PARTNER INFLICTED BRAIN INJURY AS A CONSEQUENCE OF INTIMATE PARTNER VIOLENCE

by

Clarice M. Edwards

BA in Neuroscience and BA in Psychology, Ohio Wesleyan University, 2013, 2013

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This thesis was presented

by

Clarice M. Edwards

It was defended on

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and approved by

Thesis Advisor: Martha Ann Terry, PhD, Associate Professor and MPH Program Director, Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh

Jessica Burke, PhD, Associate Professor and Associate Chair, Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh

Thomas Songer, PhD, Assistant Professor, Epidemiology, Graduate School of Public Health, Training Core Director Consortium for Injury Research and Community Action, University of Pittsburgh

Martha Ann Terry, PhD

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Clarice M. Edwards MPH

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ABSTRACT

Public Health Significance Intimate partner violence is a major public health problem with an estimated one in three women experiencing abuse in her lifetime. Two common acts of violence in IPV situations are blows to the head and attempted strangulation, which both increase the risk of brain injury in survivors. Although this population is likely to sustain more brain injuries than the general population, survivors of IPV are not well represented in brain injury research. This is likely due in part to several barriers to identification of IPV survivors who have endured hits to the head or oxygen deprivation, including social stigma surrounding abuse victimization.

Methods A review of the limited literature available on the topic of IPV-related brain injury was conducted using PubMed and PsycINFO databases.

Results The literature search resulted in 25 relevant articles that included both empirical articles and reviews. Several researchers have attempted to estimate the prevalence rate of brain injuries in the IPV population with small convenience samples. Overall, research suggests that IPV-related brain injuries are common and cause a myriad of negative health consequences that may be masked by or attributed to IPV experience. Additionally, this population is exposed to

high levels of environmental stress and likely repeated injuries to the head leading to potentially worse outcomes than other brain injury populations.

Conclusions Due to lack of published literature and specific factors in IPV context, it is clear that more research in this specific area is necessary and that applying findings from research in other populations is not sufficient. Future research should include longitudinal studies in the IPV survivor population and accurate, nationally representative estimates of IPV-related brain injury are needed. Improvement of screening practices and development of community partnerships are critical for the success of this field moving forward and for the creation and implementation of targeted interventions.

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PREFACE

Acknowledgements:

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1.0 INTRODUCTION

Brain injury and intimate partner violence are each individually serious public health concerns with millions affected and high costs to society (Faul, Xu, Wald, Coronado, & Dellinger, 2010; Walters, Chen, & Breiding, 2013). In 2010, emergency department (ED) visits, hospitalizations, and deaths associated with traumatic brain injury (TBI) alone or in tandem with other injuries totaled about 2.5 million in the United States (cdc.gov, updated 2016). It may not come as a surprise then that the estimated direct and indirect costs of these injuries in 2010 total an enormous $76.5 billion, although 90% of the total medical costs are attributed to fatal injuries or those that require hospitalization, which are usually severe in nature (Coronado, McGuire, Faul, Sugerman, & Pearson, 2012). The most recent national estimates of intimate partner violence (IPV) show that more than one in three women are affected by physical violence, rape, and/or stalking by an intimate partner in their lifetime (Walters et al., 2013). An estimated $10.4 billion in 2012 dollars is the latest projected cost to society for intimate partner violence (Liebschutz & Rothman, 2012).

Scientific explorations of traumatic brain injury and intimate partner violence have increased since the late 20th century. The 1970s brought a major increase in interest in TBI and its recognition as a public health problem (Boake & Diller, 2005). This occurred for several reasons including integration of more high-speed roadways leading to unprecedented numbers of head injuries caused by motor vehicle accidents. Since then, several specific groups that suffer from higher rates of brain injury, such as soldiers with blast injuries and athletes with concussions, have been the focus of research in the field. Research on IPV and its consequences increased around the same time, as violence between intimate partners was recognized as a problem in our society (Straus, Gelles, & Steinmetz, 1980). The acknowledgment of IPV's negative impacts led to the appearance of shelters and later, the emergence of more empirical evidence of various types and patterns of partner abuse (Kelly & Johnson, 2008). Although these problems are well known and researched independently, the discussion of the two in tandem is nearly absent in scientific and medical discourse. Research since the mid-1990s has begun to touch on the subject of IPV-related brain injury; however, investigation in this area is severely lacking (Ackerman & Banks, 2009; Banks, 2007; Fox, Davies, Scholl, Watt, & Forster, 2016; Kwako et al., 2011). The intersection of brain injury and IPV requires more attention, research funding, and innovative interventions.

This master's thesis will examine the complex relationship between intimate partner violence (IPV) and brain injury. In order to explore this association, a review of the current literature that addresses brain injury in the IPV survivor population will be conducted. Then, the gaps in scientific knowledge and important implications for research and practice will be considered. An overview of IPV and brain injury will be presented and relevant factors of each will be explored in detail. The author will discuss the nature of the relationship between the two and propose potential reasons for the relative lack of attention to their connection in the literature. Overarching themes in published literature will be presented and the author will provide suggestions for the more in-depth examination of this budding field.

2.0 BACKGROUND

2.1 INTIMATE PARTNER VIOLENCE

Today, both lay people and researchers often use the terms intimate partner violence and domestic violence interchangeably. When looking at these terms historically, domestic violence is a narrower term that was utilized first and refers specifically to a heterosexual relationship, generally to spouses or those who cohabitate, in which a male perpetrates violence against a female victim (inpublicsafety.com, 2015). Intimate partner violence is a more inclusive term emerging in the last 10 to 15 years allowing for discussion of violence in a relationship without mention of gender, housing accommodation, or sexuality.

In research, these two terms are defined in a variety of ways based on what acts of violence are or are not included (see Table 1, p. 26). Domestic violence has been described as "a broad categorization for a pattern of behaviors that include verbal insults, threats, psychological, emotional and economic attacks, and physical abuse" (Smith, Mills, & Taliaferro, 2001, p. 327). IPV has been defined as "a pattern of physical, sexual, and/or emotional violence by an intimate partner in the context of coercive control" (Wuest et al., 2008, p. 1049). Another group outlines IPV more generally as "the willful intimidation, physical assault, battery, sexual assault, and or other abusive behavior perpetrated by an intimate partner against another" (Mahoney, 2011, p. 386). The Centers for Disease Control and Prevention (CDC) offers "physical, sexual, or psychological harm by a current or former partner or spouse" (www.cdc.gov) as a more succinct definition of IPV. The term intimate partner violence is used in this document, and most of the discussion throughout will refer to female survivors of abuse at the hands of a male intimate, as this group makes up the majority of known cases (Walters et al., 2013).

2.1.1 Epidemiological assessment

Abuse is often discussed in three major categories: physical, psychological/emotional, and sexual (Thompson et al., 2006). These forms of abuse can be concurrent or occur independently. Physical abuse will be the main focus moving forward, as it is the abuse type that is most likely to lead to brain injury. On a global scale, the World Health Organization (WHO) estimates that about one in every three women who has been in a relationship has experienced physical and/or sexual violence by an intimate partner (García-Moreno, 2013).

Specifically in the United States, according to the National Intimate Partner and Sexual Violence Survey (NISVS) 2010 report, one in three women will experience physical abuse from a partner in her lifetime, and for one in four, this abuse will be severe (Walters et al., 2013). Globally and domestically, it is clear that the large majority of IPV victims are women; however, this issue transcends boundaries of background, age, race, class, and region of the world (Garcia-Moreno, Jansen, Ellsberg, Heise, & Watts, 2006; Walters et al., 2013). Though IPV touches everyone, some groups do appear to be at higher risk. For instance, lifetime prevalence of rape, physical violence, and/or stalking by an intimate partner is 43.7% for non-Hispanic Black women and 46% for American Indian or Alaska Native women as compared to 34.6% for non-Hispanic White women (Walters et al., 2013).

2.1.2 Categorization of IPV

Intimate partner violence can be categorized several different ways. Partner violence can be reciprocal, in which both partners perpetrate violence against one another, or nonreciprocal (Whitaker, Haileyesus, Swahn, & Saltzman, 2007). Research suggests that about 25% of relationships had some violence and in nearly half of those, it was reciprocal. In non-reciprocally violent relationships, women are more likely to be the perpetrator; however, men are more likely than women to inflict injury during partner violence.

The CDC surveillance guidelines suggest data elements of duration, frequency, and consequences to adequately describe physical IPV experience (Centers for Disease Control and Prevention, 2015). IPV experience is most frequently measured in surveys for occurrence in the victim's lifetime and past 12 months. Some assessments of emergency department visits identify IPV as the cause of trauma at the visit. The CDC guidelines also recommend measuring the length of the current violent relationship, and gathering information about any consequences following the most recent violent episodes, including physical and psychological outcomes and necessary medical or mental health treatment.

Reports of IPV frequency often focus on overall prevalence and neglect to characterize the level of severity associated with IPV. However, in its "Multi-country Study on Women's Health and Domestic Violence," WHO explored the severity of IPV events (World Health Organization, 2005). Though controversial, the WHO chose to rank acts of violence by severity according to an act's likelihood to cause injury. Slapping, pushing, or shoving were ranked as moderate physical violence, while hitting with a fist, throwing objects, kicking, dragging, and threatening or actual use of a weapon were considered severe.

2.1.3 Associated health consequences

IPV experience is associated with various health consequences including both physical and mental health problems (García-Moreno, 2013). Physical health outcomes related to IPV can be split into three main categories: immediate and direct, longer-term and direct, and indirect (Plichta, 2004). Immediate, direct physical health problems include physical injury or death. Between 2003 and 2012, over one third of female homicide victims were murdered by a male intimate partner (ncdsv.org). To further complicate the matter, women are most at risk for serious injury or homicide when attempting to leave a violent relationship (Fleury, Sullivan, & Bybee, 2000).

Survivors of IPV also experience a myriad of non-fatal physical injuries such as lacerations, bruises, and broken bones. According to the National Violence Against Women (NVAW) Survey, 41.5% of women with a history of IPV reported a physical injury as a result of their most recent episode of abuse by an intimate (Tjaden & Thoennes, 2000). Head, neck, and face (HNF) injuries are often indicated as the most commonly sustained injury types in this population, exposing IPV survivors to increased risk for traumatic brain injury (Saddki, Suhaimi, & Daud, 2010; Sheridan & Nash, 2007). Saddki and colleagues (2010) found that 50.4% of the female survivors of IPV in their hospital-based sample had endured an injury to the maxillofacial region, or the face and jaw area. The same study also reported injury to the non-maxillofacial regions of the head in 24.4% of the sample and neck injury in 10.3%. In a review examining injury patterns in IPV, researchers had similar findings, reporting that injuries to the head, neck, and face areas are the most common based on data from several prior studies (Sheridan & Nash, 2007). Finally, in an emergency department sample, Ochs and others found that 94.4% of IPV victims had HNF injuries (Ochs, Neuenschwander, & Dodson, 1996). Attempted strangulation and suffocation are also common in IPV (Sheridan & Nash, 2007). One potential result of strangulation and suffocation attempts is hypoxic/anoxic injury, another outcome that IPV victims are at elevated risk for that may lead to brain damage.

