

COVID-19-induced surge in the severity of gender-based violence might increase the risk for acquired brain injuries

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Abstract

While initial reports have emphasized a global rise in the frequency of intimate partner violence following COVID-19, emerging data are now showing a concerning surge in the severity of COVID-19-induced physical intimate partner violence. One of the most dangerous, frequent, yet hidden consequences of severe physical intimate partner violence is acquired brain injury, including repetitive mild traumatic brain injury and hypoxic brain injury. Although the increase in high-risk physical abuse during COVID-19 is gaining recognition, what still remains absent is the urgent discussion on intimate partner violence-related acquired brain injury during these times. The potential analogous surge in intimate partner violence-related acquired brain injury may have implications for both healthcare providers and healthcare actions/policies as repeated brain injuries have been associated with residual functional deficits and chronic disability. In addition, even in the pre-pandemic times, intimate partner violence-related acquired brain injury is likely unrecognized and/or misclassified due to overlap in symptoms with other comorbid disorders. This review aimed to raise awareness about intimate partner violence-related acquired brain injury within the context of COVID-19. Health actions and policies that should be considered as part of the pandemic response to minimize adverse outcomes associated with intimate partner violence-related acquired brain injury have also been discussed.

Keywords

Acquired brain injury, COVID-19, hypoxic brain injury, intimate partner violence, mild traumatic brain injury, neurology, orthopedics/rehabilitation/occupational therapy, women, women's health

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Introduction

The unprecedented COVID-19 pandemic, that originated in December 2019¹ continues over a year later, claiming millions of lives.² Recently, the re-surge in COVID-19 cases and the spread of newly discovered, highly transmissible and lethal COVID-19 variants in some parts of the United States and around the world have called for increased compliance with the state and community mitigation strategies (lock-downs, strict isolation, quarantines, and travel restrictions) by the Centers for Disease Control.^{3–6} Although these mitigation strategies have assisted in curbing the overall progression of COVID-19,⁷ they have also created numerous hardships including health-related predicaments for vulnerable populations.⁸ Among those unduly affected marginalized groups,^{9–11} female survivors of intimate partner violence (IPV) have potentially taken one of the hardest hits.^{1,11,12} IPV is any form of physical, psychological, verbal, or sexual

abuse perpetrated by a current or former intimate partner,¹³ which affects about one in three females globally.¹⁴ Sheltering-in-place led to an average of 7.5% increase in IPV service calls during the first 12 weeks of COVID-19 in major metropolitan areas in the United States.¹⁵ The IPV calls also soared from those city blocks that lacked the history of such calls.¹⁵ From 7% to 27% increase was also reported in IPV-related aggravated assault and subsequent arrests in large North American cities in the early aftermath of the

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pandemic.¹⁶ Even after a year later, when the economy has started to open back-up, many US domestic violence organizations are reporting continued increases in IPV help calls.¹⁷

Gender-based violence continues to escalate with many countries around the world reporting doubling of IPV cases following the COVID-19 outbreak.^{11,18} Yet, the true incidence of IPV may be even higher as these crimes are generally underreported.^{18,19} While the reported 20%–50%^{12,20} increase in IPV worldwide in 2020^{8,11,21} is one public health concern, another emerging health problem likely fueled by mitigation strategies is the rise in the *severity* of physical abuse in female survivors during COVID-19.^{1,22} A recent study conducted at an urban medical center demonstrated that the incidence of severe physical IPV (e.g. visceral injury) at this hospital was 3.8 times greater in 2020 compared to the last 3 years (2017–2019).¹ This study also showed that those IPV survivors who reported to the hospital sustained a total of 28 deep injuries within a 7-week period in 2020 alone versus a total of 16 deep injuries within the same 7-week window in the previous 3 years (2017–2019) combined.¹

