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Examining acquired brain injury-associated symptoms and fluid-based biomarkers in females surviving intimate partner violence: An observational pilot study protocol

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Abstract

Background: Acquired brain injury (ABI), including traumatic brain injury and hypoxic/anoxic injury, presents significant public health concerns; however, existing literature has focused primarily on male populations, such as military personnel and contact sports participants. Sex-related differences in ABI outcomes necessitate focused research due to potential heightened risk and distinct physiological responses among females.

Objectives: This pilot study aims to explore fluid-based biomarkers for neurological injury and inflammation in females experiencing intimate partner violence (IPV)-related assaults to the head, neck, or face. It seeks to assess the feasibility and acceptability of non-invasive sweat patch collection for biomarker analysis and its association with post-injury symptoms.

Design: This study will be a prospective longitudinal observational pilot study involving approximately 50 participants recruited from two mid-Atlantic-based hospital emergency departments.

Methods and analysis: Participants will undergo clinical interviews, provide blood and sweat samples, and complete questionnaires assessing ABI history, IPV-related symptoms, cognitive function, psychological well-being, and sweat patch acceptability, across three study visits. Screening procedures will identify eligible participants, followed by consent procedures, biosample collection, brain injury and IPV history survey administration, symptom and cognitive function instrument administration, and acute medical record data collection. Analyses will include random effects regression, product moment correlations, and descriptive statistics.

Ethics: Participants will be informed about the study's purpose, procedures, and potential risks before providing consent. Compensation will be provided for participation, with withdrawal options available. Ethical considerations include ensuring participant confidentiality and addressing psychological disorders beyond exclusion criteria.

Discussion: Understanding fluid-based biomarkers in IPV-related ABI can inform interdisciplinary interventions and precision care models. Findings may facilitate early detection, treatment, and safety planning for affected females, emphasizing the importance of tailored, accessible care for this vulnerable population. Future research should focus on translating these findings into evidence-based practice to improve outcomes for women with ABI, particularly those resulting from IPV.

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Plain language summary

Studying brain injury symptoms in females hurt by intimate partner violence

Acquired brain injury (ABI) is a serious health issue that includes injuries from accidents or lack of oxygen. Most research has looked at males, especially in military or sports contexts, leaving women's experiences less understood. This is particularly important for females who experience intimate partner violence (IPV), as they may face different risks and health problems. This pilot study protocol aims to find signs of brain injury and inflammation in females who have been hurt on the head, neck, or face because of IPV. It will also check if using sweat patches to collect samples is easy and acceptable, and how these samples relate to symptoms after the injury. About 50 females will be recruited from two emergency departments in the mid-Atlantic area of the U.S. They will take part in interviews, provide blood and sweat samples, and answer questions about their injury history, experiences with IPV, thinking skills, and mental health. Once researchers make sure possible participants understand what the study involves and that they may leave at any time, researchers will ask for their consent to enroll in the study. By learning about brain injury signs in these females, the study hopes to create better support and care tailored to their needs. The results may help design additional studies to improve how we detect and treat ABIs from IPV, highlighting the need for specialized help.

Keywords

intimate partner violence, brain injury, women's health, biomarkers

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Introduction

Acquired brain injury (ABI) has been recognized as a significant and widespread public health problem,[1] gaining increased scientific and clinical focus in the 20 years following Operations Iraqi and Enduring Freedom. Research and media interest have also raised our collective awareness of brain injuries in contact sport athletes, such as football players and boxers. Almost 5 million U.S. emergency department (ED) visits each year are for ABI evaluation.[2] However, much of what we know about ABIs, and their sequelae has been derived from primarily male samples or samples that limit sex and gender identity data disaggregation for specific analysis.[1] Emerging ABI literature demonstrates sex-related differences in both injury response and treatment.[3–8] Females may be at increased risk of negative post-ABI outcomes, based on biological sex differences (e.g., neuroanatomy, hormones, and immune response), environmental and social factors, and various other sources of heterogeneity,[1] yet more research is required to understand the nature and impacts of these differences.