Longer-term, direct physical health problems include disability due to a severe injury, arthritis, gastrointestinal disorders, and chronic pain (Wong & Mellor, 2013). Brain injury resulting from a blow to the head or brain damage due to lack of oxygen from strangulation attempts can have long-term effects and lead to disability. More indirect physical health consequences include a decline in self-reported health measures and health behaviors (Plichta, 2004).

In some instances, IPV results in injuries that require visits to the emergency department or hospitalization. Findings from a study of emergency department visits by women estimate that 22 to 35% of all visits are related to injury or illness stemming from abuse or stress related to an abusive situation (Randall, 1990). However, because of the stigma surrounding IPV, abuse leading to potential brain injury is severely underreported. It is estimated that less than 15% of abused women seek medical care (Conti, 1998) and even in this sub-population, victims tend to downplay signs of abuse during emergency treatment to avoid legal involvement (Corrigan, Wolfe, Mysiw, Jackson, & Bogner, 2003). Even if a health care provider sees a victim of IPV, she is often not identified as such. Although these women are coming to the hospital because of abuse, they are rarely if ever screened for IPV (Conti, 1998). It has been estimated that fewer than 10% of all abuse cases are identified in emergency departments. A more recent study shows that lack of IPV victim identification is not quickly improving (Rhodes et al., 2011). The large majority of IPV victims in the study were not identified or provided any intervention in the ED. Several studies have suggested the adoption of policies and procedures for screening, identification, and referral of abuse victims, yet less than 50% of all emergency departments have done this and it is unknown how many actually enforce these measures (Campbell, 2002; Conti, 1998).

In the realm of mental health, IPV has additional severe and lasting impacts. Research in this field has revealed associations between IPV experience and “depression, post-traumatic stress disorder (PTSD), generalized anxiety disorder, phobias, obsessive compulsive disorder, panic disorders, somatization, attempted suicide, and substance-related disorders” (Wong & Mellor, 2013, p. 173). Rates of depression in women who have experienced IPV are estimated to be more than double that of the general female population. Two reviews on this topic reported depression rates range between 38 and 83% in IPV victims compared to 20% in the general population (Cascardi, O'Leary, & Schlee, 1999; Golding, 1999; Hiral, Desai, & Jann, 2000). Carbone-Lopez and colleagues (2006) found that women who experience systematic abuse, defined as extensive relationship violence with sustained use of physical force and the presence of multiple forms of physical aggression, had a likelihood of experiencing serious depression three times that of women with no IPV experience.

PTSD is another health problem commonly associated with IPV (Simmons et al., 2008); several studies with IPV-exposed samples showed that 63.8% of participants suffered from PTSD (Golding, 1999). In the 2010 NISVS Survey Report, 62.3% of women with lifetime experience of rape, physical violence, and/or stalking by an intimate partner endorsed at least one item about PTSD symptoms beginning after the violence occurred (Walters et al., 2013). Although health outcomes have been studied largely in those experiencing physical and sexual abuse, similar issues arise as a result of psychological abuse (Coker, Smith, Bethea, King, & McKeown, 2000). In fact, Coker and colleagues (2000) reported that women experiencing psychological abuse alone were more likely than non-abused controls to endorse poor physical and mental health.

2.1.4 Additional factors in IPV

Intimate partner violence is a complex social problem interwoven with various other factors, many of which increase the risk for IPV victimization. Risk factors include lack of social support, financial insecurity, less education, unemployment, and previous experience of child abuse (Capaldi, Knoble, Shortt, & Kim, 2012). The “cycle of violence” concept posits that children who experience abuse or maltreatment are at greater risk for perpetrating violent crime including abuse later in life (Maxfield & Widom, 1996).

Race and ethnicity are also associated with IPV risk. Over 40% of non-Hispanic Black women and American Indian and Alaska Native women report rape, physical abuse, and/or stalking in their lifetime (Walters et al., 2013). For women who identify as multiracial, the lifetime prevalence is about one in two. Cultural norms are yet another factor where higher victimization rates have been found in some groups compared to others. Research shows increased risk of experiencing IPV specifically in immigrant women (Raj & Silverman, 2002). Researchers theorize that this violence could be at least partially due to gender power differentials in the culture of their country of origin (Wong & Mellor, 2013). Another example of cultural influence comes from a study conducted by Linton in the Native American population that found rurality and intoxication were significant contributing factors to the relationship between Native American race and TBI as a consequence of interpersonal violence (Linton, 2015).

2.2 PARTNER-INFLICTED BRAIN INJURY

An acquired brain injury, abbreviated ABI, is “an injury to the brain, which is not hereditary congenital, degenerative, or induced by birth trauma” (biausa.org). This umbrella term includes several types of brain insults resulting from various causes, and also includes both traumatic brain injury (TBI) and hypoxic/anoxic brain injury (HAI), the two brain injury types most likely to be sustained from IPV (Kwako et al., 2011). A traumatic brain injury is damage to the brain caused by an external force, often an acute event such as a blow or penetrating injury to the head. Both open and closed head injuries fall into this category. Hypoxic/anoxic injury is damage to the brain caused by significant lack of oxygen, a common cause of which is strangulation (Smith et al., 2001). ABI can disrupt normal brain function and cause significant motor and cognitive impairments, severely reducing quality of life (Hickey, Anderson, & Jordan, 2016).

Women who experience IPV are at high risk for HAI and TBI, often resulting from attempted strangulation or suffocation or a blow to the head, face, or neck. Several published articles refer to both of these injury types as TBI, while others use the looser term “brain injury” (Hunnicutt, Lundgren, Murray, & Olson, 2016; Kwako et al., 2011; Valera & Berenbaum, 2003). The broader term ABI encompasses both HAI and TBI. This term does not specifically fit the context of brain injury related to IPV either as it includes other non-traumatic post-partum brain abnormalities such as tumors and infections (Turner-Stokes, Disler, Nair, & Wade, 2005). To move this area of research forward, this document introduces the term partner-inflicted brain injury (PIBI), defined as traumatically induced physiological disruption of normal brain function caused by a non-accidental injury perpetrated by an intimate partner. This term aims to incorporate both the context and outcome of brain injury in IPV situations.

2.2.1 Epidemiological assessment

Traumatic brain injury affects approximately 10 million people annually (Hyder, Wunderlich, Puvanachandra, Gururaj, & Kobusingye, 2007). WHO projects that by 2020, traumatic brain injuries will surpass several diseases as a major cause of death and disability globally. In the United States, a person suffers a traumatic brain injury about every 16 seconds (allaboutbraininjury.com, 2009). TBI occurs more often than spinal cord injuries, breast cancer, and HIV/AIDS infections combined. According to CDC data from 2002-2006, each year in the U.S. roughly 1.7 million people sustain a traumatic brain injury costing an estimated $10 billion annually for acute care and rehabilitation (Faul et al., 2010). Approximately 52,000 of TBIs result in death, while those who survive are vulnerable to long-term disability. Consequently, an estimated 5.3 million people in the U.S. live with a TBI-related disability (Centers for Disease Control and Prevention, 2014). Although these numbers are alarming, they are likely an underestimate due to the number of concussions or mild TBIs that go unreported (Bruns & Hauser, 2003). However, in recent years, attempts to address underreporting of brain injury in sports have increased (Greenwald, Chu, Beckwith, & Crisco, 2012). One popular strategy is to conduct a baseline function assessment in athletes that may be compared to post-hit performance to track changes that may be related to head trauma (Collie, Darby, & Maruff, 2001).

The CDC states that the leading causes of TBI include falls, assaults, unintentional blunt trauma, and motor vehicle accidents (cdc.gov/traumaticbraininjury). While falls are most common for young children and adults over the age of 65, the leading cause for TBI-related ED visits in people aged 15-24 was assaults. Due to lack of published data, reliable prevalence estimates for HAI strangulation injuries to neural tissue are unavailable. However, one study found that 68% of the women surveyed had been strangled by an intimate partner (Wilbur et al., 2001). This is an area for improvement that will be considered in the discussion.

2.2.2 Types of brain injury

Three main types of PIBI are relevant for this thesis: open head injuries, closed head injuries, and hypoxic-anoxic injuries. Open head injury is a head injury in which an external force causes a skull fracture or penetrating injury to the skull (Hunnicutt et al., 2016). A closed head injury occurs when an impact to the head does not result in a skull fracture or other structural compromise. A hypoxic-anoxic brain injury occurs when the brain does not receive adequate oxygen to function normally and may alternatively be referred to as ischemic insult (Zasler, pcadv.org).

TBI, which includes open and closed head injuries, is generally defined as disruption of normal brain functioning caused by an external force. TBI researchers define two phases of injury: primary and secondary. Primary injury refers to the initial mechanical trauma or blow to the head, usually leading to neural tissue displacement and damage (Werner & Engelhard, 2007). Secondary injury refers to a cascade of neurochemical events that occurs over the days and months subsequent to the impact, leading to alterations in neurons and neurometabolic processes, as well as cell death (Barkhoudarian, Hovda, & Giza, 2011).

HAIs, damage caused by lack of oxygen to neural tissues, stem from hypoxia and anoxia. Anoxic injury occurs when no oxygen reaches bodily tissues, in this case brain tissue. Anoxia can occur after several minutes of hypoxia, or reduced oxygen flow to tissues. These terms are referred to together as HAI and are sometimes used synonymously. The most common cause of HAI in IPV victims is manual strangulation, defined as “the compression of the neck with one or two hands that may result in the restriction of blood flow and oxygenation to the brain" (Smith et al., 2001, p. 323).

One of the major challenges in the TBI field is defining the injury and operationalizing it in research. Diagnostic criteria specifically for mild TBI are not uniform, making comparison across studies and populations extremely difficult (see Table 1, p. 26). Some researchers require loss of consciousness (LOC) or another alteration in consciousness, such as post-traumatic amnesia or dizziness, after an event to classify a head injury as a TBI (Iverson & Pogoda, 2015; Valera & Berenbaum, 2003). Others use symptom clusters to define what constitutes a TBI (Corrigan et al., 2003). The American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (APA's DSM-V) lists TBI as a neurocognitive disorder (NCD). The diagnostic criteria in the DSM-V include (1) meeting criteria of NCDs as determined by neurocognitive testing, (2) having evidence of a blow to the head with one or more of a specific cluster of symptoms such as LOC, and (3) developing neurocognitive issues directly after the causal event (American Psychiatric Association, 2013).

Traumatic brain injuries are often classified into three main categories based on severity: mild, moderate, and severe. The most common method of classifying a TBI is the Glasgow Coma Scale (GCS), which combines eye opening with motor and verbal responses to determine an individual's level of consciousness (Jones, 1979). Mild TBI, or mTBI, is referred to as a brief change in mental status or consciousness with GCS scores of 13 – 15. Moderate injuries include GCS scores 9 – 12 and severe TBIs, often identified by an extended period of unconsciousness or memory loss after the injury, have GCS scores of 3 – 8 (Jones, 1979). Comprising around 85% of all TBIs, mTBI is the most commonly sustained form of TBI and includes concussions (Bazarian, Cernak, Noble-Haeusslein, Potolicchio, & Temkin, 2009). This type of injury can be difficult to diagnose because alterations in brain morphology are often not detected by common neuroimaging techniques (Murray, Lundgren, Olson, & Hunnicutt, 2016).