One of the most dangerous, frequent, yet hidden health consequences of physical IPV is acquired brain injuries (ABIs), which include repeated mild traumatic brain injuries (mTBIs) also called concussions and hypoxic brain injuries (from strangulation).¹ If the severity of physical IPV has amplified¹ following COVID-19, then it is logical to assume that there could be an analogous increase in repeated ABI episodes. Notwithstanding, the urgent discussion of IPV-related ABI is lacking from academic and media reports that have identified the rise in COVID-19-induced violence.^{8,11,21,23} A preliminary search of one of the academic databases revealed 28 results for IPV and COVID-19, 13 results for traumatic brain injury (TBI) and COVID-19, and no (0) results on TBI and COVID-19 and IPV. Similarly, a search for COVID-19 and strangulation and IPV yielded zero results related to IPV. Thus far, only one Letter to the Editor has pointed to the potential synchronous surge in gender-violence-related TBIs in females as a result of COVID-19-induced stressors and restrictive stay-at-home orders.²⁴ It is imperative that IPV-related ABI is recognized so that female survivors can receive ABI-informed²⁵ diagnosis and treatment.

IPV-related ABI in female survivors

Data show that the existing global prevalence of IPV-related ABI is high even in the absence of the current pandemic. One study showed that women living with IPV are seven times more likely to sustain a head injury with loss of consciousness compared to women living without IPV.²⁶ Another study reported that about three out of four females in abusive relationships suffer from at least one brain injury, including strangulation, and nearly two out of four suffered from repetitive ABIs.²⁷ It is likely that survivors may sustain additional ABIs during recovery from a prior ABI.

While a single head trauma may not be disabling, repeated ABIs may cause cumulative physiological and behavioral effects resulting in chronic disability.^{28,29} Data in females who have experienced IPV have shown associations between repetitive brain injuries and cognitive, motor and psychosocial functioning as well as structural and functional brain connectivity.^{1,27,30–32} In addition, repetitive mTBIs could dysregulate cerebral blood flow^{28,33} in association with autonomic nervous system abnormalities such as attenuated heart rate variability, which may prolong recovery.^{34,35} The cumulative effects of repeated ABIs could cause neurophysiological and behavioral dysfunction including chronic neuroinflammation and systemic deficits.³⁶ Of note, repeated ABIs may exacerbate injury outcomes leading to residual functional impairments, especially when the second injury occurs within a short period of the primary insult.²⁹ Specifically, at the cellular level, repeated mTBIs may produce neuronal cell death, astrocyte hyperactivity, blood–brain barrier breach, microglial activation, and severe myelin pathology, which may lead to neurodegeneration.³⁷ Behavioral effects of repeated mTBIs may include learning and memory deficits, reduced comprehension, difficulty multi-tasking, overall weakness, slow movements, resting tremor, gait/balance difficulties, feet shuffling, leg dragging, and muscle twitching.^{37,38} While a comprehensive review of the effects of repeated ABIs is beyond the scope of this article, it is clear that the threat of increasing rates of mTBIs and strangulation exists as a consequence of COVID-19-induced IPV that needs to be addressed. Although evidence-based interventions are scarce in IPV-induced repeated mTBIs, healthcare providers may target aggregated impairments and focus on improving daily functioning in survivors.

Health and policy actions for IPV-related ABIs likely fueled by the mitigation strategies of COVID-19

Healthcare providers are often the first point of contact for female survivors.^{1,39} However, even during normal times, healthcare providers encounter challenges in identifying ABI in IPV survivors, especially mTBIs.³⁹ During the pandemic, the signs and symptoms of IPV-related head trauma can be overlooked or misclassified as healthcare providers are inundated with patients presenting with COVID-19.¹ Healthcare providers should be trained in appropriately screening for ABIs related to IPV both in the general population and in minorities (e.g. ethnic/racial minorities, Lesbian, Gay, Bisexual, Transgendered, and Questioning (LGBTQ), and refugees). While the prevalence of IPV-related ABI in minorities is not known, IPV is often experienced at a higher rate in marginalized groups as well as people who are Black, indigenous, and of color.^{40–42} In some cases, IPV appears to have been normalized in these communities.⁴³ Even in a fully functional healthcare system, minorities with ABI may experience challenges in seeking

and receiving medical care due to structural, social, financial, and technological insecurities.⁴⁴ COVID-19-induced IPV may add another layer of complexity in identifying and treating ABIs in the minority population.⁴⁴ Thus, culturally sensitive and minority-centered approaches such as listening to and validating IPV experiences in a non-judgmental manner, identifying barriers to communication, providing treatment at women shelters or community centers, and administering consult and testing in the presence of a female that belongs to the same ethnic/racial group may facilitate diagnosis and management of IPV-related ABI in under-represented populations.^{43,45}