For this protocol, ABI is operationally defined as inclusive of both traumatic brain injury (TBI) as caused by an external force)[1] and hypoxic/anoxic injury which can result from strangulation. ABI often includes a mix of focal and diffuse neurological damage resulting from the trauma. Injury to the brain initiates a cascade of acute immune and inflammatory responses that, if sustained, can result in a constellation of functional and structural deficits,[9] presenting considerable risk for negative acute and long-term cognitive, physical, and behavioral outcomes. Specifically, if inflammatory activities are excessive or prolonged, then additional risk to neuronal integrity results, thus sufficient regulation is essential.

Symptoms of ABI, such as memory loss, attention, and cognitive deficits, can be highly variable, as well as subtle and nuanced. Population-based estimates demonstrate the vast majority of diagnosed ABIs (approximately 94.5%) have a Glasgow Coma Scale (GCS) rating of 13–15, thus are categorized as "mild,"[2] which are often undetectable on computed tomography (CT).[2] However, approximately 53% of patients diagnosed with mild ABI report continued impairments 1 year after injury.[10] These symptoms can interfere with daily activities, quality of life, adherence to care plans, and other important functions.[11] Additionally, those experiencing repetitive mild head trauma or hypoxic events can take longer to recover[12] and have increased susceptibility to serious neurodegenerative pathologies, such as Alzheimer's disease and chronic traumatic encephalopathy.[13]

Females, intimate partner violence, and ABI: Females are at heightened risk of ABI from intimate partner violence (IPV), which frequently involves physical violence directed at the head, face, and neck. Lifetime population-based prevalence estimates reflect over 40.5 million U.S. females (one in three, or 32.5%) report severe physical IPV, over 4 million report being "knocked out after getting hit, slammed against something, or choked," and 4.5 million report an IPV-related "head injury."[14] Among females who have experienced IPV, prevalence of ABI has been estimated to range from 19% to 75%.[15] Strangulation (aka "choking"), an IPV assault mechanism experienced by over 20 million U.S. women in their lives,[14] can compromise brain oxygenation and also result in significant ABI.[16,17] IPV often includes repetitive violence, increasing the risk for multiple and additive brain injuries, yet the cumulative neurological consequences of injuries in this population have been examined in only a few descriptive studies[18–21] and remain largely unknown. Females with a history of IPV

have demonstrated higher levels of peripheral inflammatory biomarkers,[22,23] which may contribute to increased susceptibility to neuroinflammation and resultant long-term cognitive and emotional problems. The intersection of IPV and ABI is recognized as an area requiring more integrative research,[1,15,24–26] with preliminary studies underscoring this important need.[11,17,27]

Assessment challenges: ABI symptoms are heterogenous, complex, and may present subtly and evolve over time. Those experiencing IPV and their healthcare teams may attribute ABI symptoms solely to psychological trauma and stress. For example, there is overlap in the symptom characteristics of ABI and post-traumatic stress disorder,[28] yet evidence from emerging but still limited research supports their differentiation in females experiencing IPV.[29] Continued investigation is important as these different issues require different interventions, and ABI injuries and trajectories may be varied.[1] Clinical assessment for ABI that relies solely on self-report can be problematic due to potential memory deficits, other cognitive challenges, and minimization of symptoms.

A few encouraging investigations are examining combinations of assessment instruments and biomarkers for IPV-related ABI to support clinicians in diagnosis, treatment, and prognosis of ABI.[17,29] Magnetic resonance imaging can identify more subtle injuries,[30] such as differences in neural structures and functional connections in females experiencing IPV and ABI,[31] but is relatively time-consuming, expensive, and still inaccessible to many patients. Fluid biomarkers are also being studied in populations not specific to IPV, reflecting inflammatory responses after ABI can be measured within 6 h and up to 12 months after trauma.[32] Although the most sensitive and specific test panels are still to be determined, these studies suggest glial fibrillary acidic protein (GFAP) and Ubiquitin C-terminal hydrolase L1 are diagnostic of acute brain injuries, with additional evidence that neurofilament light (NfL), Tau and inflammatory markers (cytokines) relate to more sub-acute processes and chronic symptoms.[33–35]

