine D, Sullivan K, Proctor S, & Kregel M. Multiple mild traumatic brain injuries are associated with increased rates of health symptoms and gulf war illness in a cohort of 1990–1991 Gulf War veterans. *Brain Sciences* 2017;7:79. doi: 10.3390/brainsci7070079.
- [14] Defense Manpower Data Center. Table of Active Duty Females by Rank/Grade and Service. Alexandria, VA; DMDC 2018.
- [15] Women Veterans Health Strategic Health Care Group, Department of Veterans Affairs. A profile of women veterans today; 2012. Women Veterans Health Strategic Health Care Group, Department of Veterans Affairs. A Profile of Women Veterans Today. 2012.
- [16] Amara JH, Pogoda TK, Kregel M, Iverson KM, Baker E, Hendricks A. Determinants of utilization and cost of VHA care by OEF/OIF veterans screened for mild traumatic brain injury. *Mil Med* 2014;179:964–72. <https://doi.org/10.7205/MILMED-D-13-00559>. Amara JH, Pogoda TK, Kregel M, Iverson KM, Baker E, & Hendricks A. Determinants of utilization and cost of VHA care by OEF/OIF veterans screened for mild traumatic brain injury. *Military Medicine* 2014;179:964–972. doi: 10.7205/MILMED-D-13-00559.
- [17] Amoroso T, Iverson KM. Acknowledging the risk for traumatic brain injury in women veterans. *J Nerv Ment Dis* 2017;205:318–23. <https://doi.org/10.1097/nmd.0000000000000621>. Amoroso T, & Iverson KM. Acknowledging the risk for traumatic brain injury in women veterans. *J Nerv Ment Dis* 2017;205:318–323. doi: 10.1097/nmd.0000000000000621.
- [18] Gerber MR, Iverson KM, Dichter ME, Klap R, Latta RE. Women veterans and intimate partner violence: current state of knowledge and future directions. *J Womens Health* 2014;23:302–9. <https://doi.org/10.1089/jwh.2013.4513>. Gerber MR, Iverson KM, Dichter ME, Klap R & Latta RE. Women veterans and intimate partner violence: Current state of knowledge and future directions. *J Women's Health* 2014;23:302–9. doi: 10.1089/jwh.2013.4513.
- [19] Dichter ME, Cerulli C, Bossarte RM. Intimate partner violence victimization among women veterans and associated heart health risks. *Womens Health Issues* 2011;21:190–4. <https://doi.org/10.1016/j.whi.2011.04.008>. Dichter ME, Cerulli C & Bossarte RM. Intimate partner violence victimization among women veterans and associated heart health risks. *Women's Health Issues* 2011;21:190–4. doi: 10.1016/j.whi.2011.04.008.

- [20] Dichter ME, Wagner C, True G. Timing of intimate partner violence in relationship to military service. *Mil Med* 2015;180:1124–7. Dichter ME, Wagner C, & True G. Timing of intimate partner violence in relationship to military service. *Military Medicine* 2015;180:1124–7.
- [21] Banks ME. Overlooked but critical: traumatic brain injury as a consequence of interpersonal violence. *Trauma Violence Abuse* 2017;8:290–8. <https://doi.org/10.1177/1524838007303503>. Banks ME. Overlooked but critical: Traumatic brain injury as a consequence of interpersonal violence. *Trauma, Violence, & Abuse* 2017;8:290–8. doi: 10.1177/1524838007303503.
- [22] Valera EM, Campbell J, Gill J, Iverson KM. Correlates of brain injuries in women subjected to intimate partner violence: identifying the dangers and raising awareness. *J of Aggression, Maltreatment & Trauma* 2019 (Online First). Valera EM, Campbell J, Gill J, Iverson KM. Correlates of Brain Injuries in Women Subjected to Intimate Partner Violence: Identifying the Dangers and Raising Awareness. *J of Aggression, Maltreatment & Trauma* 2019. Online First.