Healthcare providers must understand that a subset of COVID-19 patients could have neurological symptoms that may result from IPV itself and/or mTBI symptoms. Psychological disorders such as anxiety, depression, and post-traumatic stress disorder (PTSD) could also co-exist in survivors of IPV with ABI; these comorbidities may mask the symptoms of IPV-related ABI or could lead to an inappropriate diagnosis. In addition, IPV and substance use commonly co-occur in survivors. One review reported 20%–57% prevalence of IPV among female substance users.⁴⁶ Due to an overlap of symptoms (e.g. altered consciousness and difficulty concentrating/remembering)⁴⁷ between ABI and substance use disorder, IPV-related ABI could possibly be misclassified as the latter. A direct and multi-symptom (cognitive, physical, emotional & sleep) domain evaluation alongside a thorough neurological exam is necessary to arrive at a precise diagnosis. In addition, headaches, dizziness, forgetfulness, coughing, and/or sore throat^{48,49} frequently exist in patients with mTBI and/or in patients who have experienced strangulation. These symptoms must be distinguished from other concomitant disorders including COVID-19.

Healthcare providers must evaluate patients holistically during the pandemic, taking a systems approach. Providers must be aware that TBI-related mechanisms may differ in female survivors from those involving sport- or military-related injury. These mechanisms may include being kicked, hit with large objects, being shaken, or being slammed against objects.^{50,51} A TBI from a blunt trauma to the head may influence the brain differently than the injury resulting from blocking of oxygen.⁵¹ As such, ABIs in the IPV population may present with unique symptom profiles.⁵¹

As the access to in-person appointments at community clinics is limited during COVID-19,¹ a thorough evaluation of signs and symptoms during discrete tele-medicine visits would be valuable in classifying and treating injuries. Healthcare providers must be cognizant that disclosing physical abuse or related signs and symptoms might not be easy for survivors for a number of reasons including the possibility of their perpetrator being in the room. Providers must be trained in discerning non-verbal cues to help facilitate the identification of IPV-related neurological symptoms. In addition, while providing in-office assessment for

neurological sequelae, providers must be aware that the fear of proximity and being touched might be heightened in survivors during the pandemic. Prior to conducting any exams, providers must summarize the exam in advance and provide the opportunity for before and after exam questions.²⁵

If abuse is suspected, information and an opportunity to disclose abuse should be provided in a trauma-informed way if possible. Importantly, for a TBI to occur, loss of consciousness is not necessary and intracranial findings are unlikely to be present if the TBI is “mild.” Clinicians may use Canadian CT Head Rule⁵² or National Emergency X-Radiography Study II Clinical Guidelines⁵³ to ascertain the need of neuroimaging in mTBI patients.^{54,55} As the severity of abuse has risen during the pandemic, the possibility of survivors presenting with moderate to severe TBI is highly likely. In patients with moderate to severe head trauma, a non-contrast computed tomography (CT) scan is considered appropriate in identifying subdural or epidural hematoma that needs immediate surgical intervention.⁵⁴ Healthcare providers must understand that survivors may not be aware of the presence or significance of a TBI secondary to abuse from her partner.³⁹ Direct questioning about alterations or losses of consciousness, strong forces to the head, and strangulation may be required to gather information on IPV-related ABI (see Figure 1). First responders or healthcare providers may take immediate actions to provide appropriate resources/referrals to IPV-related ABI survivors (see Figure 1).