Fluid-based biomarker collection: Blood and cerebrospinal fluid are currently the most studied fluids for biomarkers, but obtaining these samples can be uncomfortable for patients, invasive, and require collection and immediate processing at a clinic or laboratory. Newer technologies have been developed which allow for collection of fluid-based biomarkers via sweat patch,[36] which have been reported to correlate well with blood levels in small study samples. Furthermore, these methods have been successfully tested in other populations such as older adults[37] and premenopausal women with depression.[38] As sweat patches are non-invasive and can be sent using regular mail services, they may prove more acceptable and convenient for use by individuals who have been assaulted. Further benefits of sweat patch collection, such as bypassing diurnal rhythm challenges, could make this method more feasible for longitudinal monitoring of injury markers to understand more integrative activities. Testing to isolate fluid-based biomarkers of neurological injury and inflammation, as well as to determine sweat patch acceptability and feasibility, in women with IPV-related ABI is also needed.

Thus, the *purpose* of this pilot study will be to examine markers of neurological injury and inflammation, along with physical and psychological symptoms, over time for females after an IPV-related assault to their head, face, or neck (H/F/N).

Methods

Study design

This pilot study will employ a prospective longitudinal observational design to achieve the following aims:

- *Aim 1*: Estimate the association of fluid-based brain-related injury markers (BRIMs) and inflammation (cytokines, from blood and sweat) with post-injury physical, cognitive, and behavioral/psychological symptoms over time in a diverse sample of approximately 50 women presenting for ED evaluation after an IPV-related H/F/N assault.
  - *Aim 1a*: Examine congruence between blood and sweat analyses in measures of BRIMs and cytokines over time.
- *Aim 2*: Determine acceptability and feasibility of non-invasive sweat patch use for biomarker collection and analysis at baseline and over time among this population.

This research will focus on acceptability and feasibility to inform development of a larger, appropriately powered study of biomarkers specific to this population and more inclusive of individuals presenting for other services outside of an ED (e.g., domestic violence centers).

Sample size estimation

The total sample size will be 50 females meeting inclusion criteria. As this is an acceptability and feasibility study, sample size was not determined by statistical power. Instead, the focus will be on descriptive measures of feasibility and acceptability and estimating effect sizes to determine if there is a signal in the data to support further work in this area. With $N = 50$, power = 0.80, and alpha = 0.05, we will be able to detect moderate effect sizes for associations of 0.38 or greater.

Setting

This pilot study will be conducted in two mid-Atlantic-based hospital EDs varying in location, trauma level, and training programs (academic, academic affiliate).

Table 1. Study inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
• Biological female (self-report of assigned female at birth) • ⩾18 years of age • Present to one of the recruitment site EDs to receive care within 72 h of an IPV-related assault that involved the H/F/N • Able to consent independently • Glasgow Coma Scale (GCS) score of 12–15 • Ability to read and understand the English language, without hearing impairment that would preclude a phone conversation	• Male patients • Individuals younger than 18 years old • Females who experienced IPV that did not involve assault to the H/F/N • Females who experienced assault and/or strangulation by means other than IPV • Individuals with any of the following: ○ History of neurological illness (e.g., Huntington's disease, Parkinson disease, dementia); ○ History of seizure disorders unrelated to head injury; ○ Decompensated mental health disorders requiring acute hospitalization ○ Current active homicidal and/or suicidal ideation, with intent requiring crisis intervention • Individuals who cannot read and understand English or have a hearing impairment precluding a conversation with a study team member • Individuals not able to follow study procedures

IPV: intimate partner violence; ED: emergency department; H/F/N: head, face, or neck

Study population and recruitment

Female patients presenting to the study site EDs with assault-related injuries or injuries to the head, neck, or face will be screened by ED research staff based on established inclusion and exclusion criteria (see Table 1). The clinical care team will assess if a patient is able to provide consent and can be approached for recruitment. Research staff will collaborate with the ED social worker when available to find an appropriate time to engage the patient. Additionally, screening may also occur through two concurrent TBI studies at the same EDs. Assault-related injuries or injuries involving the (H/F/N) will be screened by a member of the ED research staff ("research staff") to participate in this study, according to inclusion and exclusion criteria (see Table 1). The patients' clinical care team will be relied upon to determine if a patient is consentable and whether they may be approached for recruitment. When possible, research staff will coordinate with the ED social worker to determine a good time to approach the patient. An additional screening source will be through two TBI studies concurrently running in the study site EDs. The two additional studies are unique to the ED department where this research protocol will take place and have different aims from this study. If research staff are screening for these other two studies and identify potential participants that may meet the study criteria, they would preferentially offer enrollment in this study until the sample goal is reached.