- [23] Kwako LE, Glass N, Campbell J, Melvin KC, Barr T, Gill JM. Traumatic brain injury in intimate partner violence: a critical review of outcomes and mechanisms. *Trauma Violence Abuse* 2011;12:115–26. <https://doi.org/10.1177/1524838011404251>. Kwako LE, Glass N, Campbell J, Melvin KC, Barr T, & Gill JM. Traumatic brain injury in intimate partner violence: A critical review of outcomes and mechanisms. *Trauma, Violence, & Abuse* 2011;12:115–126. doi: 10.1177/1524838011404251.
- [24] Valera EM, Berenbaum H. Brain injury in battered women. *J Consult Clin Psychol* 2013;71:797–804. <https://doi.org/10.1037/0022-006x.71.4.797>. Valera EM, & Berenbaum H. Brain injury in battered women. *J Consult Clin Psychol* 2013;71:797–804. doi: 10.1037/0022-006x.71.4.797.
- [25] Monahan K. Intimate partner violence, traumatic brain injury, and social work: moving forward. *Soc Work* 2018;63:179–81. <https://doi.org/10.1093/sw/swy005>. Monahan K. Intimate partner violence, traumatic brain injury, and social work: Moving forward. *Social Work* 2018;63:179–181. doi: 10.1093/sw/swy005.
- [26] Murray CE, Lundgren K, Olson LN, Hunnicutt G. Practice Update. *Trauma Violence Abuse* 2015;17:298–305. <https://doi.org/10.1177/1524838015584364>. Murray CE, Lundgren K, Olson LN, & Hunnicutt G. Practice Update. *Trauma, Violence, & Abuse* 2015;17:298–305. doi: 10.1177/1524838015584364.
- [27] St Ivany A, Schminkey D. Intimate partner violence and traumatic brain injury: state of the science and next steps. *Fam Community Health* 2016;39:129–37. <https://doi.org/10.1097/FCH.0000000000000094>. St Ivany A, & Schminkey D. Intimate partner violence and traumatic brain injury: State of the science and next steps. *Fam Community Health* 2016;39:129–137. doi: 10.1097/FCH.0000000000000094.
- [28] Iverson KM, Pogoda TK. Traumatic brain injury among women veterans: an invisible wound of intimate partner violence. *Med Care* 2015;53:112–9. <https://doi.org/10.1097/mlr.0000000000000263>. Iverson KM, & Pogoda TK. Traumatic brain injury among women veterans: an invisible wound of intimate partner violence. *Medical Care* 2015;53:112–9. doi: 10.1097/mlr.0000000000000263.
- [29] Iverson KM, Dardis CM, Pogoda TK. Traumatic brain injury and PTSD symptoms as a consequence of intimate partner violence. *Compr Psychiatry* 2017;74:80–7. <https://doi.org/10.1016/j.comppsy.2017.01.007>. Iverson KM, Dardis CM, & Pogoda TK. Traumatic brain injury and PTSD symptoms as a consequence of intimate partner violence. *Compr Psychiatry* 2017;74:80–7. doi: 10.1016/j.comppsy.2017.01.007.
- [30] Belanger HG, Kretzmer T, Vanderploeg RD, French LM. Symptom complaints following combat-related traumatic brain injury: relationship to traumatic brain injury severity and posttraumatic stress disorder. *Journal of the Int Neuropsychol Soc* 2010;16:194–9. <https://doi.org/10.1017/S1355617709990841>. Belanger HG, Kretzmer T, Vanderploeg RD, French LM. Symptom complaints following combat-related traumatic brain injury: relationship to traumatic brain injury severity and posttraumatic stress disorder. *Journal of the Int Neuropsychol Soc* 2010;16:194–9. doi: 10.1017/S1355617709990841.