2.2.3 Frequency of brain injury

In motor vehicle accidents and falls, victims are likely to suffer from a single instance of TBI. However, some populations that endure TBIs at particularly high rates are more likely to sustain several or repeat TBIs. The population in which this is most notably recognized by research and the media is professional athletes (DePalma, 2015; Zuckerman et al., 2015). A neurodegenerative disease called chronic traumatic encephalopathy (CTE) has been recently identified in former wrestlers and football players (Bieniek et al., 2015). The symptoms associated with CTE include depression, memory loss, confusion, problems with judgment and impulse control, aggression, and, in later stages, dementia (Gavett, Stern, & McKee, 2011). CTE occurs in people who have experienced repetitive brain trauma and can only be diagnosed post-mortem via neuropathology. Each repeated episode of traumatic impact to the head does not necessarily have to be symptomatic at the time of injury to contribute to CTE pathology. Symptoms generally become apparent eight to ten years after exposure to repeated head trauma, long after the acute and post-acute healing has occurred (Gavett et al., 2011).

Research suggests that repeated TBIs result in additional pathologies beyond those seen from a single TBI. After a TBI, the affected neural tissue may be bruised and cell death may occur in many brain cells, or neurons (Barkhoudarian et al., 2011). Cells with compromised cell membranes release a myriad of chemicals that can be harmful to remaining healthy tissue such as excitatory neurotransmitters (i.e., glutamate). This chemical in abundance in the extracellular space can lead to excitotoxicity, or cell damage or death caused by overactivation of the receptors of other surrounding cells, opening channels that allow a massive influx of positive ions that results in catabolic (self-digesting) processes (Werner & Engelhard, 2007). After the initial ionic flux, the sodium-potassium pump, which stabilizes the membrane potential of neurons, begins to work at maximal capacity to regain balance (Barkhoudarian et al., 2011). Because this pump requires adenosine triphosphate or ATP, the cell's main source of energy, the cell's energy stores become depleted quickly in the neurochemical crisis caused by TBI and the pumps begin failing.

The processes described above and many others degrade cellular and vascular structures and cause further cell death (Werner & Engelhard, 2007). The inflammatory response, including pro-inflammatory cytokines, prostaglandins, and free radicals, may trigger other negative outcomes. The injured brain is in a fragile state for several weeks to months after an injury during stabilization of the alteration in the neurochemical environment caused by the injury (Barkhoudarian et al., 2011). During this post-injury period, the brain is especially vulnerable to damage in the event of an additional insult. Thus, when a person sustains multiple injuries, the brain is in a more vulnerable state for each subsequent injury. The pathology that is unique to repetitive brain injury is the accumulation of a protein called tau, a consequence that occurs over time (Gavett et al., 2011). Other telltale markers of CTE include gross pathology such as larger ventricles and overall decreased brain mass due to atrophy of several lobes and structures.

2.2.4 Severity, location, and mechanism determine symptoms

As noted above, the severity of a TBI is described as mild, moderate, or severe injury. This classification gives some indication of the intensity of symptoms following the injury. Other factors that help determine symptoms and recovery are the location and mechanism of the injury.

The connection between injury location and symptoms was discovered through lesion studies of the brain, in which scientists have demonstrated what is known as localization of function (Müller & Knight, 2006). This phenomenon suggests that different functions of the brain are localized to a specific brain region; for example, vision processing occurs in the occipital lobe at the back of the brain. Thus, if a person sustains an injury to the back of the head, it is likely that she will experience vision-related symptoms.

Two major mechanistic groupings of traumatic brain injury are contact (impact loading) and noncontact (inertial loading) (Saatman et al., 2008). Contact injuries cause focal damage and result from the head being struck by or against an object (e.g., a blow to the head or head being hit against the ground). These situations often cause coup-contrecoup injury, or damage to the site of contact with the external force or the area opposite of the impact, leading to contusions, or bruising of neural tissue. A noncontact injury occurs when the motion of the brain and skull are decoupled (e.g., violent shaking) and causes more diffuse injuries such as tissue tearing. Rotational injuries occur when neurons are sheared as a result of the brain rotating within the skull, stretching and pulling on the tissue. This type of injury tends to produce diffuse axonal injury (DAI), which consists of pervasive damage to axons, the part of the nerve cell that sends messages, and white matter tracts, which are bundles of axons that allow the cerebrum to send messages to the rest of the body (McCrea, 2008).

In most cases, it is likely that both impact and inertial forces play a role in the resulting tissue damage, and these types of injury can lead to differing outcomes (Hardman & Manoukian, 2002). Researchers theorize that coup-countercoup injury, involving acceleration/deceleration forces, is more common in sports injuries, whereas rotational injury is more likely in an interpersonal violence situation (Corrigan et al., 2003). This highlights the importance of studying and treating these two populations independently.

HAI works via a distinctive, but similar mechanism. The brain requires a constant supply of oxygen and glucose to supply energy for normal neuronal functioning (Budd, 1998). When this supply is decreased or cut off completely, damage results in minutes. When oxygen is suboptimal, the brain enters a state of inadequate energy and ion imbalance ensues. Next, assuming the oxygen depletion is relatively brief and not lethal, the normal bioenergentic state will be restored. However, after the restoration phase, there is a period of secondary cell death. This is why damage can often be delayed from the actual oxygen-limiting event, in the case of IPV, strangulation. In general, the decrease in oxygen availability will be similar across the brain during a strangulation or suffocation attempt. Therefore, the damage would theoretically not be specific to a certain cell type or brain region, but result in overall damage. However, some nerve cells are more sensitive to oxygen deprivation than others and die sooner, such as those in the hippocampus and cerebellum (Hawley, McClane, & Strack, 2001). Thus, it is clear that the various mechanisms by which brain injuries can occur must be taken into account when considering deficits and treatment plan.

2.2.5 Associated health consequences

Brain injury can lead to death or disability that significantly impacts quality of life. Cognitive impairments are the typical symptoms discussed in TBI, but motor function, behavioral issues, and emotional or mental health problems also accompany brain injury (Centers for Disease Control and Prevention, 2014). Motor function effects include paralysis and postural instability (Walker & Pickett, 2007). Behavioral issues generally encompass problems with social interactions, planning and organization, aggression, and judgment (Centers for Disease Control and Prevention, 2014). A common emotional complaint after TBI is post-traumatic depression (Kreutzer, Seel, & Gourley, 2001). Post-concussive syndrome, or PCS, is a disorder occurring weeks to months after the injury that may include trouble concentrating, frequent headaches, dizziness, memory problems, alterations in mood, fatigue, and judgment problems (Ryan & Warden, 2003). With the presence of these symptoms, it has been documented that TBI has a negative effect on ability to function in a professional or academic environment (Hoofien, Gilboa, Vakil, & Donovick, 2001).

Intimate partner violence occurs far too frequently and often leads to serious injuries. Brain injuries result from blows to the head, violent shaking, and oxygen deprivation to neural tissues. Considering this, the intersection of these two issues and the importance of studying their relationship are evident.

3.0 METHODS

3.1 SEARCH STRATEGY

To locate relevant peer reviewed articles, searches were conducted using the PubMed (07/12/2016) and PSYCinfo (08/29/2016) databases. In PubMed, in order to capture the concepts of brain injury and intimate partner violence, the search terms used were “brain injury” and its associated MeSH terms in conjunction with “intimate partner abuse,” “intimate partner violence,” and “domestic violence” and their respective MESH terms (see Appendix A). This search resulted in 65 articles (Figure 3-1). The search was then adapted for PSYCinfo using database subject headings, adding six additional new articles. A final search was conducted on September 7, 2016, to ensure that all relevant articles were included; this resulted in one additional publication (search output not shown). Resulting articles from each search were evaluated for inclusion. To be included, studies must have adult participants who had experienced intimate partner violence and focus on head or brain injury. The search had no publication year restriction, as the search results were already scarce without this limitation. Articles on studies that included populations under the age of 18, incarcerated populations, case studies, or focused on IPV perpetrators with brain injury were excluded.

Eighteen articles were deemed relevant and met inclusion criteria, and were thus selected for this literature review. Next, the studies cited in each of the 18 articles selected in the original search were reviewed for additional relevant literature. This secondary search method produced seven additional articles that met the inclusion criteria for a final total of 25 papers (Appendix B). One article could not be accessed and is denoted with red text in the table.

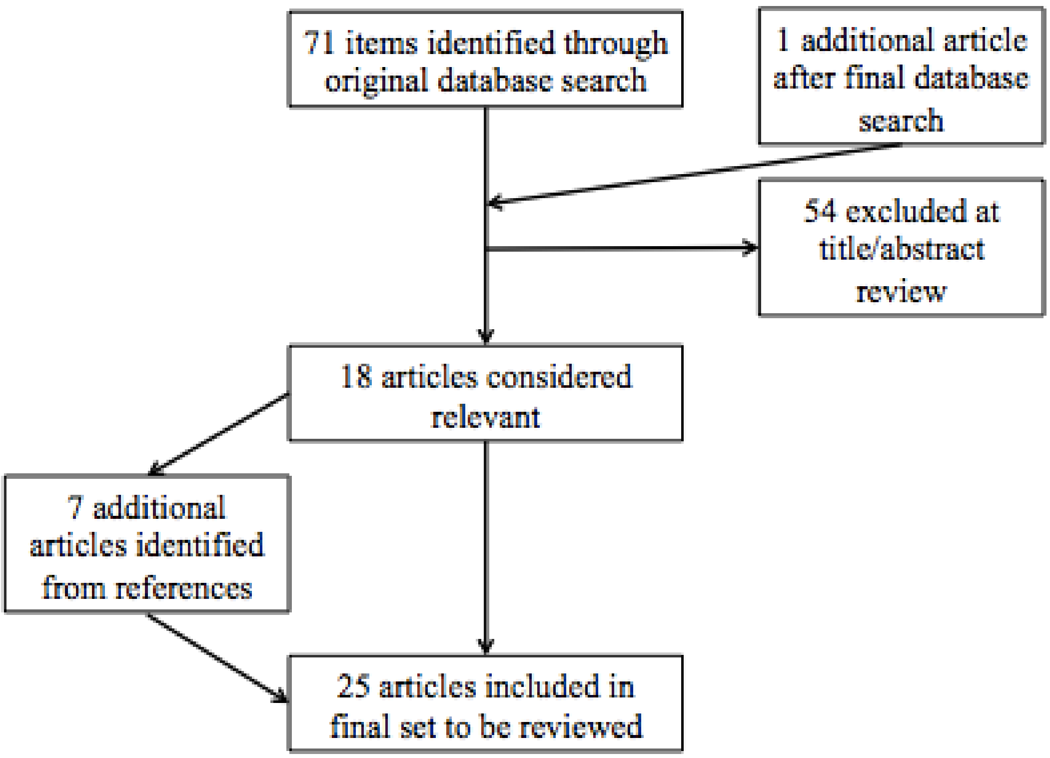

Figure 3-1: Search strategy diagram depicting literature selection process.