In the event an eligible patient is admitted and transferred to an inpatient floor before a consent approach occurs, the research staff may conduct the approach on the inpatient floor. This study will not exclude patients suffering from psychological disorders beyond the described exclusion criteria.

Study procedure

Upon consent, each participant will complete a clinical interview/medical history review and survey instruments, as well as provide samples of peripherally accessed blood and sweat, across three total study visits. Each participant will remain in the study for 3 months unless they consent for future contact during the consent process. Initial and follow-up visits will each take approximately 90 min (about 1 and a half hours) to complete. The study will be open for enrollment for 2 years. Study visit timeframes and a timeline of study activities and procedures is provided in Figure 1.

Acute data from medical chart/records: Data will be collected from the medical records to obtain the following information at baseline: details related to assault and injuries; GCS scores; demographics (i.e., age, race/ethnicity, area of residence, socioeconomic status (years of education, employment, insurance)); marital/relationship status including living situation (e.g., married, partnered, living together); medical/surgical/social history and physical exam findings, including menstrual cycle (last menstrual period, regularity of cycles); medical care provided during ED visit (i.e., medications, imaging, laboratory analyses, consults/referrals, and procedures undertaken during this period of study observation); and final diagnoses and discharge instructions.

Biosamples: Based on established time frames for presence/absence of the aforementioned fluid biomarkers, along with expected reasonable time frames for potential participant presentation to a study site after injury, this study will be examining GFAP, NfL, IL-6, IL-8, IL-10, and TNF-α (see Table 2 for definitions). These will be measured in sweat and plasma (see sections "Blood" and "Sweat" below for collection descriptions) using a high-definition-1 analyzer, which

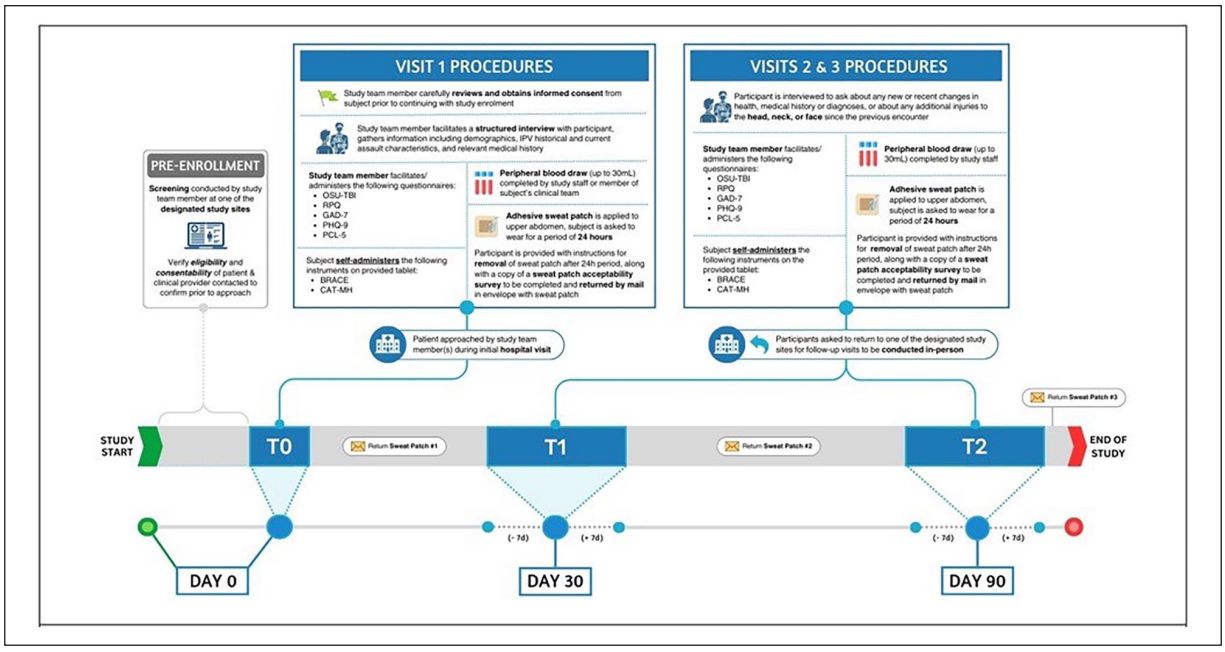

Figure 1. Timeline of study visits and associated activities.