Community-based education strategies regarding COVID-19 and IPV-related ABI may assist female survivors in protecting themselves from physical violence during the pandemic. Female survivors must be educated about protecting their head/neck/face from beatings and seeking appropriate help if leaving home is necessary during the pandemic (Figure 1). Education strategies may also help survivors in recognizing that an escape from abuse is still possible during the pandemic. Survivors should know that some Justice Centers as well as shelters remain open during the pandemic and may assist with providing safe referrals to healthcare providers. Equipping outreach/Justice Centers with means such as electronic documents to raise awareness about the sequelae of ABI both among survivors and healthcare providers is necessary. A multidisciplinary approach to clinical management of IPV-related ABIs involving the expertise of a psychiatrist as well as occupational and/or physical therapists and IPV advocates is necessary (Figure 1). This will facilitate treatment and prognosis while also allowing participation of IPV survivors in the re-opening of the economy by addressing injury-related effects that would otherwise prohibit survivors from safe return to work.

Moreover, to protect survivors from recurring violence and potential ABIs, we should consider prioritizing survivors for receiving COVID-19 vaccine as this could reduce their fear of contracting the disease and may allow them to leave home more safely if that is their desire. Justice Centers, shelters, and other community sites could be properly

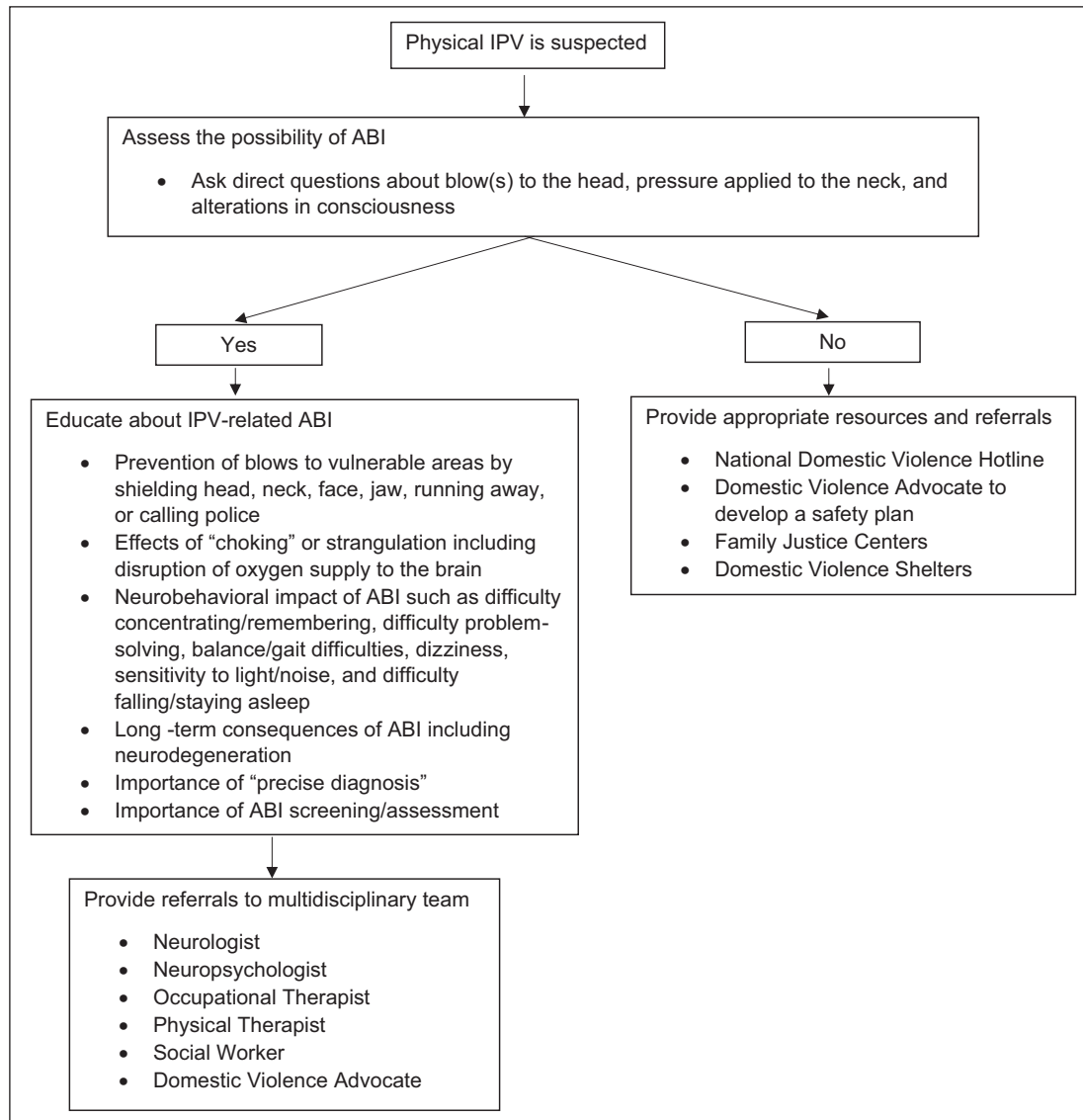


Figure 1. Flowchart illustrating stepwise approach to immediate actions with IPV survivors.

staffed with trauma-informed medical personnel to provide COVID-19 vaccines to survivors. We believe that vaccinating survivors early in this manner would ultimately reduce the burden on the healthcare system.

Conclusion

Quarantines appear necessary to control the transmission of COVID-19; however, these measures should be context-specific and must be executed while respecting basic human rights. A global need exists to prevent and eradicate violence against women. Although the severity of gender-based violence has escalated in the current COVID-19 milieu, aggressive efforts to reduce the incidence and severity of IPV, as well as resulting ABIs are lacking. At the time of this writing, COVID-19 is still a threat in the US and worldwide with many countries re-imposing national lockdowns or social

distancing measures. In addition, the recent, extremely contagious mutation of COVID-19 has resulted in newfound fears and even firmer confinement orders. However, COVID-19 and related mitigation strategies have underscored blatant health disparities by having the greatest negative effects on marginalized populations. Notably, the prolonged mitigation strategies appeared to have backfired for vulnerable populations possibly causing worse health implications than COVID-19 itself.