- [31] Benge JF, Pastorek NJ, Thornton GM. Postconcussive symptoms in OEF–OIF veterans: factor structure and impact of posttraumatic stress. *Rehabil Psychol* 2009;54. <https://doi.org/10.1037/a0016736>. Benge JF, Pastorek NJ, & Thornton GM. Postconcussive symptoms in OEF–OIF veterans: Factor structure and impact of posttraumatic stress. *Rehabil Psychol* 2009;54. doi: 10.1037/a0016736.
- [32] Polusny MA, Kehle SM, Nelson NW, Erbes CR, Arbisi PA, Thurax P. Longitudinal effects of mild traumatic brain injury and posttraumatic stress disorder comorbidity on postdeployment outcomes in National Guard Soldiers Deployed to Iraq. *Arch Gen Psychiatry* 2011;68:79–89. <https://doi.org/10.1001/archgenpsychiatry.2010.172>. Polusny MA, Kehle SM, Nelson NW, Erbes CR, Arbisi PA, Thurax P. Longitudinal Effects of Mild Traumatic Brain Injury and Posttraumatic Stress Disorder Comorbidity on Postdeployment Outcomes in National Guard Soldiers Deployed to Iraq. *Arch Gen Psychiatry* 2011;68:79–89. doi: 10.1001/archgenpsychiatry.2010.172.
- [33] Iverson KM, Pogoda TK, Gradus JL, Street AE. Deployment-related traumatic brain injury among operation enduring freedom/operation Iraqi freedom veterans: associations with mental and physical health by gender. *J Womens Health* 2013;22:267–75. <https://doi.org/10.1089/jwh.2012.3755>. Iverson KM, Pogoda TK, Gradus JL, & Street AE. Deployment-related traumatic brain injury among Operation Enduring Freedom/Operation Iraqi Freedom veterans: Associations with mental and physical health by gender. *J Women's Health* 2013;22:267–275. doi: 10.1089/jwh.2012.3755.
- [34] Porter KE, Stein MB, Martis B, Avallone KM, McSweeney LB, Smith ER, et al. Postconcussive symptoms following combat-related traumatic brain injury (TBI) in veterans with posttraumatic stress disorder (PTSD): influence of TBI, PTSD, and depression on symptoms measured by the neurobehavioral symptom inventory (NSI). *J Psychiatr Res* 2018;102:8–13. <https://doi.org/10.1016/j.jpsychires.2018.03.004>. Porter KE, Stein MB, Martis B, Avallone KM, McSweeney LB, Smith ER, ... Rauch S. Postconcussive symptoms following combat-related traumatic brain injury (TBI) in Veterans with posttraumatic stress disorder (PTSD): Influence of TBI, PTSD, and depression on symptoms measured by the Neurobehavioral Symptom Inventory (NSI). *J Psychiatr Res* 2018;102:8–13. doi: 10.1016/j.jpsychires.2018.03.004
- [35] Iverson KM, Stirman SW, Street AE, Gerber MR, Carpenter SL, Dichter ME, et al. Female veterans' preferences for counseling related to intimate partner violence: informing patient-centered interventions. *Gen Hosp Psychiatry* 2016;40:33–8. Iverson KM, Stirman SW, Street AE, Gerber MR, Carpenter SL, Dichter, ME, Bair-Merritt MH, Vogt D. Female veterans' preferences for counseling related to intimate partner violence: Informing patient-centered interventions. *General Hospital Psychiatry* 2016;40:33–38.
- [36] GfK. Knowledge panel design summary. <http://www.gfk.com/Documents/GfK-KnowledgePanel-Design-Summary.pdf> 2013.
- [37] Donnelly KT, Donnelly JP, Dunnam M, Warner GC, Kittleson C, Constance JE, et al. Reliability, sensitivity, and specificity of the VA traumatic brain injury screening tool. *J Head Trauma Rehabil* 2011;26:439–53. <https://doi.org/10.1097/HTR.0b013e3182005de3>. Donnelly KT, Donnelly JP, Dunnam M, Warner GC, Kittleson C, Constance JE, ... Alt M. Reliability, sensitivity, and specificity of the VA traumatic brain injury screening tool. *J Head Trauma Rehabil* 2011;26:439–453. doi: 10.1097/HTR.0b013e3182005de3.