Table 2. Outcome measures from biological samples (blood and sweat).[33]

Measures	Clinical relevance
Glial fibrillary acid protein (GFAP)	• Protein that makes up CNS astrocyte skeletons • Reflects damage to astroglia, with increased expression in response to TBI
Neurofilament light (NfL)	• Protein in long myelinated axons • Highly specific marker of axonal injury, demonstrates potential prognostic utility
Interleukin-6 (IL-6)	• Multi-functional cytokine with both pro- and anti-inflammatory properties that may have prognostic value • A main inflammatory response regulator, promoting short-term defense from tissue injury and infection
Interleukin-8 (IL-8)	• Pro-inflammatory cytokine that attracts and activates neutrophils in areas of inflammation to mediate inflammatory process after TBI • Higher levels are linked to poorer health outcomes
Interleukin-10 (IL-10)	• Potent anti-inflammatory cytokine with immuno-regulatory functions, may serve neuroprotective role • Elevated levels can suggest severity of injury
Tumor necrosis factor-alpha (TNF-α)	• Initiates and regulates cytokine cascade during inflammatory response, mediating gliosis, BBB deterioration, demyelination, inflammation, disease progression, and cell death • When considered with other inflammatory cytokines, like IL-6 and IL-10, it has been linked to poorer 6-month post-TBI outcomes

CNS: central nervous system; BBB: blood/brain barrier; TBI: traumatic brain injury.

is a paramagnetic bead-based enzyme-linked immunosorbent assay (ELISA) for protein detection that maximizes sensitivity, with detection 100–1000× that of ELISA methods. Multiplex technology will be used to simultaneously quantify the neuronal/glial and inflammatory proteins. The laboratory staff follows current U.S. Food and Drug Administration guidance for bioanalytical method validation and quality assurance.

Blood: To examine brain-related injury markers (GFAP, NfL) and inflammatory cytokines (IL-6, IL-8, IL-10, TNF-α), non-fasting blood samples will be collected by research staff. Up to 30 mL of blood will be collected. Blood plasma tubes containing ethylenediaminetetraacetic acid (an anticoagulant) will be collected and inverted five times to mix thoroughly and stored upright on wet ice until processing. Within 120 min (about 2 h), plasma tubes must be spun down at 2000 × *g* for 15 min in a 4°C refrigerated centrifuge. Serum separator tubes must be collected and gently inverted five times, returning to the upright position at room temperature for 30 min. After 30 min, serum tubes are spun

at 1300 × *g* for 15 min at room temperature. Aliquots for all sample tube types are labeled appropriately and stored in a −80°C freezer for downstream analysis.

Sweat: To examine brain-related injury markers (GFAP, NfL) and inflammatory cytokines (IL-6, IL-8, IL-10, TNF-α), research staff will apply a sweat patch to the participant, who will wear the patch for a 24-h period at home after each study visit. After each 24-h period, the participant will remove the research sweat patch, place it into a biospecimen bag, and mail it to the laboratory in a pre-labeled, pre-paid envelope. Per manufacturer's technical guide, collected specimens are stable for 30 days at room temperature. Upon receipt, the sweat patch will be stored in the lab for extraction and further downstream analysis. In the lab, the absorbing pads are frozen in a −80°C freezer until extraction and analysis. The pads will be cut by sterile tweezers and cutting knives, rolled, and placed into filter tubes with 500 µL of sweat washing buffer (1× phosphate-buffered saline, 0.5% polysorbate 20, and 0.2% bovine serum albumin). Next, the samples will be placed at 4°C to incubate for 20 min and then will be centrifuged at 4000 × *g* in a refrigerated 4°C centrifuge for 20 min. The filtered sweat extractions will be aliquoted, labeled appropriately and stored in a −80°C freezer.