As the world is in the process of the post-pandemic re-opening, healthcare providers should be vigilant to the possibility that many women may have sustained repeated neurotrauma while adhering to shelter-in-place mandates. Healthcare providers should be proactive in assessing for an ABI if a survivor presents with a history of physical injury to the head, neck, or face. Any episodes of "shaking," "throwing against an object," "choking," or loss of consciousness as

well as symptoms of headache, dizziness/imbalance, memory loss, sleep or visual dysfunction, loss of bowel/bladder control, or reproduction of symptoms on changing positions (orthostatic tolerance)⁵⁶ must be comprehensively evaluated. IPV-related ABI survivors may present with more chronic symptoms compared to non-IPV ABI survivors due to the likelihood of repeated ABIs in females who experience physical IPV. The effects of the potential neurotrauma from IPV could be profound in terms of recovery and psychosocial and financial outcomes. Therefore, raising awareness of IPV-related ABIs as well as supportive actions for education and interventions such as those discussed in this review must be part of the COVID-19 response. The recommendations outlined in this article should be useful in developing situation-specific guidelines and in implementing effective health strategies for female survivors of IPV-related ABI.

Limitations and future directions

This review aimed to serve as a resource for healthcare providers and first responders on the topic of IPV-related ABI within the setting of COVID-19. While the information on IPV-related ABI detection and management as well as health and policy actions remain valuable, the statements on the state of COVID-19 may become dated due to swiftly evolving information on the pandemic. Some COVID-19-related references used may not have gone through the peer-review process, and hence caution is required in interpretations. A critical analysis of the literature was not provided as the purpose of the review was to inform the readers of the ramifications for IPV-induced ABI due to the pandemic.

Future retrospective studies may examine if COVID-19 was a risk factor for IPV-related ABI and whether it mediated the frequency and severity of IPV-induced ABI. Retrospective studies may also assess whether clinicians provided appropriate and targeted assessment and treatment to patients with ABI from IPV during the pandemic. Retrospective studies may identify COVID-19-related risk factors associated with IPV-related ABI. Future studies with prospective, longitudinal designs may study the short-term and long-term neurobehavioral effects of IPV on ABI within the COVID-19 framework. Future cross-sectional work may determine the prevalence of IPV-related ABI in minorities (e.g. LGBTQ community, refugees, and migrants) and elderly and may also investigate whether minorities with IPV-related ABI fared worse because of the pandemic.