- [38] Sohal H, Eldridge S, Feder G. The sensitivity and specificity of four questions (HARK) to identify intimate partner violence: a diagnostic accuracy study in general practice. *BMC Fam Pract* 2007;8:49. <https://doi.org/10.1186/1471-2296-8-49>. Sohal H, Eldridge S, & Feder G. The sensitivity and specificity of four questions (HARK) to identify intimate partner violence: A diagnostic accuracy study in general practice. *BMC Fam Pract* 2007;8:49. doi: 10.1186/1471-2296-8-49.
- [39] American Psychological Association. Diagnostic and statistical manual of mental disorders (DSM-5®). American Psychiatric Pub; 2013. American Psychological Association. Diagnostic and statistical manual of mental disorders (DSM-5®): American Psychiatric Pub. 2013.
- [40] Bovin MJ, Marx BP, Weathers FW, Gallagher MW, Rodriguez P, Schnurr PP, et al. Psychometric properties of the PTSD checklist for diagnostic and statistical manual of mental disorders—fifth edition (PCL-5) in veterans. *Psychol Assess* 2016;28:1379–91. <https://doi.org/10.1037/pas0000254>. Bovin MJ, Marx BP, Weathers FW, Gallagher MW, Rodriguez P, Schnurr PP, & Keane TM. Psychometric Properties of the PTSD Checklist for Diagnostic and Statistical Manual of Mental Disorders—Fifth Edition (PCL-5) in Veterans. *Psychological Assessment* 2016;28:1379–1391. doi: 10.1037/pas0000254.
- [41] Weathers FW, Litz BT, & Keane TM. The PTSD checklist for DSM-5 (PCL-5). from <http://www.ptsd.va.gov>. 2013.
- [42] Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *Am J Prev Med* 1994;10(2):77–84. [https://doi.org/10.1016/S0749-3797\(18\)30622-6](https://doi.org/10.1016/S0749-3797(18)30622-6). Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *Am J Prev Med* 1994, 10(2):77–84. [https://doi.org/10.1016/S0749-3797\(18\)30622-6](https://doi.org/10.1016/S0749-3797(18)30622-6)
- [43] Bjorgvinsson T, Kertz SJ, Bigda-Peyton JS, McCoy KL, Aderka IM. Psychometric properties of the CES-D-10 in a psychiatric sample. *Assessment* 2013;20(4):429–36. <https://doi.org/10.1177/1073191113481998>. Bjorgvinsson T, Kertz SJ, Bigda-Peyton JS, McCoy KL, Aderka IM. Psychometric properties of the CES-D-10 in a psychiatric sample. *Assessment* 2013, 20(4):429–36. <https://doi.org/10.1177/1073191113481998>
- [44] Bastien CH, Vallieres A, Morin CM. Validation of the insomnia severity index as an outcome measure for insomnia research. *Sleep Med* 2001;2:297–307. Bastien CH, Vallieres A, & Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Med* 2001;2:297–307.
- [45] Lovibond PF, Lovibond SH. The structure of negative emotional states: comparison of the depression anxiety stress scales (DASS) with the Beck Depression and Anxiety Inventories. *Behav Res Ther* 1995;33:335–43. Lovibond PF, & Lovibond SH. The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behav Res Ther* 1995;33:335–343.
- [46] Mitchell MC, Burns NR, Dorstyn DS. Screening for depression and anxiety in spinal cord injury with DASS-21. *Spinal Cord* 2007;46:547–51. <https://doi.org/10.1038/sj.sc.3102154>. Mitchell MC, Burns NR, & Dorstyn DS. Screening for depression and anxiety in spinal cord injury with DASS-21. *Spinal Cord* 2007;46:547–551. doi:10.1038/sj.sc.3102154.