Instruments/questionnaires: The following instruments or questionnaires will be administered to participants:

1. To obtain ABI historical and most recent assault characteristics:
   a. Ohio State University Traumatic Brain Injury Identification Method (OSU-TBI-ID): a validated standardized procedure for eliciting lifetime history of TBI via a 3–5-min structured interview.[39]
   b. IPV-related history and symptoms questionnaire: a survey with questions regarding IPV-related injuries and symptoms which will take approximately 8–10 min to complete, adapted from the following validated instruments: Boston Assessment of TBI-Lifetime (BAT-L) for Civilian Survivors of IPV[40]; the Miller Abuse Physical Symptoms and Injury Scale (MAPSAIS)[41]; and the Partner Abuse Symptom Scale (PASS).[42]
2. To determine lifetime and most recent physical symptoms and cognitive function:
   a. Rivermead Post-Concussion Symptoms Questionnaire: a validated 16-item self-reported questionnaire for assessment of the presence and severity of various post-concussion symptoms.[43]
   b. Brain Baseline Assessment of Cognition and Everyday Functioning (BRACE)[44]: an iPad-based tool that is completed in 5–7 min and screens for cognitive impairment, which measures psychomotor speed (Trail Making Test Part A), set-shifting and mental flexibility (Trail Making Test Part B), processing speed (Stroop Color Test), and visuospatial learning and memory (Visual-Spatial Learning Test).[45]
3. To collect psychological and behavioral symptoms, for comparison between and within participants over time:
   a. General Anxiety Disorder-7 (GAD-7): Aa validated 7-item initial screening tool for generalized anxiety disorder.[46]
   b. Patient Health Questionnaire-9 (PHQ-9): A validated 9-item brief depression severity measure.[47]
   c. Post-Traumatic Stress Disorder Checklist (PCL-5): A validated 20-item self-report rating scale for key post-traumatic stress disorder (PTSD) symptoms.[48]
   d. Computerized adaptive testing for mental health (CAT-MH)[49]:
      I. Major Depressive Disorder (screener): using an average of four items, this module produces a screening diagnosis of MDD and a corresponding confidence level associated with that diagnosis.
      II. Depression: using an average of 12 questions, this module produces continuous severity scores of depression based on symptomatology experienced and takes an average of 66 s to complete.
      III. Anxiety: using an average of 12 questions, this module produces continuous severity scores of anxiety based on symptomatology experienced and takes an average of 79 s to complete.
      IV. Post-traumatic stress disorder: Using an average of six items, this module measures PTSD severity takes an average of 37 s to complete.
      V. Substance use disorder: This module provides a crosswalk between mental health symptoms (depression, anxiety, PTSD), social supports, risky behaviors, and self-reports of the abuse of substances (tobacco, alcohol, illegal drugs, opioids) and takes an average of 144 s to complete.
4. *Sweat patch acceptability and feasibility*: Upon returning each sweat patch, participants will be asked to complete a brief, 5-point Likert scale survey to assess their perceptions on satisfaction, ease of use, and comfort using the sweat patch. In addition to participant survey feedback, sweat patch acceptability will also be measured by the percent of participants that agree to use the sweat patch. Feasibility of sweat patch use

Table 3. Primary and secondary outcome variables.

Primary outcome variables	Secondary outcome variables
Aim 1: • Fluid-based BRIM and cytokine levels over three time points Aim 2: • Acceptability and feasibility of non-invasive sweat patch use	Aim 1a: • Comparing levels of BRIMs and cytokines between blood and sweat measures

BRIM: brain-related injury markers.

will be measured by the proportion of patches returned and the proportion of returned patches with adequate sample for analysis.

- *Study compensation procedure*: All participants who consent and complete the study visit will be provided with a $50 gift card for each visit (total: $150 for 3 visits). Those who are withdrawn from the study by the PI or do not complete all study procedures at each visit may receive a gift card at the discretion of the study team. As a measure of acceptability will be that participants agree to wear a sweat patch, their declining to do so will not negatively affect their compensation.

Analysis plan

Primary and secondary outcome variables for each aim are provided in Table 3.