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References

- Gosangi B, Park H, Thomas R, et al. Exacerbation of physical intimate partner violence during COVID-19 lockdown. *Radiology* 2020; 298: E38–E45.
- From insights to action: gender equality in the wake of COVID-19. Digital library: publications. UN Women, <https://www.unwomen.org/en/digital-library/publications/2020/09/gender-equality-in-the-wake-of-covid-19> (accessed 26 November 2020).
- Centers for Disease Control and Prevention (CDC). *COVID-19 and your health*. CDC, 2020, <https://www.cdc.gov/coronavirus/2019-ncov/transmission/variant.html> (accessed 15 February 2021).
- UK COVID-19 variant to become dominant in US by March, CDC warns, <https://www.beckershospitalreview.com/public-health/uk-covid-19-variant-to-become-dominant-in-us-by-march-cdc-warns.html> (accessed 15 February 2021).
- Staff IJ. State COVID-19 cases continue resurgence, plus 12 more deaths. *Indianapolis Business Journal*, <https://www.ijb.com/articles/state-covid-19-cases-continue-climb-plus-12-more-deaths> (accessed 29 July 2021).
- Ebrahim SH, Ahmed QA, Gozzer E, et al. COVID-19 and community mitigation strategies in a pandemic. *BMJ* 2020; 368: m1066.
- Coronavirus disease 2019 (COVID-19) situation report: 44, https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200304-sitrep-44-covid-19.pdf?sfvrsn=783b4c9d_2; [https://www.google.com/search?q=Coronavirus+disease+2019+\(COVID-19\)+situation+report%E2%80%949444.+https%3A%2F%2Fwww.who.int%2Fdocs%2Fdefault-source%2Fcoronaviruse%2Fsituation-reports%2F20200304-sitrep-44-covid-19.pdf%3Fsfvrsn%3D783b4c9d_2&rlz=1C1GCEU_enUS884US884&oq=Coronavirus+disease+2019+\(COVID-19\)+situation+report%E2%80%949444.+https%3A%2F%2Fwww.who.int%2Fdocs%2Fdefault-source%2Fcoronaviruse%2Fsituation-reports%2F20200304-sitrep-44-covid-19.pdf%3Fsfvrsn%3D783b4c9d_2&aqs=chrome..69i57.869j0j15&sourceid=chrome&ie=UTF-8](https://www.google.com/search?q=Coronavirus+disease+2019+(COVID-19)+situation+report%E2%80%949444.+https%3A%2F%2Fwww.who.int%2Fdocs%2Fdefault-source%2Fcoronaviruse%2Fsituation-reports%2F20200304-sitrep-44-covid-19.pdf%3Fsfvrsn%3D783b4c9d_2&rlz=1C1GCEU_enUS884US884&oq=Coronavirus+disease+2019+(COVID-19)+situation+report%E2%80%949444.+https%3A%2F%2Fwww.who.int%2Fdocs%2Fdefault-source%2Fcoronaviruse%2Fsituation-reports%2F20200304-sitrep-44-covid-19.pdf%3Fsfvrsn%3D783b4c9d_2&aqs=chrome..69i57.869j0j15&sourceid=chrome&ie=UTF-8)
- Matoori S, Khurana B, Balcom MC, et al. Addressing intimate partner violence during the COVID-19 pandemic and beyond: how radiologists can make a difference. *Eur Radiol* 2021; 31: 2126–2131.
- Are some ethnic groups more vulnerable to COVID-19 than others?, <https://www.ifs.org.uk/inequality/chapter/are-some-ethnic-groups-more-vulnerable-to-covid-19-than-others/> (accessed 15 February 2021).
- Greenaway C, Hargreaves S, Barkati S, et al. COVID-19: exposing and addressing health disparities among ethnic minorities and migrants. *J Trav Med* 2020; 27: taaa113.
- Van Gelder N, Peterman A, Potts A, et al. COVID-19: Reducing the risk of infection might increase the risk of intimate partner violence. *Eclinicalmedicine* 2020; 21: 100348.
- Ertan D, El-Hage W, Thierrée S, et al. COVID-19: urgency for distancing from domestic violence. *Eur J Psychotraumatol* 2020; 11(1): 1800245.