- [47] Kroenke K, Spitzer RL, Williams JB. The PHQ-15: validity of a new measure for evaluating the severity of somatic symptoms. *Psychosom Med* 2002;64:258–66. Kroenke K, Spitzer RL, & Williams JB. The PHQ-15: validity of a new measure for evaluating the severity of somatic symptoms. *Psychosom Med* 2002;64:258–266.
- [48] Straus MA, Hamby SL, Boney-McCoy S, Sugarman DB. The revised conflict tactics scale (CTS2): development and preliminary psychometric data. *J Fam Issues* 1996;17:283–316. <https://doi.org/10.1177/019251396017003001>. Straus MA, Hamby SL, Boney-McCoy S, & Sugarman DB. The revised conflict tactics scale (CTS2): Development and preliminary psychometric data. *J Fam Issues* 1996;17:283–316. doi:10.1177/019251396017003001.
- [49] Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J R Stat Soc B Methodol* 1995;57(1):289–300. Benjamini Y., & Hochberg Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal statistical society: series B (Methodological)*, 57(1), 289–300.
- [50] Dichter ME, Butler A, Bellamy S, Medvedeva E, Roberts CB, Iverson KM. Disproportionate mental health burden associated with past-year intimate partner violence among women receiving care in the veterans health administration. *J Trauma Stress* 2017(6):555–63. <https://doi.org/10.1002/jts.22241>. Dichter ME, Butler A, Bellamy S, Medvedeva E, Roberts CB, & Iverson KM. Disproportionate mental health burden associated with past-year intimate partner violence among women receiving care in

- the Veterans Health Administration. *J Trauma Stress* 2017;6:555–563. doi: 10.1002/jts.22241.
- [51] Iverson KM, Mercado R, Carpenter SL, Street AE. Intimate partner violence among women veterans: previous interpersonal violence as a risk factor. *J Trauma Stress* 2013;26:767–71. <https://doi.org/10.1002/jts.21867>. Iverson KM, Mercado R, Carpenter SL, & Street AE. Intimate partner violence among women veterans: Previous interpersonal violence as a risk factor. *J Trauma Stress* 2013;26:767–771. doi: 10.1002/jts.21867.
- [52] Kimerling R, Street AE, Pavao J, Smith MW, Cronkite RC, Holmes TH, et al. Military-related sexual trauma among Veterans Health Administration patients returning from Afghanistan and Iraq. *Am J Public Health* 2010;100:1409–12. <https://doi.org/10.2105/AJPH.2009.171793>. Kimerling R, Street AE, Pavao J, Smith MW, Cronkite RC, Holmes TH, & Frayne SM. Military-related sexual trauma among Veterans Health Administration patients returning from Afghanistan and Iraq. *Am J Public Health* 2010;100:1409–1412. doi:10.2105/AJPH.2009.171793.
- [53] Dardis CM, Dichter ME, Iverson KM. Empowerment, PTSD and revictimization among women who have experienced intimate partner violence. *Psychiatry Res* 2018;266:103–10. <https://doi.org/10.1016/j.psychres.2018.05.034>. Dardis CM, Dichter ME, & Iverson KM. Empowerment, PTSD and revictimization among women who have experienced intimate partner violence. *Psychiatry Res* 2018; 266:103–110. doi: 10.1016/j.psychres.2018.05.034.
- [54] Iverson KM, Litwack SD, Pineles SL, Suvak MK, Vaughn RA, Resick PA. Predictors of intimate partner violence revictimization: the relative impact of distinct PTSD symptoms, dissociation, and coping strategies. *J Trauma Stress* 2013;26:102–10. <https://doi.org/10.1002/jts.21781>. Iverson KM, Litwack SD, Pineles SL, Suvak MK, Vaughn RA, & Resick PA. Predictors of intimate partner violence revictimization: The relative impact of distinct PTSD symptoms, dissociation, and coping strategies. *J Trauma Stress* 2013;26:102–110. doi: 10.1002/jts.21781.