4.0 RESULTS

As noted above, because of the paucity of research on the subject of IPV-related brain injury, no date limitation was placed on the literature search. Due to this methodology decision, several articles referenced were published in the late 1990s and early 2000s. Of the 25 articles deemed to be relevant to this thesis, only ten were empirical articles based on original research. All but three of these were from before 2007. The three published after 2007 were qualitative in nature, carried out with a specific subpopulation (e.g., women veterans), or pertained to all interpersonal violence combined. The remainder of the papers retrieved were literature reviews focusing on specific subjects such as health outcomes or screening tools.

IPV experience is associated with increased risk of developing both physical and mental health problems, including brain injury (Davis, 2014; Iverson & Pogoda, 2015; Kwako et al., 2011; Wong & Mellor, 2013). However, the IPV survivor population is nearly absent from brain injury research, and currently no TBI screening tools exist that are specific to this population (Goldin, Haag, & Trott, 2016). Recent publications suggest that collaboration of experts in the IPV and neurotrauma fields is necessary to arrive at a more holistic understanding of partner-inflicted brain injury (Hunnicutt et al., 2016).

The literature search resulted in 25 relevant articles for examination. The results of the literature reviewed will be laid out in several subsections that correspond to common themes in several of the articles. These subsections reflect the current understanding of IPV-related brain injury and expose gaps in this area of research. They are the following: common types of injury in IPV, prevalence estimates of PIBI, symptom overlap between IPV and TBI, biological impact of PIBI, PIBI's role in the cycle of violence, chronic injury due to IPV environment, population problems, post-concussive syndrome (PCS) symptom outcomes and implications, and future directions.

4.1.1 Common types of injury in IPV

Two major injury types resulting from IPV are HNF injury and HAI. Several articles touched on the overwhelming number of HNF injuries estimated in the IPV survivor population, exposing them to increased risk for traumatic brain injury (Jackson, Philp, Nuttall, & Diller, 2002; Kwako et al., 2011; Roberts & Kim, 2006; Zieman, Bridwell, & Cárdenas, 2016). Although all available prevalence estimates are from studies with small convenience samples, mostly from hospitals or shelters, research suggests that between 35 and 94% of IPV victims suffer injuries to the face, neck, or head (Kwako et al., 2011; Zieman et al., 2016). Researchers also posit that IPV abusers often hit victims in the back of the head as opposed to the face so that visible marks will not be evident (Corrigan et al., 2003). In a sample of battered women involved in support groups through community outreach programs or women's shelters, 92% reported being hit in the head or face during an episode of partner violence (Jackson et al., 2002). Risk of strangulation is also high in the IPV population, with estimates of up to 72% in surveys of battered women (Mechanic, Weaver, & Resick, 2008; Smith et al., 2001).

Despite the evidence that the vast majority of women who experience IPV sustain injuries that implicate possible damage to the brain, PIBI is often ignored as a potential consequence. Recognition of this "silent epidemic" as a serious and understudied public health problem has led several researchers to consider the likelihood of TBI and HAI in IPV survivors. The next section will elucidate the articles that contain estimates of PIBI prevalence in this population.

4.1.2 Prevalence estimates of PIBI

While not every blow to the head or lapse in adequate oxygenation will lead to a PIBI, each injury has the potential to do so. A major study in three metropolitan cities found that, of women presenting at emergency departments for domestic violence-related concerns, about one third reported loss of consciousness and two thirds stated that they had residual problems that could be associated with latent head injuries (Corrigan et al., 2003). Thus, although reliable representative statistics are not available due to lack of research and sampling issues, it is clear that PIBI is occurring in this population. Current research that specifically attempts to identify the prevalence of PIBI resulting from IPV is scarce, and the estimates are vulnerable to the same limitations as the approximations for HNF injury. The most troublesome limitation of these estimates is that the available samples represent a small fraction of people who experience IPV. However, the search process identified a set of studies in this area that offer estimates (Table 1).

Studies utilized many different identifying variables for PIBI such as residual PCS symptoms after an IPV incident, while others employed LOC. One study conducted in three major metropolitan cities found that 30% of women presenting at emergency departments for IPV-related concerns reported LOC, and 67% endorsed having problems that may be associated with previous undetected head injuries such as headache, dizziness, and memory loss with onset after an assault (Corrigan et al., 2003). Corrigan et al. also reported that 15% of their sample endured blows to the head that required hospitalization.

In another study, 44% of women recruited at a shelter reported a head injury that resulted in LOC along with somatic complaints consistent with latent brain injury (Monahan & O'Leary, 1999). Jackson and others (2002) found that 92% of their sample of women who had experienced IPV suffered blows to the head and that in 40% of them, the blow resulted in a LOC, a common research indicator of brain injury. The same study noted that 83% of the women had been severely shaken as well as hit in the head, and nearly one in 10 had been hit in the head over 20 times in the past year. Similarly, in a study of a mixed sample from shelters and supportive programming for victims of IPV, 74% had sustained at least one incident of partner-induced brain injury (defined by the researchers as alterations in consciousness following a blow to the head or strangulation attempt) and about half of the women reported multiple incidents (Valera & Berenbaum, 2003). Finally, of victims who experienced strangulation, 17% reported a LOC (Wilbur et al., 2001).

These estimates are alarming, but they are likely an underestimate of the full impact of PIBI due to lack of reporting and treatment seeking in this population. Women who experience violence at the hands of an intimate partner are unlikely to seek medical care (Goldin et al., 2016; Valera & Berenbaum, 2003; Zieman et al., 2016). One group of researchers reported that only 21% of their patients sought medical care for their injuries, suggesting that reporting may be worse than previously estimated (Zieman et al., 2016). This occurs for several reasons including social stigma surrounding IPV, lack of transportation, financial control by their perpetrator, poor decision-making abilities due to multiple head traumas, and lack of knowledge that symptoms could be tied to a PIBI (Monahan & O'Leary, 1999). Researchers posit that IPV victims “may initially describe TBI-like symptoms but not connect them to their experiences with injury to the head or neck” (Murray et al., 2016, p. 301).

Additionally, current estimates of IPV-related brain injury prevalence may be low due to inadequate identification of IPV victimization in the ED. As previously discussed, IPV screening and identification of survivors is nearly non-existent. It is estimated that 72% of IPV victims seen in EDs are not identified ("Use screening tools, partnerships to improve identification, care of victims of IPV," 2015). Implementing IPV screening practices would assist in identifying victims of IPV and, by extension, detecting PIBI cases when a woman who presents with a brain injury in the ED screens positive for IPV, or vice versa in the shelter setting. Finally, the media attention surrounding the subject of TBI is solely focused on military veterans and professional male athletes, which leaves IPV survivors out of the spotlight. The resultant lack of public attention can lead to health care professionals, advocates, and survivors themselves being less likely to recognize the symptoms of TBI in women, thus allowing PIBI to go undetected (Murray et al., 2016).

Table 1: Definitions of IPV and brain injury and estimates from relevant publications

Author (year)	Sample origin	Definition of IPV	Definition of TBI/HAI	Method	% positive
Banks (2007)	N/A	N/A	Can be a consequence of being hit in the head with fists or other objects; having one's head pushed against a hard object, such as a floor or wall; violent shaking; or attempted asphyxiation mTBI: injury to the brain, even in the absence of visible bruising or open cuts to the head	Lit review	N/A (only stated measurements of head, neck, and facial injuries at 94.4%)
Corrigan et al. (2003)	Metropolitan emergency departments (female patients with DV)	Pattern of abusive behavior including a wide range of physical, sexual, and psychological maltreatment (APA)	Head injury information collected: cause of injury, presence and length of LOC, hospitalization, and residual neurobehavioral sequelae	Interview	30% LOC and 67% residual problems related to injury
Davis (2014)	N/A	N/A	Concussion and MTBI are used interchangeably to define brain injuries that are not accompanied by structural changes on the computerized axial tomography scan	Lit review (PCS, PTSD, depression focus)	N/A
Goldin et al. (2016)	N/A	Physical aggression between couples in marital or intimate relationships that often results in physical	N/A	Lit review (screening tool focus)	N/A

Table 1 Continued		damage to the body and can lead to long-term functional difficulties			
Hunnicutt et al. (2016)	N/A	Any form of physical, sexual, emotional, psychological, and/or verbal abuse between partners in a [current or former] intimate relationship (from Murray et al, 2016)	Caused by a blow to the head, face, or neck; a fall into/onto a hard surface; or strangulation: external compression of the neck… may disrupt normal functioning of the brain, resulting in changes in physical, cognitive, and/or emotional wellbeing, depending on the extent and severity of the injury	Lit review (SEM focus)	Estimates 30-74% discussed
Iverson and Pogoda (2015)	New England Dept. of Veterans Affairs (female patients)	Assessed using behaviorally specific statements that assess how partners resolve conflict; subscales for physical assault, sexual coercion, and sever psychological aggression	A blow or jolt to the head that disrupts physiological functioning of the brain Screening criteria for TBI history: if reported that IPV-related head events were associated with LOC, AIC, concussion, or head injury	Mail survey	18.8% met screening criteria for IPV-related TBI history
Jackson et al. (2002)	Support groups at three shelters and four community outreach programs	N/A	Injury that results from blows to the head; a subset of minor head injury in which damage to the head includes damage to the brain	Self-report questionnaires (paper surveys)	92% blows to the head and 40% LOC

Table 1 Continued Kwako et al. (2011)	N/A	Pattern of physical and/or sexual violence in the context of coercive control by an intimate or ex-intimate partner	Physiological disruption in brain function resulting from an external physical force, including blunt force and acceleration/deceleration	Lit review	Estimates 30-74% discussed (in table p. 118)
Monahan and O'Leary (1999)	Shelter sample with severe, ongoing physical violence from a partner	N/A	Use of the term "subtle head injury"	Clinical interview, medical history form, and observation	44% head injury with LOC and residual injury-associated somatic complaints
Murray et al. (2016)	N/A	Any form of physical, sexual, emotional, psychological, and/or verbal abuse between partners in a [current or former] intimate relationship	An alteration in brain function, or other evidence of brain pathology, caused by an external force (BIAA)	Lit review	N/A
St. Ivany and Schminkey (2016)	N/A	Behaviors intended to exert power and control over another individual, including physical, sexual, verbal, emotional, and financial abuse	N/A	Lit review	60-92% of abused women obtain TBI directly correlated with IPV
Valera and Berenbaum (2003)	Battered women (women who had experienced any type of physical abuse by a current or past intimate partner) recruited	N/A	Mild Traumatic Brain Injury Committee of the American Congress of Rehabilitation Medicine, 1993 definition: traumatically induced physiological disruption of	Semi-structured interviews	74% at least 1 partner-related brain injury and 51% sustained multiple injuries