13. Campbell JC, Anderson JC, McFadgion A, et al. The effects of intimate partner violence and probable traumatic brain injury on central nervous system symptoms. *J Womens Health* 2018; 27(6): 761–767.
14. Stöckl H, Devries K, Rotstein A, et al. The global prevalence of intimate partner homicide: a systematic review. *Lancet* 2013; 382(9895): 859–865.
15. Leslie E and Wilson R. Sheltering in place and domestic violence: evidence from calls for service during COVID-19. *J Public Econ* 2020; 189: 104241.
16. Matori S, Khurana B, Balcom MC, et al. Intimate partner violence crisis in the COVID-19 pandemic: how can radiologists make a difference. *Eur Radiol* 2020; 30(12): 6933–6936.
17. O’Connell S. Central Mass agencies seeing increase in help calls for domestic violence. *Telegram & Gazette*, <https://www.telegram.com/story/news/2021/07/28/ywca-central-massachusetts-domestic-violence-marcia-szymansk/5391090001/> (accessed 29 July 2021).
18. Campbell AM. An increasing risk of family violence during the COVID-19 pandemic: strengthening community collaborations to save lives. *Foren Sci Int: Rep* 2020; 2: 100089.
19. Pandemics and violence against women and children. Center for Global Development, <https://www.cgdev.org/publication/pandemics-and-violence-against-women-and-children> (accessed 17 April 2020).
20. Boserup B, McKenney M and Elkbuli A. Alarming trends in US domestic violence during the COVID-19 pandemic. *Am J Emerg Med* 2020; 38(12): 2753–2755.
21. Agüero JM. COVID-19 and the rise of intimate partner violence. *World Dev* 2021; 137: 105217.
22. Images APTNS via G. Is domestic violence rising during the coronavirus shutdown? Here’s what the data shows. The Marshall Project, 2020, <https://www.themarshallproject.org/2020/04/22/is-domestic-violence-rising-during-the-coronavirus-shutdown-here-s-what-the-data-shows> (accessed 28 April 2020).
23. Intimate partner violence COVID journal of Pakistan Medical Association, https://www.google.com/search?q=Intimate+partner+violence+COVID+journal+of+Pakistan+Medical+Association&rlz=1C1GCEU_enUS884US884&aq=Intimate+partner+violence+COVID+journal+of+Pakistan+Medical+Association&aqs=chrome..69i57.14720j0j7&sourceid=chrome&ie=UTF-8
24. Valera EM. When pandemics clash: Gendered violence-related traumatic brain injuries in women since COVID-19. *Eclinicalmedicine* 2020; 24: 100423.
25. Raja S, Hasnain MM, Hoersch MM, et al. Trauma informed care in medicine: current knowledge and future research directions. *Fam Community Health* 2015; 38(3): 216–226.
26. Anderson JC, Stockman JK, Sabri B, et al. Injury outcomes in African American and African Caribbean women: the role of intimate partner violence. *J Emerg Nurs* 2015; 41(1): 36–42.
27. Valera EM and Berenbaum H. Brain injury in battered women. *J Consult Clin Psychol* 2003; 71(4): 797–804.
28. Fehily B and Fitzgerald M. Repeated mild traumatic brain injury: potential mechanisms of damage. *Cell Transplant* 2017; 26(7): 1131–1155.
29. Prins ML, Alexander D, Giza CC, et al. Repeated mild traumatic brain injury: mechanisms of cerebral vulnerability. *J Neurotrauma* 2013; 30(1): 30–38.
30. Wong JY-H, Choi AW-M, Wong JK-S, et al. Impact of mild traumatic brain injury on physical, mental and cognitive functioning of abused women admitted to emergency units. *Health Soc Care Commun* 2020; 2020: 13218.
31. Valera E and Kucyi A. Brain injury in women experiencing intimate partner-violence: neural mechanistic evidence of an “invisible” trauma. *Brain Imaging Behav* 2017; 11(6): 1664–1677.
32. Valera EM, Cao A, Pasternak O, et al. White matter correlates of mild traumatic brain injuries in women subjected to intimate-partner violence: a preliminary study. *J Neurotrauma* 2019; 36(5): 661–668.