- [55] Krause ED, Kaltman S, Goodman L, Dutton MA. Role of distinct PTSD symptoms in intimate partner reabuse: a prospective study. *J Trauma Stress* 2016;19:507–16. <https://doi.org/10.1002/jts.20136>. Krause ED, Kaltman S, Goodman L, & Dutton MA. Role of distinct PTSD symptoms in intimate partner reabuse: A prospective study. *J Trauma Stress* 2016;19:507–516. doi: 10.1002/jts.20136.
- [56] Fortier MA, DiLillo D, Messman-Moore TL, Peugh J, Denardi KA, Gaffey KJ. Severity of child sexual abuse and revictimization: the mediating role of coping and trauma symptoms. *Psychology of Women Quarterly* 2009;33:308–20. <https://doi.org/10.1111/j.1471-6402.2009.01503>. Fortier MA, DiLillo D, Messman-Moore TL, Peugh J, Denardi KA, & Gaffey KJ. Severity of child sexual abuse and revictimization: The mediating role of coping and trauma symptoms. *Psychology of Women Quarterly* 2009;33:308–320. doi: 10.1111/j.1471-6402.2009.01503.
- [57] Curry P, Ramaiah R, Vavilala MS. Current trends and update on injury prevention. *Int J Crit Illn Inj Sci* 2011;1:57–65. <https://doi.org/10.4103/2229-5151.79283>. Curry P, Ramaiah R, Vavilala MS. Current trends and update on injury prevention. *Int J Crit Illn Inj Sci* 2011;1:57–65. doi: 10.4103/2229-5151.79283.
- [58] Curry SJ, Krist AH, Owens DK, Barry MJ, Caughey AB, Wong JB. Screening for intimate partner violence, elder abuse, and abuse of vulnerable adults: US preventive services task force final recommendation statement. *JAMA* 2018;320:1678–87. <https://doi.org/10.1001/jama.2018.14741>. Curry SJ, Krist AH, Owens DK, Barry MJ, Caughey AB, ... Wong JB. Screening for Intimate Partner Violence, Elder Abuse, and Abuse of Vulnerable Adults: US Preventive Services Task Force Final Recommendation Statement. *JAMA* 2018;320:1678–1687. doi:10.1001/jama.2018.14741.
- [59] Goldin Y, Haag HL, Trott CT. Screening for history of traumatic brain injury among women exposed to intimate partner violence. *PM&R* 2016;8:1104–10. <https://doi.org/10.1016/j.pmrj.2016.05.006>. Goldin Y, Haag HL, & Trott CT. Screening for history of traumatic brain injury among women exposed to intimate partner violence. *PM&R* 2016;8:1104–1110. doi: 10.1016/j.pmrj.2016.05.006.
- [60] Jackson H, Philp E, Nuttall RL, Diller L. Traumatic brain injury: a hidden consequence for battered women. *Prof Psychol Res Pract* 2002;33:39–45. <https://doi.org/10.1037/0735-7028.33.1.39>. Jackson H, Philp E, Nuttall RL, & Diller L. Traumatic brain injury: A hidden consequence for battered women. *Professional Psychology: Research and Practice* 2002;33:39–45. doi:10.1037/0735-7028.33.1.39.
- [61] Bair-Merritt MH, Lewis-O'Connor A, Goel S, Amato P, Ismailji T, Jelley M, et al. Primary care-based interventions for intimate partner violence: a systematic review. *Am J Prev Med* 2014;46:188–94. <https://doi.org/10.1016/j.amepre.2013.10.001>. Bair-Merritt MH, Lewis-O'Connor A, Goel S, Amato P, Ismailji T, Jelley M. ... Cronholm P. Primary care-based interventions for intimate partner violence: A systematic review. *Am J Prev Med* 2014;46:188–194. doi:10.1016/j.amepre.2013.10.001.
- [62] Warshaw C, Sullivan C, Rivera E. A systematic review of trauma-focused interventions for domestic violence survivors. National Center on Domestic Violence Trauma, & Mental Health, 2013:1–26. Warshaw C, Sullivan C, & Rivera E. A systematic review of trauma-focused interventions for domestic violence survivors National Center on Domestic Violence, Trauma, & Mental Health 2013.