Table 1 Continued	from community programs or shelters		brain function, as manifested by at least one of the following: 1. Any period of LOC 2. any loss of memory for events immediately before or after the accident 3. any alteration in mental state at the time of the accident (e.g., feeling dazed, disoriented, or confused) 4. focal neurological deficit(s) that may or may not be transient; Used the following to differentiate between mild and moderate/severe: but where the severity of the injury does not exceed the following: - LOC of approximately 30 minutes or less - After 30 minutes, an initial Glasgow Coma Scale (GCS) of 13-15 - Posttraumatic amnesia (PTA) not greater than 24 hours		

Table 1 Continued					
Wilbur et al. (2001)	Shelter sample (3 sites)	N/A	N/A	Individual interviews	17% LOC
Wong et al. (2013)	N/A	N/A	Caused by external forces, such as blunt trauma to the face, or during rapid acceleration and deceleration or rotation, resulting in neurological deficits, LOC, brain damage, and even death CDC definition of mTBI: traumatically induced physiological disruption of brain function, as manifested by at least one of the symptoms of LOC, loss of memory, alteration in mental state, and neurological deficit; LOC < 30 minutes, PTA < 24 hours	Lit review brain region focus	Over 90% of all injuries in abused women on head, neck, or face
Wong and Mellor (2014)	N/A	Any behavior within an intimate relationship that causes physical, psychological or sexual harm to those in the relationship; physical aggression,	N/A	Lit review health outcomes focus	N/A

Table 1 Continued		psychological abuse, forced intercourse or sexual coercion, and various controlling behaviors			
Zieman et al. (2016)	Neurology clinic patients	N/A (patients referred from high risk populations/shelters)	Diagnosed by physician at practice with TBI from DV	Chart extraction	81% had LOC related to injuries

4.1.3 Symptom overlap between IPV and TBI

Both intimate partner violence and traumatic brain injury are independently associated with physical, emotional, neurocognitive, and mental health consequences (Goldin et al., 2016; Kwako et al., 2011; Stern, 2004). Physical symptoms include chronic pain, headaches, and sleep disturbances. Emotional and mental health consequences include symptoms related to post-traumatic stress disorder (PTSD), depression, and anxiety (Wong & Mellor, 2013). Neurocognitive complaints such as alterations in memory, attention, and executive functioning or decision-making are also common in both conditions (Kwako et al., 2011; Valera & Berenbaum, 2003). In one study, abuse patients reported behavioral symptoms, including aggressiveness and impulsivity, as most severe, followed by cognitive and physical symptoms (Zieman et al., 2016).

The considerable overlap in sequelae resulting from IPV and TBI was a common theme in the literature reviewed. Several studies have noted that "symptoms commonly displayed by women who experience IPV mirror those associated with PCS" (Kwako et al., 2011, p. 121). Researchers posit that health consequences previously described as products of abuse severity or PTSD from chronic violent episodes may, in reality, be linked to multiple mTBIs. Neuropsychological functioning is a specific example that has previously been presented as an outcome of PTSD or depression instead of a potential result of TBI (Kwako et al., 2011). Kwako and colleagues (2011) proposed a model that positioned TBI as a "precipitating factor" for outcomes such as PCS symptoms. This model posits that TBI has a role in contributing to negative health consequences attributed to IPV via endocrine, neuronal, and immune mechanisms.

This symptom similarity is viewed as a major problem because of the likelihood of misdiagnosis leading to missed treatment opportunities for brain injury. Previously, physical symptoms such as headaches or chronic pain and mental health issues such as depression were treated separately by clinicians and viewed as two distinct problems in the IPV population. In addition, researchers previously hypothesized that difficulties with cognitive and psychological function reported by survivors of abuse is determined by IPV severity itself (Hunnicutt et al., 2016). The integration of clusters of symptoms and a purposeful view of the 'whole individual' would aid in more accurate diagnoses and appropriate treatments in this population.

4.1.4 Biological impact of PIBI

Another major theme across publications is the biological interactions associated with the specific injury type and context of PIBI. Structurally, several brain regions have been studied in IPV and are of concern in PIBI, most notably the prefrontal cortex (PFC). The PFC is the front-most region of the human brain and sits directly behind the frontal bone. It is responsible for executive functions such as judgment, decision-making, and behavioral responses to sensory stimuli (Wong, Fong, Lai, & Tiwari, 2014). Women who have experienced IPV have reduced gray matter volume in the PFC, which could explain alterations in cognitive and behavioral dimensions (Wong et al., 2014). Because the PFC lies directly behind the forehead, it is highly susceptible to trauma in an IPV situation due to hits directly to the front of the head or face as well as countercoup injuries from blows to the back of the head.

One study examined the genomics, or particular genetic variations present in a particular individual, involved in PIBI and recovery (St Ivany & Schminkey, 2016). The researchers explain that success of a person's recovery from TBI is determined in part by these variations, which affect modification, expression, and regulation of genes. Other factors that may be partially influenced by genomics in TBI recovery include memory formation, neuroinflammaory processes, cognitive deficits, depression, and aggression (St Ivany & Schminkey, 2016). This emerging portion of the TBI recovery and rehabilitation field could aid in predicting efficacy and treatment on an individual basis.

Biological responses to chronic stress are well documented in trauma-exposed populations (Hunnicutt et al., 2016; Kwako et al., 2011; St Ivany & Schminkey, 2016; Wong et al., 2014). The effect of IPV experience on the physiological mechanisms associated with the stress response hinges upon the hypothalamic-pituitary-adrenal (HPA) axis. The HPA axis includes the hypothalamus, the pituitary gland, and the adrenal glands. The hypothalamus is a brain structure within the limbic system (often referred to as the emotional brain) that is heavily involved in homeostasis, or the physiological regulation of bodily functions to maintain equilibrium (Wong et al., 2014). In response to a threatening stimulus, such as an intimate partner yelling or acting violently, the amygdala or “fear center” of the brain signals to the paraventricular nucleus (PVN) of the hypothalamus, which releases corticotrophin-releasing hormone (CRH) as part of the autonomic nervous system’s “fight or flight” response. The CRH stimulates the anterior pituitary gland, located just beneath the hypothalamus, to release adrenocorticotropic hormones (ATCH), which enter the blood stream and travel to the adrenal glands that sit atop each kidney. When ATCH reaches the adrenal glands, they secrete glucocorticoids, or “stress hormones,” such as cortisol.

Increased levels of cortisol in the blood are responsible for many downstream effects of the “fight or flight” response including decreased metabolism, increased heart rate, and increased blood flow to muscles. All of these reactions make sense evolutionarily speaking and could be lifesaving in response to occasional fatal danger; however, constant recruitment of this system in response to chronic psychological stress can lead to HPA-axis dysfunction (Wong et al., 2014). Consequently, the stress response occurs more often and results in higher levels of cortisol and other stress hormones in the bloodstream. There is also evidence to suggest that chronic activation of this response can have marked effects on the immune system, but studies regarding the direction and strength of this relationship are still inconclusive (Wong et al., 2014).

4.1.5 Cycle of violence: PIBI's role

The literature touches on how IPV-related brain injury can be not only a result of previous violence, but also a cause of violence perpetration by the victim. In this case, the "cycle of violence" is expanded not just from an abused or maltreated child to an adult who engages in violent crime, but includes violence victims who are mothers at increased risk of perpetrating child abuse (Hunnicutt et al., 2016; St Ivany & Schminkey, 2016).

In other words, PIBI may also increase child abuse and maltreatment, leading to potential TBI in affected children, which perpetuates the cycle. In this context, proper identification, assessment, and rehabilitation of IPV victims who have incurred mTBIs is an important opportunity to break the cycle of child abuse and partner violence (Banks, 2007).

4.1.6 Chronic injury due to IPV environment

IPV often occurs as a series of episodes rather than a single event; therefore, repeated injuries are a likely outcome. Valera and Berenbaum (2003) reported that about half of their IPV survivor sample had incurred multiple PIBIs. Zieman and others (2016) reported a much higher number;

almost 88% of the patients in their study reported more than one brain injury. As for HAI-type IPV-related brain damage resulting from strangulation, 34% of women surveyed by Smith and others (2001) reported three to five strangulation attempts, and 23% reported more than five.

Repeated brain injuries can lead to cumulative damage, worse outcomes, and longer recovery times (Hunnicutt et al., 2016; Kwako et al., 2011; Murray et al., 2016; Valera & Berenbaum, 2003). Secondary-impact syndrome, a condition resulting from sustaining a second brain injury before healing from a prior one, can lead to poor memory and judgment, lack of ability to perform tasks at the pre-injury level, and even death (Banks, 2007). In one sample, a quarter of the women had been hit in the head or face over 20 times in the past five years, and the researchers found a significant correlation between frequency of being hit in the head and severity of cognitive symptoms (Jackson et al., 2002). Prolonged experience of partner-perpetrated violence is a reality for many women, and the above statistics show that repeated head trauma is not uncommon in this group.

4.1.7 Population differences

St. Ivany and Schminkey (2016) did some simple calculations using current estimates for IPV-related TBI and noted that, even using the low end projections, "85 times more women than Iraq and Afghanistan veterans and 37,000 times more women than NFL players" (p. 129) are living with a TBI in the United States. However, the vast majority of research in the field of TBI has been conducted in contact sport athletes, military personnel, and single-incident head trauma victims (Banks, 2007; Hunnicutt et al., 2016; Kwako et al., 2011; Murray et al., 2016). Although these efforts have revealed a wealth of knowledge that can be utilized as a starting point for other related TBI research, their findings cannot be applied to all populations. Those who experience

IPV-related brain injury are a unique population and research within the context of violent relationships is necessary.

Several TBI screening tools exist; however, they are aimed at detecting TBI in the general population (6), service members (2), or athletes (1) (Goldin et al., 2016). In the general population, TBI is generally generated from a single event, such as an automobile accident, fall or assault, and the screening tools created for this population are largely tested on young healthy males (St Ivany & Schminkey, 2016). In addition, most of these tools are specifically evaluating events that cause blows to the head and often ignore HAI all together (Goldin et al., 2016). Also, as stated above, in athlete populations, comparisons of pre- and post-injury function are possible. This is unlikely to occur in victims of IPV because a visit to the doctor in the context of the abuse before the first victimization that could result in TBI is uncommon. Injury mechanism also appears to differ between athletes and IPV victims, with athletes receiving more flexion-extension type injuries while abuse victims are more likely to suffer from rotational forces, with increased risk of significant PCS symptoms (Corrigan et al., 2003).

The IPV population is likely to have poorer outcomes after a PIBI than other brain injury-prone populations for several reasons, including assault as the cause of the TBI, substantial psychological stress prior to the injury, and female gender (Corrigan et al., 2003). All three of these are present in the majority of IPV-related PIBI occurrences. Seeking care immediately after incurring head trauma and receiving timely treatment tend to confer more favorable results after injury (Murray et al., 2016). Being rushed to the hospital or medical area is likely for other populations that experience high rates of TBI, but for IPV victims, it is not common. For several reasons, battered women often do not seek medical care until their injuries are severe. They are also often misdiagnosed and thus receive inadequate or inappropriate treatment (Banks, 2007).

Additionally, brain injury victims who are not given proper time away from responsibilities and activities to rest fare worse than those allowed to recuperate (Banks, 2007; Murray et al., 2016). Athletes receive return-to-play instructions and notifications from doctors that they should ease up on practice, play, and school work to get adequate rest (Banks, 2007; Hunnicutt et al., 2016). Given their unique social context and environmental conditions, this is not usually the case with IPV victims who sustain injuries.