Before beginning any analyses, the data will be audited for quality and completeness, and distributions evaluated with reference to planned analysis models. The evaluation of distributions will include detection of outliers in quantitative data and checking distributions of variables to ensure they meet assumptions of planned analyses. Means, medians, and interquartile ranges (IQRs) will be used to describe the BRIM and cytokine variables, as well as the physical, cognitive, and psychological symptoms.

Management of missing data: Missing data will be examined for patterns and baseline responses compared between those with and without missing data. Variables related to missingness will be included in the analyses, which should yield valid inferences.[50] Once the pattern of missingness has been identified, an appropriate approach to handling missing data will be determined.

Analysis for specific Aim 1: Random effects regression will be used to describe fluid-based BRIMs and cytokines (blood and sweat) across time. Individual trajectories of the fluid-based BRIMs and cytokines will be estimated, with time as the primary predictor. Two indicator variables, one for re-assault between T-0 and T-1 and the second for re-assault between T-1 and T-2 will be included in the model as covariates. Next, H/F/N assault characteristics will be added to determine if the trajectories vary by assault characteristics. The relationship of each trajectory with change in physical, cognitive, and psychological outcomes over time will then be examined using growth mixture models. These models will allow testing of whether the characteristics of the BRIM and cytokine trajectories are predictive of health outcomes from baseline to T-2.

Analysis for specific Aim 1a: Product moment correlations will be used to examine the congruence between the pairs of blood and sweat measures. To determine if the congruence varies by time since injury, the correlation analyses will first be stratified by time (baseline, T-1, T-2). To determine if the congruence varies by level biomarker, correlation analyses will be stratified by the level of the blood biomarker (low, medium, high).

Analysis for specific Aim 2: Descriptive statistics will be used to determine acceptability and feasibility of non-invasive sweat patch use for biomarker collection and analysis at baseline and over time among this population. For acceptability, the percent of females that agree to use the sweat patch, as well as the median level and IQR of participants' satisfaction, ease of use, and comfort with patches. Next, *t*-tests and chi-square tests will be used to examine variability in acceptability by demographic characteristics and living situation (e.g., is partner living with her at the time). Similarly, feasibility measures will be summarized by the proportion of patches returned for analysis at each time point (adherence to protocol) and proportion of returned patches with enough sample for successful analytic processing. Logistic regression will be used to test if return of the patch (yes/no), and enough sample for processing (yes/no), varies by demographic characteristics and living situation (e.g., is partner living with her at the time).

Ethical Considerations

Provision for the protection of study participants was guided by the protocol set forth by the Nursing Research Consortium on Violence and Abuse.[51]

As a result of participating in this study, it is possible that participants may be identified by others, including law enforcement or healthcare personnel, as being a victim or perpetrator of violence. For those enrolled into the study, during the informed consent process, the interviewer will explain that this study is confidential and voluntary, that no identifying information (e.g., names, birthdates, location names, etc.) will be included in any published reports. Participants will also be informed that they can choose not to answer any question without it affecting their participation in this study. All study advertising for recruitment of participants will be directed toward staff members at the recruitment sites and not for direct patient communication. There is also a slight risk that confidentiality may be breached in the management of data, although multiple safeguards will be implemented to avoid this risk. Study

data will be stored in a secure HIPAA compliant database, and only de-identified data will be analyzed. Access to data will be limited to approved team members with password protected access. Participants will be made aware of these risks during the consent procedure, informed of their rights and the voluntary nature of the study, and informed that they can remove themselves from the study at any time. Additionally, during the consent process, participants will be informed this study is covered by a Certificate of Confidentiality through the National Institutes of Health, along with a description of these protections.

Safety and confidentiality for all potential and enrolled participants will be supported throughout the study by discreet communication and trained staff who can involve security if needed. Research staff will be advised to speak to potential participants privately in their ED room. If another person (e.g., family member or intimate partner) is present in the room, research staff will be directed to ask them to exit briefly prior to presenting the study to the patient. If that person is unwilling to leave or if the patient does not agree to hear about the study, research staff will thank the patient for her time and exit. The research staff will also receive training and a detailed script to guide all telephone communications with enrolled participants, including but not limited to: referring to the study generically as "a women's health study," asking if it is a good time to talk, asking about privacy, listening for background noises or eavesdropping, and how to contact police if necessary. Furthermore, the sweat patch itself has no identifying marks on it to suggest it is for an IPV-related study.