- [63] Galovski TE, Monson C, Bruce SE, Resick PA. Does cognitive-behavioral therapy for PTSD improve perceived health and sleep impairment? *J Trauma Stress* 2009;22:197–204. <https://doi.org/10.1002/jts.20418>. Galovski TE, Monson C, Bruce SE, & Resick PA. Does cognitive-behavioral therapy for PTSD improve perceived health and sleep impairment? *J Trauma Stress* 2009;22:197–204. doi: 10.1002/jts.20418.
- [64] Prince C, Bruhns M. Evaluation and treatment of mild traumatic brain injury: the role of neuropsychology. *Brain Sci* 2017;7:105. <https://doi.org/10.3390/brainsci7080105>. Prince C, & Bruhns M. Evaluation and Treatment of Mild Traumatic Brain Injury: The Role of Neuropsychology. *Brain Sciences* 2017;7:105. doi: 10.3390/brainsci7080105.
- [65] Vasterling JJ, Bryant RA, Keane TM. PTSD and mild traumatic brain injury. New York, NY: Guilford Press; 2012. Vasterling JJ, Bryant RA, Keane TM. PTSD and Mild Traumatic Brain Injury. 2012. New York, NY: Guilford Press.
- [66] Polytrauma Rehabilitation Center, Richmond VA Medical Center, Department of Veterans Affairs. (2018, June 13, 2018). Traumatic Brain Injury Polytrauma System of Care. (Retrieved August 30, 2018).
- [67] Grillo AR, Danitz SB, Dichter ME, Driscoll MA, Gerber MR, Hamilton AB, Wiltsey-Stirman S, Iverson KM. Strides toward recovery from intimate partner violence: elucidating patient-centered outcomes to optimize a brief counseling intervention for women. *J Interpers Violence* 2019. <https://doi.org/10.1177/0886260519840408> Advance online publication. A.R. Grillo, S.B. Danitz, M.E. Dichter, M.A. Driscoll, M.R. Gerber, A.B. Hamilton, S. Wiltsey-Stirman, & K.M. Iverson. Strides toward recovery from intimate partner violence: Elucidating patient-centered outcomes to optimize a brief counseling intervention for women. *J of Interpers Violence*, 2019. Advance online publication. DOI: 10.1177/0886260519840408.
- [68] Fortier CB, Amick MA, Grande LJ, McGlynn S, Kenna A, Morra L, et al. The Boston assessment of traumatic brain injury-lifetime (BAT-L) semi-structured interview: evidence of research utility and validity. *J Head Trauma Rehabil* 2014;1:89–98 (PMC3997066). Fortier CB, Amick MA, Grande LJ, McGlynn S, Kenna A, Morra L, Clark A, Milberg WP, & McGlinchey RE. The Boston Assessment of Traumatic Brain Injury-Lifetime (BAT-L) Semi-structured Interview: Evidence of Research Utility and Validity. *The Journal of Head Trauma Rehabilitation* 2014;1:89–98. PMC3997066
- [69] Valera EM, Berenbaum H. Brain Injury Severity Assessment (BISA) Interview. Urbana-Champaign: Dissertation archives at the University of Illinois; 1997. E.M. Valera and H. Berenbaum. Brain Injury Severity Assessment (BISA) Interview. Dissertation archives at the University of Illinois, Urbana-Champaign. 1997.
- [70] Campbell JC, Anderson JC, McFadgion A, Gill J, Zink E, Patch M, et al. The effects of intimate partner violence and probable traumatic brain injury on central nervous system symptoms. *J Womens Health* 2018;27:761–7. Campbell JC, Anderson JC, McFadgion A, Gill J, Zink E, Patch M, Callwood G, Campbell D. The Effects of Intimate Partner Violence and Probable Traumatic Brain Injury on Central Nervous System Symptoms. *J Women's Health* 2018;27:761–767.