4.1.8 PCS symptom outcomes and implications

Researchers posit that physical and psychological problems stemming from TBI may leave victims without the capacity to advocate for themselves and/or leave the violent relationship (Linton, 2015). Residual effects of brain injury pose a particular risk to victims of IPV as they can make it harder for a woman to assess danger and defend herself, to remember safety plans (for her and children), to go to school or work (which ties into financial dependence), to locate and access services, to retain custody of her children, and to appear competent in a court of law (New York State Office for the Prevention of Domestic Violence, 2002). Intervention in this population is even more critical because women are more likely than men to develop post-concussive syndrome, and victims of abuse show poorer outcomes than other-cause TBIs (Corrigan et al., 2003).

Some PIBI symptoms may increase victims' vulnerability and increase risk for further violence from their abusive partners (Jackson, 2002). One PCS symptom many PIBI survivors suffer is altered emotional processing, which can lead to increased or decreased emotional expression (Banks, 2007). Thus, patients can present with flattened affect or inability to control their emotional expression. In addition, women experiencing PIBI may be less able to interpret emotional expression conveyed by others. All of these factors may influence the victim's ability to perceive danger and act accordingly. Another PCS symptom with poor outcomes for IPV victims specifically is the memory loss associated with PIBI. This may cause problems for women when trying to remember their safety plan for when the abuser becomes violent (Murray, 2016). Decision-making may also be difficult due to PCS symptom clusters such as confusion, impulsivity, and attention problems likely to be seen in those with frontal lobe or PFC injuries (Murray et al., 2016; Wong et al., 2014). One study revealed that women with brain injuries felt that their ability to make informed decisions relating to shelter and child care was compromised (Banks & Ackerman, 2002). Learning problem-solving strategies in therapy is a capacity building exercise that can benefit survivors of PIBI (Murray, 2016).

Holding a job or attending school requires attention, concentration, problem solving, and abstract thinking that women who suffer from PIBI may not possess as consequences of their injuries. However, staying in or returning to the workplace or school could mean financial self-sufficiency and decreased isolation for the IPV survivors who need it most (Murray et al., 2016). The ability to get and hold a job, and thus be financially independent of the abuser, may be the single most important factor for supporting a survivor in leaving an abusive relationship. In order to gain custody of children from her abuser, an IPV survivor must appear competent to care for them in a court. Some PIBI symptoms that may complicate this task include confusion, lack of attention, difficulty remembering details and sequences of events, speech problems, and emotional issues. Generally speaking, Jackson and colleagues explain that "the frequency and severity of symptoms…make it difficult to think through or cope with the complex…organizational tasks required for battered women to stop the violence, disengage from violent partners, and/or establish independent lives" (2002, p. 43).

4.1.9 Future directions

Each empirical study and review identified in the literature search included several suggestions for future directions. Many publications suggested that researchers undertake longitudinal studies in IPV survivors in order to understand the developmental trajectory as well as risk and protective factors for PIBI (Stern, 2004). Studying this phenomenon across the lifespan is also useful to better understand the cycle of violence, future victimization, and how PIBI affects financial, social, psychological, and environmental factors over time both in women who stay in abusive relationships and those who leave (Hunnicutt et al., 2016).

Most researchers agreed that utilizing more extensive samples to arrive at better prevalence estimates as well as effects of PIBI is still necessary (Corrigan et al., 2003; Linton, 2015; Valera & Berenbaum, 2003; Wong et al., 2014). Outcome studies to determine best practices in rehabilitation and treatment techniques specific to IPV survivors are another key area of research (Banks, 2007; Murray et al., 2016). Neuroimaging studies to further elucidate mechanisms relating to how and why some victims of IPV (with or without TBI) develop negative neurocognitive and mental health outcomes were suggested as well (Hunnicutt et al., 2016; Wong et al., 2014).

Health care professionals and IPV advocates have a critical role to play moving forward. Buy-in from these groups is essential for growth and acceptance of the integration of neurotrauma and IPV (Murray et al., 2016; Valera & Berenbaum, 2003). Training advocates who are not TBI experts to identify potential PIBI victims is key to increasing effective screening by meeting battered women where they seek assistance (Murray et al., 2016; Stern, 2004). Due to lack of awareness of PIBI in the medical community, Stern (2004) suggests incorporating courses in medical school on the subject of violence against women using materials from the

American College of Physicians. However, buy-in may not be as easy as simply providing resources due to time constraints and other barriers service providers experience (Banks, 2007; Stern, 2004). One less logistical barrier is the motivation to care for brain-injured patients, who can be quite difficult to interact with in a treatment setting. Patients or clients with brain injury may engage in inappropriate behavior due to lack of inhibition, confusion, and other PCS-related symptoms making them appear difficult, noncompliant, and impatient to care providers and staff (Banks, 2007).

When discussing practice guidelines, importance of screening was a major focus (Goldin et al., 2016; Hunnicutt et al., 2016; Iverson & Pogoda, 2015; Linton, 2015; Murray et al., 2016; Roberts & Kim, 2006; Stern, 2004). Goldin and others (2016) state that screening may prevent or reduce years of suffering and inappropriate treatments. Screening for PIBI in the IPV population is critical because it is the most efficient way to identify IPV victims who have incurred one or multiple PIBIs and get them the health care and assistance they need to decrease the burden of their injury. This is important for providing an accurate diagnosis, prescribing an appropriate treatment plan, and preventing subsequent PIBIs to avoid the negative effects of repeated head trauma (Banks, 2007; Corrigan et al., 2003; Goldin et al., 2016; St Ivany & Schminkey, 2016). Secondary prevention in the form of earlier identification and treatment as well as reduced number of repeated PIBIs are all possible through more effective screening processes. This will ensure more promising prognoses for this population in the future.

Although the experts agree that screening is paramount to understanding and decreasing the impact of PIBI, several issues with current screening tools and procedures must be addressed. The most problematic is that there is not a TBI screening tool specifically geared toward the IPV-affected population (Goldin et al., 2016). The tools that do currently exist are not particularly applicable to this vulnerable population due to difficulties with safe endorsement of an event and lack of questions regarding shaking, hits to the face, and attempted strangulation. In addition, TBI screening tools are either self-administered or interview-based. Self-administered instruments, although possibly inaccurate in this population, appear to be the best option because the only probable witnesses to the causal event is the perpetrator and possibly children. Other diagnostic techniques such as neuroimaging do not detect most mTBIs (Ackerman & Banks, 2003; Valera & Berenbaum, 2003). Thus, in order to detect mTBIs with greater accuracy in the future, a creative approach should be used including neurological examinations, self-report data, and neurocognitive batteries as well as new and improved technologies.

Hunnicutt and colleagues (2016) published a call to action for interdisciplinary research and practice in the PIBI realm and introduced the idea of viewing this issue through the lens of the socio-ecological model or SEM. They claim that using the SEM will improve understanding of the reciprocal interaction between the body and various social factors relevant to IPV and TBI. Previously, both IPV and TBI were studied mainly on the individual level and sometimes the interpersonal level (e.g., safety plans and couples therapies). Expanding our thought process to include the community and societal levels creates the context necessary to develop useful interventions for this population. Especially since the social context of IPV is what makes PIBI different from other-cause TBI, the SEM is helpful for both research and practice.

Another important and relatively rarely made point is the ethics of doing research with this population. While it is generally understood that research and treatment for those who experience IPV must address safety concerns first and foremost, Hunnicutt and colleagues (2016) express apprehension about increasing stigma toward survivors, victim blaming, and ammunition utilized by perpetrators to discredit or invalidate the victim. Research findings surrounding PIBI could exacerbate these issues if they are portrayed inappropriately in the media promoting the message that survivors are “damaged goods.” Additionally, an abusive partner could use the documented sequelae of a brain injury against a victim in court, bringing into question her ability to make appropriate child care decisions, for example.

Interventions and services specifically geared towards those who have suffered a PIBI at are crucial (Hunnicutt et al., 2016; Kwako et al., 2011; Murray et al., 2016; St Ivany & Schminkey, 2016; Stern, 2004; Wong et al., 2014). Holistic interventions that address the physical symptoms as well as psychosocial outcomes are recommended (Kwako et al., 2011; St Ivany & Schminkey, 2016). Researchers also suggest creating community-based programs that avoid victim blaming and focus on skill and capacity development (St Ivany & Schminkey, 2016; Wong et al., 2014). Focusing on improvement or attainment of skills and adaptive behaviors rather than victim blaming or merely asking a woman why she does not leave her abusive partner will be a welcomed change from previous attempts at secondary intervention (St Ivany & Schminkey, 2016).

5.0 DISCUSSION

Why is partner-inflicted brain injury not receiving more attention? IPV is a major, widespread, and long-standing problem. Research has shown that head injury is common in women who experience IPV (Corrigan et al., 2003; Jackson et al., 2002). So why is this area so under-explored and under-publicized when TBI is a current hot topic in both research and the media?

Four key reasons help explain why this “silent epidemic” in public health has been overlooked: research populations, stigma, access, and misdiagnosis. Population incompatibility is clear in this area because the major research populations for TBI are different from the research population for IPV. Research regarding TBI is almost exclusively conducted with male-dominated populations: military veterans, professional athletes, and male rodents (McKee et al., 2013; White-Gbadebo & Hamm, 1993; Zuckerman et al., 2015). These lines of research are also often supported by funders with specific interests that do not involve women’s health, such as the National Football League and the Department of Defense. Because women are significantly more likely to experience IPV than men, IPV research is often conducted with female survivors of assault (Coker et al., 2002; Goldin et al., 2016; Linton, 2015; Muelleman, Lenaghan, & Pakieser, 1996; Tjaden & Thoennes, 2000; Wong & Mellor, 2013). A funding source for this area of research is the Office of Women’s Health within the Department of Justice. These distinct groups create a perfect setting for these two related issues to appear unrelated to the public health and medical communities.

A second contributing factor is the stigma related to intimate partner violence, which leads to underreporting. This underreporting combined with inadequate or nonexistent screening protocols creates the misunderstanding that PIBI resulting from IPV is not a common occurrence. A third issue is that women in IPV situations may not be able to access medical care due to a controlling partner, or conversely, even if she can access treatment, it may be contingent on an abusive partner's insurance coverage. Finally, many symptoms of traumatic experiences and related disorders such as PTSD have considerable overlap with symptoms of TBI. Therefore, it is extremely likely that women will be misdiagnosed and their TBI will go undetected due to the lack of established association between battery and brain injury.

After exploring the scant literature in existence on the topic of PIBI and reporting the main corroborated results across several publications, suggestions for the future of research about the intersection of IPV and neurotrauma will now be discussed.