Some participants may find it distressing to recall the circumstances surrounding abusive experiences. Participants will be provided with a list of resources for counseling and any additional assistance (e.g., shelters or programs for domestic violence, mental health services, and legal services) related to abuse or adverse physical and mental health outcomes. Study team members will be trained not to press participants to answer questions or engage in any discussion that seems to be distressing to them. Research staff may take a participant out of the study if they experience significant psychological distress that prevents them from continuing discussion during the study visit. The decision to remove a participant from the study may be made either to protect the participant's health and safety or because the study team member believes the participant is not appropriate for the study. The visit will be terminated if the participant is too distressed, too fatigued, or too frustrated by the effort. If participants feel they are in need of psychological/mental health services, research staff will refer the participant to counseling agencies the same day of their interview and report incidents or concerns to the study principal investigator. Additionally, study activities will be conducted within the ED, where licensed healthcare professionals are available to support participants in acute distress.

Phone numbers for the study team and the institutional IRB will be provided for participants to report any study-related concerns including violence during the study. Violence that is related to the conduct of the protocol will be reported as an adverse event to the study IRB using established procedures. Violence unrelated to the protocol that is incidentally communicated during the information gathering is not reportable as a research-related adverse event. State mandated reporting requirements will be clearly stated in the consent form. Study questions do not specifically address topics that would mandate reporting (i.e., untreated contagious diseases, imminent harm, child abuse); however, participants will be informed of the actions taken if they share any information related to a mandated reporting situation.

Discussion

To advance the development and tailoring of interdisciplinary interventions that are based on unique factors for females with ABI, it is critically important to conduct foundational research that specifically examines populations at heightened risk of injury, acutely and over time, with those experiencing IPV being a particularly vulnerable group.[4] Prior literature establishing the widespread prevalence of IPV has underscored the need for integrated, coordinated, and pragmatic care for females experiencing IPV that does not rely on expensive and limited-resource specialty assessments for mild-ABI diagnoses and related treatment.[24] An understanding of fluid-based biomarker changes can support nurses, physicians, and other professionals in creating innovative, precision care models,[52] leading to improved and enhanced prevention, early detection, treatment, and safety planning for females with IPV-related ABI. Additional research is needed to lay the foundation for translation into evidence-based practice. Findings from this study may inform future research to design and test translational, interdisciplinary precision models and systems of care that are coordinated, cost-effective, pragmatic, equitable, and readily accessible to women with ABI, especially as a result of IPV.

Declarations

Ethics approval and consent to participate

This study received ethical approval from the Johns Hopkins Medicine Institutional Review Board (approval #00405313) on March 7, 2024. Provision for the protection of study participants was guided by the protocol set forth by the Nursing Research Consortium on Violence and Abuse (NRCVA).[49] During the informed consent process, the research staff will review the written IRB-approved informed consent form and provide a verbal explanation in terms suited to the participant's comprehension of the purposes, procedures, and potential risks of the study and of their rights as research participants. Participants will then be given time to consider the research study and ask questions prior to signing the written consent form.

Consent for publication

As this article reports on the study protocol, and does not include any patient data, consent for publication is not applicable.

Author contribution(s)

Michelle Patch: Conceptualization; Methodology; Project administration; Software; Visualization; Writing – original draft; Writing – review & editing.
Allison Jacobi-Dorbeck: Methodology; Project administration; Resources; Software; Visualization; Writing – original draft; Writing – review & editing.
Tamar Rodney: Writing – original draft; Writing – review & editing; Methodology.
Gabor Kelen: Conceptualization; Methodology; Resources; Supervision; Writing – original draft.
Jacquelyn C Campbell: Conceptualization; Methodology; Resources; Supervision; Writing – original draft; Writing – review & editing.
Leah H Rubin: Methodology; Resources; Software; Supervision; Writing – original draft; Writing – review & editing.
Chelsea Wagner: Methodology; Project administration; Resources; Writing – original draft.
Nancy Perrin: Methodology; Writing – original draft.
Jessica Gill: Conceptualization; Methodology; Resources; Supervision; Writing – original draft.

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