5.1 MTBI DEFINITION

The various definitions of mTBI make comparison across studies relatively difficult. However, many publications reference the American Congress of Rehabilitation Medicine definition:

> [A] traumatically induced physiological disruption of brain function as manifested by at least one of the following: 1. any period of loss of consciousness; 2. any loss of memory for events immediately before or after the **accident**, 3. any alteration in mental state at the time of the **accident** (e.g., feeling dazed, disoriented, or confused); and [4.] focal neurological deficit(s) that may or may not be transient…(emphasis added, 1993, p. 86)

In order to make this definition more inclusive of IPV-related brain injuries (i.e., PIBIs), the word "accident" (highlighted above) should be replaced with the word "incident" or "event." Revising the definition to better reflect partner violence-related injuries reduces stigma and allows a relatively underrepresented population within mTBI to be acknowledged, without decreasing the relevance for any other group or cause. Recognizing intentional mTBI as a part of the overall issue and focusing the broad spectrum of definitions used today is a preliminary step in the direction of interdisciplinary research to combat PIBI.

5.2 RESEARCH FUTURE DIRECTIONS

5.2.1 Accurate prevalence rates

Current estimates of IPV-related TBI and HAI are not reliable due to sampling and reporting complications in this vulnerable population (Corrigan et al., 2003). One potential reason for the wide range of prevalence estimates in the articles discussed is the use of various qualifiers for PIBI. Some researchers are more conservative and require LOC, while others use PCS symptoms to delineate which participants are likely to have a latent brain injury. However, some experts suggest that LOC may not be necessary to incur a brain injury (Corrigan et al., 2003). Thus, having a better set of diagnostic criteria for brain injuries may lead to more reliable numbers. Obtaining more accurate prevalence rates also requires a more effective sampling scheme that can capture a larger portion of those who experience IPV, not the small fraction that is reached at EDs or shelters. In the United States, there are two large-scale IPV surveys, one conducted by CDC and the other by the National Institute of Justice (NIJ); however, neither includes questions related to TBI or HAI (Hunnicutt et al., 2016).

The most cost-effective approach to achieving a representative sample is to incorporate brain injury-related questions into the National Violence Against Women Survey and the

National Intimate Partner and Sexual Violence Survey. This is a relatively simple solution because the infrastructure already exists and the majority of TBI screening questions are already in self-administered or interview format, lending themselves to easy adaptation to telephone interviewing. One major weakness of this approach is that the use of telephone interviewers might introduce a social desirability bias, albeit less so than a face-to-face interviewer, they may still affect respondents' answers especially for stigmatized, sensitive topics. This issue could be minimized by asking questions in a way that allows safe and private endorsement of events without outright admission of IPV (Goldin et al., 2016). Another way to minimize bias is using interactive voice response software, or IVR during telephone interviews. IVR is a program used in computer-assisted telephone interviewing (CATI) that allows for the respondent to answer a question without another human hearing their response. It can also be used in tandem with live interviewing where IVR is used for only sensitive sections of a survey (Brooks et al., 2016).

One additional course of action that would contribute to more data and better estimates would be to work with TBI researchers to add IPV as a mechanism of injury to databases. There are several national TBI databases, often associated with level one trauma centers, that collect and organize variables related to TBI in patients. One of these variables is mechanism of injury including categories such as falls, motor vehicle accidents, and assault. However, the selections are not precise enough to include IPV independent of all-cause assaults. The inclusion of IPV as a separate option would allow for researchers to assess TBIs in the survivor population.

5.2.2 Longitudinal studies

Longitudinal studies are essential to understanding the complex relationship between IPV and brain injury and how the health problems associated with PIBI relate to victim outcomes.

Tracking changes in physical, mental, and social health over time could reveal the cumulative toll these injuries take on those who suffer PIBIs. Current data come from studies that are cross-sectional in nature, and although the results are informative, knowledge of temporality would aid in mechanistic understanding of sequelae associated with PIBI and creation of quality, context-specific interventions.

One specific type of longitudinal study would investigate whether a PIBI has a moderation effect on other physiological or psychological health outcomes. This could be accomplished by conducting a longitudinal cohort study of women within the IPV population. Comparison of a group that has been exposed to PIBI and a group with no PIBI exposure on a specific health outcome such as depression would yield useful results. Post-traumatic depression is a common occurrence after TBI (Kreutzer et al., 2001). Depression is also one of the most prevalent emotional symptoms of IPV (Barker-Collo, Starkey, & Theadom, 2013; Cascardi et al., 1999; Golding, 1999). This kind of study could serve to uncover whether a significant portion of IPV survivors with depression are actually experiencing PTD (e.g., worse depressive symptoms because of a brain injury) or if PIBI has no effect beyond that of IPV alone. This type of comparison would enable researchers to examine PIBI's effect on a myriad of health outcomes as well such as anxiety and chronic pain. This vein of research essentially serves to elucidate whether symptoms result from the emotional trauma of experiencing IPV or if PIBI changes brain circuitry in a way that leads to these issues. This could help explain the similarities in symptoms experienced following IPV and TBI, as it is possible that many women with disorders attributed to IPV alone may be suffering symptoms associated with a brain injury resulting from the abuse.

5.2.3 Type and frequency matter

The most recent estimate of cost to society related to IPV in general is over 8.3 billion dollars (Max, Rice, Finkelstein, Bardwell, & Leadbetter, 2004). This includes medical costs and lost productivity, but does not include the costs of running shelters and assistance programs, or legal fees. In terms of PIBIs, the fact that these injuries are going undetected or misdiagnosed would influence the overall cost as well. Furthermore, the chronic nature of IPV and cumulative symptomology of repeated head trauma both point to poorer prognoses and even higher costs to society than previously estimated. New estimates that reflect these issues should be calculated to better illuminate the true expense associated with this hidden consequence of IPV.

Although it is clear that repetitive blows to the head and strangulation attempts occur within the context of IPV, there is no existing research pertaining to symptomology and consequences of multiple PIBIs in those who suffer from partner abuse (Hunnicutt et al., 2016). Studies of CTE thus far have been conducted mostly in military veterans, professional athletes, or those with known exposure to contact sports (McKee et al., 2013). However, given the similarity in repetitive hits to the head, it is disappointing that this disease has not been explored specifically in IPV-related TBI victims. Results from research in veteran and athlete populations implicate worse outcomes in repeated head injury, but do not give us insight into potential outcomes in the unique context of IPV victimization. At present, the only way to study CTE is to examine the brain of the patient post-mortem (protectthebrain.org). Neuropathological evaluation has been completed at brain banks primarily in athletes, but studies of CTE and potentially other abnormalities using tissue from IPV victims is imperative to understand whether and to what extent CTE occurs in this population. In addition, HAI appears to be even less well studied than

TBI in the IPV survivor population. Research regarding the prevalence and mechanism of HAI alone is needed, but it should be studied in tandem with blows to the head as well.

5.2.4 Stress and PIBI

According to Corrigan et al. (2003), substantial stress in the victim prior to the injury is correlated with negative outcomes in TBI. Literature suggests that living in constant fear of being abused and potentially suffering serious injury leads to chronic stress and PTSD in many victims of IPV (DeJonghe, Bogat, Levendosky, & von Eye, 2008). Data shows that chronic stress in trauma-affected persons can lead to HPA-axis dysfunction (Heather et al., 2012). In HPA-axis dysfunction, the brain regions involved in mounting and controlling the stress response may be altered in function, structure, or communication with other brain regions (Bremner, 2006). Research shows that women with IPV experience and PTSD have greater reactivity of the anterior insula, a region of the amygdala responsible for launching the stress response cascade in reaction to a fear-inducing environmental stimulus (Simmons et al., 2008). In a study of women with mTBI, certain neurocognitive skills were inversely correlated with stress level. As stress levels increased, participants' verbal memory, reaction time, and motor processing speed scores all decreased (Bay & Covassin, 2012). Although this study was not carried out in the IPV survivor population, the implications surrounding the likelihood of the interaction of chronic stress and mTBI in women who experience IPV are clear.

Traumatic environmental events, such as episodes of IPV, can also instigate genetic alterations that can affect the stress responses via over- or under-methylation at glucocorticoid receptor genes (Yehuda et al., 2015). This causes the genes to be over- or under-expressed, amplifying or dulling the stress response, depending on age of exposure (Radtke et al., 2011;

Yehuda et al., 2015). In addition, data from animal studies indicate that chronic high stress hormone levels during the three months prior to a TBI increased motor and cognitive deficits observed after injury (White-Gbadebo & Hamm, 1993). A study by Bay and Covassin (2012) with human participants who had mild or moderate TBI (not necessarily IPV-related) suggests that chronic stress, such as that of living in violent relationship, could have deleterious effects on brain recovery, specifically emotional outcomes.

Therefore, the lack of diagnosis of PIBI in people who experience IPV is especially dangerous given the victims' situations. Allowing these injuries to go undetected knowing that most victims will be recuperating in a highly stressful environment sets them up for a far less successful recovery. The fact that chronic stress has the potential to enhance deficits after a brain injury is yet another reason to push for better screening. It also serves as an important catalyst for more research into how stress and HPA-axis dysfunction affect the injured brain and recovery. Animal models of IPV-related TBI would help us better understand the specific mechanisms of this type of brain injury in a chronically stressful environment. A study similar to that of White-Gbadebo and Hamm's (1993) cited above, but with sustained elevated stress hormone levels after the injury would be a more accurate model of TBI recuperation in an abusive situation, illuminating the true hindrance of the IPV context to recovery.

5.2.5 Cycle of violence: role of brain injury

Throughout this thesis, the focus has been on IPV-related TBI, specifically describing the connection between these two issues in one direction, that is, brain injury incurred by the IPV victim. One emerging concept is that brain injury and IPV have various and cyclical effects on one another. Some data suggest that TBI begets IPV; perpetrators of IPV are highly likely to have a previous brain injury (Elbogen et al., 2012; Farrer, Frost, & Hedges, 2012; Freedman & Hemenway, 2000). Literature suggests that consequences of TBI in male abusers such as impulse control and aggression could, to some extent, explain IPV perpetration (Cohen, Rosenbaum, Kane, Warnken, & Benjamin, 1999; Crane & Easton, 2015; Farrer et al., 2012). In addition, findings show that the TBI rate in women at risk for abusing their children is three times that of the general population (van Vliet-Ruissen, McKinlay, & Taylor, 2014). In light of this, theoretically brain injury could partially contribute the cycle of violence: a child experiencing abuse sustains an inflicted head injury then grows up to perpetrate partner violence, potentially inflicting a brain injury leading to a higher likelihood of child abuse and so on.

5.3 PRACTICE FUTURE DIRECTIONS

5.3.1 Screening suggestions

The most important aspect related to screening moving forward is increasing the number of EDs and shelters that require staff to screen for TBI when IPV is suspected or vice versa. Implementing IPV screening protocols in EDs is an important first step to correctly diagnosing more PIBIs. Women who enter the ED with a head injury should be screened for IPV in addition to usual TBI and neural functioning batteries. In shelters and other community places where IPV victims seek assistance, staff and advocates should be trained to administer brain injury screenings. Identification and validation of a PIBI screening tool is the most pressing need in this area. Goldin and colleagues (2016) carried out a review of nine available TBI-screening instruments, none of which were created with the IPV population in mind, and found that each would need to be altered to fit a set of three criteria: (1) the tool must include events that may lead to a TBI in an abusive situation, (2) the tool must allow safe and private endorsement of events without specific outing of the perpetrator, and (3) the tool must be easy to administer (2016). Existing tools did not fit the criteria because some did not include questions about strangulation, shaking, or being hit in the face, as they were geared toward accidents, falls, sports injuries, and blast injuries. Others did not allow for the reporting of multiple events in a single screening. Most were self-report or interview administration, so ease of use was not a major issue.

It is known that women survivors of IPV prefer self-administered screening tools, this method is flawed because the respondent is the victim of a potential brain injury, and thus may have some amnesia surrounding the event, limiting accurate recall (Kataoka, Yaju, Eto, & Horiuchi, 2010). However, self-administered questionnaires are the standard for detecting brain injury in research to date (Corrigan & Bogner, 2007). The Brain Injury Screening Questionnaire (BISQ) could be used with slight alterations, such as inclusion of prompts related to shaking and blows to the face and neck as well as attempted strangulation, also recommended by the Goldin group (2016) as the result of their review. Combining the BISQ with service provider elicitation when clarification is needed could yield superior results. The prompts from service providers could be taken from the Ohio State University TBI Identification Method, an interview-based protocol for detecting TBI (Corrigan & Bogner, 2007).

Training health care and service providers to administer these screenings is an important next step. The "Traumatic Brain Injury as a Result of Domestic Violence: Information, Screening, and Model Practices" manual, which could be used to aid in training, was created by the Pennsylvania Coalition Against Domestic Violence (PCADV) in 2011 (pcadv.org). The training curriculum was intended to “build skill and resource capacities pertaining to TBI as it intersects with domestic violence for medical and program advocates” (Gilkerson, 2011, p. ix). The use of materials like this manual in trainings with non-TBI service providers to increase subject familiarity and self-efficacy to screen the women they interact with is critical.

5.3.2 Partnerships

Within the theoretical discussion of the social-ecological approach, researchers champion partnerships between IPV researchers, first responders, and health care providers (Hunnicutt et al., 2016). Shelter staff and advocates should be included in this list as well. Forging two-way connections among various service providers increases their knowledge of available IPV and health care services, which can be passed along to patients and clients. Research shows that patients suffering from IPV are more likely to access and utilize an intervention if their health care provider connects them to the program providing the service (Hathaway, Willis, & Zimmer, 2002; McCloskey et al., 2006). Giving health care providers the tools to appropriately respond to disclosure and the self-efficacy to conduct warm referral to advocates is suggested for IPV-exposed patients, and extending this practice for PIBI as well is recommended (Miller, McCaw, Humphreys, & Mitchell, 2015).

Implementing screening and universal education about signs of a TBI in the IPV population could increase the number of victims who recognize symptoms in themselves and seek medical assistance. Because they often have long-standing relationships with their patients, primary care and reproductive health clinicians (i.e., those who see women regularly) and office staff could receive training in this type of intervention.

One example of this type of partnership in the context of PIBI is in Arizona at the Barrow Neurological Institute (Zieman et al., 2016). The Barrow Neurological Institute is a clinic that specializes in TBI and has established relationships with five domestic violence and homeless shelters in surrounding communities. When a new resident arrives at one of the shelters, he or she is screened for brain injury and, if necessary, referred to the clinic for further evaluation and care. The efforts put forth by the program are grant-funded and cover visits to neurology clinics, necessary medications, psychiatric consultation, neuropsychological testing, social work services, radiographic services, and physical, occupational and speech and therapies associated with TBI (Zieman et al., 2016). More partnerships like this would not only generate a wealth of data about this difficult-to-reach population, but would also allow for significant improvements in detection and linkage to care, improving secondary prevention strategies.

5.3.3 Shift the focus

Clearly, screening for PIBI in the IPV population presents several challenges due to reporting biases, timing of screening, lack of credible witnesses to the causal event, and recall concerns. These will all need to be addressed in the current head trauma examination environment, which commonly inquires about parameters of the injury such as the amount of force at impact, area or positioning of impact, and duration of LOC. While these estimates may be useful on the playing field or battlefield, these types of parameters are not useful in most IPV-related events because a victim may not be seen by a physician until long after the event and is unlikely to have an estimate of speed or force of the insult. It is imperative that diagnostics research and practice in this field shifts to a more neurological approach. Examination of neurological deficits and symptom assessment could be utilized to find those with significant impairments and create individualized treatment plans.

6.0 CONCLUSION

IPV has a myriad of negative health outcomes, one of which is brain injury. Whether the brain injury results from a blow to the head, neck, or face or attempted strangulation, damage to neural tissue has several consequences. These consequences are especially harmful in the IPV population, as the symptoms associated with PIBI can make leaving or changing the abusive situation much more difficult. In addition, there is very little media coverage or research funding geared toward specifically toward IPV-related brain injury. It is imperative that the research, health care, and advocate communities direct attention to identifying IPV survivors and connecting them to the services they need. Although recognition of brain injury and IPV as public health crises has increased, there is a lack of research into the relationship between the two. This thesis has described the gravity of IPV and brain injury, reviewed relevant articles pertaining to IPV-related brain injuries to date, and suggested novel research directions to expand this field in specific areas of need.

A limitation of this paper is the use of only two databases to search for relevant articles; however, the additional inspection of references from selected papers to ensure all appropriate articles were included alleviated this issue to some extent. In addition, the findings considered in this review are only as reliable as the original papers, which are subject to data collection issues and biases. For instance, relying on victim self-report of events that may have caused a brain injury.

It is time to turn our attention to the millions of women silently suffering from PIBI. We must use existing infrastructures, relationships, and resources to reach out to this under-recognized population, identify those who require services, and offer support. PIBI could be the root of debilitating symptoms experienced by these women every day. There are women living without proper diagnosis, without effective treatment, and without safe, reliable support. Clearly, the best scenario would be a world in which IPV was not as prevalent or nonexistent; however, the continued work toward primary prevention is still necessary. Until this is achieved though, secondary prevention in the form of more and better research and interventions is critical to avoid chronic abuse leading to further injury and worse outcomes for survivors.

APPENDIX A: LITERATURE SEARCH DETAILS

PubMed search conducted: 07/12/2016

Recent queries in pubmed		
Search	Query	Items found
#20	Search ((((Brain Injury[tiab] OR Brain injuries[tiab] OR Traumatic Encephalopathy[tiab] OR Brain Trauma[tiab] OR Brain Traumas[tiab] OR Traumatic Encephalopathies[tiab] OR TBI [tiab] OR TBIs [tiab] OR Brain Lacerations[tiab] OR Brain Laceration[tiab] OR Brain Contusion[tiab] OR Brain Contusions[tiab] OR Cortical Contusion[tiab] OR Cortical Contusions[tiab] OR Post-Concussive Encephalopathies[tiab] OR Post-Concussive Encephalopathy[tiab] OR Post Concussive Encephalopathy[tiab] OR Post-Traumatic Encephalopathies[tiab] OR Post-Traumatic Encephalopathy[tiab] OR Post Traumatic Encephalopathy[tiab] OR Acute Brain Injury[tiab] OR Acute Brain Injuries[tiab] OR Mild Traumatic Brain Injury[tiab])) OR "Brain Injuries"[Mesh])) **AND** (((Intimate Partner Abuse[tiab] OR Dating Violence[tiab] OR Spousal Abuse[tiab] OR Partner Abuse[tiab] OR Wife Abuse[tiab] OR Family Violence[tiab] OR Domestic violence[tiab] OR Spouse abuse[tiab] OR Intimate Partner Violence[tiab])) OR ((("Domestic Violence"[Mesh:NoExp]) OR "Spouse Abuse"[Mesh]) OR "Intimate Partner Violence"[Mesh:NoExp]))	65

PSYCinfo search conducted: 08/29/2016

	Searches	Results	Type	Actions	Annotations
	traumatic brain injury/ or brain concussion/	14438	Advanced	Display Results More	
	intimate partner violence/ or partner abuse/ or domestic violence/	16661	Advanced	Display Results More	
	traumatic brain injury/ or brain concussion/	14438	Advanced	Display Results More	
	3 and 1	14438	Advanced	Display Results More	
	1 and 2	18	Advanced	Display Results More	

1 and 2: *Search terms used:* brain concussion, domestic violence, intimate partner violence, partner abuse, *t*raumatic brain injury

Search Returned: 18 text results

Citation consideration: 08/30/2016 – 08/31/2016

Six additional articles were found eligible for inclusion.

APPENDIX B: RELEVANT ARTICLES

Author, Year	Title
Ackerman & Banks, 2003	Assessment, treatment, and rehabilitation for interpersonal violence victims: Women sustaining head injuries
Banks & Ackerman, 2002	Head and brain injuries experienced by African American women victims of intimate partner violence
Banks, 2007	Overlooked but critical: traumatic brain injury as a consequence of interpersonal violence
Braker & Kingbeil, 1995	Head injuries and DV
Corrigan, 2003	Early identification of mild traumatic brain injury in female victims of domestic violence
Davis, 2014	Violence-related mild traumatic brain injury in women: identifying a triad of postinjury disorders
Goldin, 2016	Screening for History of Traumatic Brain Injury Among Women Exposed to Intimate Partner Violence
Hunnicutt et al., 2016	The Intersection of Intimate Partner Violence and Traumatic Brain Injury: A Call for Interdisciplinary Research
Iverson, 2015	Traumatic brain injury among women veterans: an invisible wound of intimate partner violence
Jackson, 2002	Traumatic Brain Injury: A Hidden Consequence for Battered Women
Kwako, 2011	Traumatic Brain Injury in Intimate Partner Violence: A Critical Review of Outcomes and Mechanisms
Linton, 2015	Interpersonal violence and traumatic brain injuries among Native Americans and women
Mechanic et al., 2008	Risk Factors for Physical Injury Among Help-Seeking Battered Women An Exploration of Multiple Abuse Dimensions
Monahan & O'Leary, 1999	Head injury and battered women: an initial inquiry

Murray, 2016	Practice Update: What Professionals Who Are Not Brain Injury Specialists Need to Know About Intimate Partner Violence-Related Traumatic Brain Injury
No authors listed, 2015	Use screening tools, partnerships to improve identification, care of victims of IPV, 2015
Roberts & Kim, 2006	Exploring the Effects of Head Injuries Among Battered Women: A Qualitative Study of Chronic and Severe Woman Battering
Smith et al., 2001	Frequency and relationship of reported symptomology in victims of intimate partner violence: the effect of multiple strangulation attacks
St Ivany & Schminkey, 2016	Intimate partner violence and traumatic brain injury: State of the science and next steps
Stern, 2004	Traumatic brain injury: an effect and cause of domestic violence and child abuse
Valera and Berenbaum, 2003/2000 (dissertation)	Brain injury in battered women
Wilbur, 2001	Survey results of women who have been strangled while in an abusive relationship
Wong & Mellor, 2013	Intimate partner violence and women's health and wellbeing: impacts, risk factors and responses
Wong et al., 2014	Bridging intimate partner violence and the human brain: a literature review
Zieman, 2016	Traumatic Brain Injury in Domestic Violence Victims: A Retrospective Study at the Barrow Neurological Institute

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