33. Leddy JJ, Cox JL, Baker JG, et al. Exercise treatment for postconcussion syndrome: a pilot study of changes in functional magnetic resonance imaging activation, physiology, and symptoms. *J Head Trauma Rehabil* 2013; 28(4): 241–249.
34. Clausen M, Pendergast DR, Willer B, et al. Cerebral blood flow during treadmill exercise is a marker of physiological postconcussion syndrome in female athletes. *J Head Trauma Rehabil* 2016; 31(3): 215–224.
35. Pertab JL, Merkley TL, Cramond AJ, et al. Concussion and the autonomic nervous system: an introduction to the field and the results of a systematic review. *Neurorehabilit* 2018; 42(4): 397–427.
36. Aungst SL, Kabadi SV, Thompson SM, et al. Repeated mild traumatic brain injury causes chronic neuroinflammation, changes in hippocampal synaptic plasticity, and associated cognitive deficits. *J Cerebr Blood Flow Metab* 2014; 34: 1223–1232.
37. Fehily B and Fitzgerald M. Repeated mild traumatic brain injury. *Cell Transplant* 2017; 26(7): 1131–1155.
38. Neurological complications of repeated concussions. Concussion.org, 2019, <https://www.concussion.org/news/neurological-complications-repeated-concussions/> (accessed 30 July 2021).
39. Haag HL, Sokoloff S, MacGregor N, et al. Battered and brain injured: assessing knowledge of traumatic brain injury among intimate partner violence service providers. *J Womens Health* 2019; 28(7): 990–996.
40. Gillum TL. African American survivors of intimate partner violence: lived experience and future directions for research. *J Aggress Maltreat Trauma* 2019; 30(6): 731–748.
41. Rollè L, Giardina G, Caldarella AM, et al. When intimate partner violence meets same sex couples: a review of same sex intimate partner violence. *Front Psychol* 2018; 9: 1506.
42. LGBTQ people are more likely to experience interpersonal violence. HRC, <https://www.hrc.org/press-releases/report-shows-lgbtq-people-are-more-likely-to-be-victims-of-interpersonal-vi> (accessed 30 July 2021).
43. Vil NMS, Sperlich M, Fitzpatrick J, et al. “I thought it was normal”: perspectives of Black nursing students from high-risk IPV communities on causes and solutions to IPV in the Black Community. *J Interpers Violence*. Epub ahead of print 8 March 2021. DOI: 10.1177/0886260521997939.
44. Kolakowsky-Hayner SA and Goldin Y. Sex and gender issues for individuals with acquired brain injury during COVID-19: a commentary. *Arch Phys Med Rehabil* 2020; 101(12): 2253–2255.
45. Vives-Cases C and Weltgesundheitsorganisation Regionalbüro für Europa. *Preventing and addressing intimate partner violence against migrant and ethnic minority women: the*

- role of the health sector policy brief*. Geneva: World Health Organization, 2014.
46. Mason R and O'Rinn SE. Co-occurring intimate partner violence, mental health, and substance use problems: a scoping review. *Glob Health Action* 2014; 7: 24815.
 47. Kaysen D, Dillworth TM, Simpson T, et al. Domestic violence and alcohol use: trauma-related symptoms and motives for drinking. *Addict Behav* 2007; 32(6): 1272–1283.
 48. Theadom A, Parmar P, Jones K, et al. Frequency and impact of recurrent traumatic brain injury in a population-based sample. *Journal of Neurotrauma* 2014; 32(10): 674–681.
 49. Smith DJ Jr, Mills T and Taliaferro EH. Frequency and relationship of reported symptomology in victims of intimate partner violence: the effect of multiple strangulation attacks. *J Emerg Med* 2001; 21(3): 323–329.
 50. Valera EM, Campbell J, Gill J, et al. Correlates of brain injuries in women subjected to intimate partner violence: identifying the dangers and raising awareness. *J Aggress Maltreat Trauma* 2019; 28(6): 695–713.
 51. Esopenko C, Meyer J, Wilde EA, et al. A global collaboration to study intimate partner violence-related head trauma: the ENIGMA consortium IPV working group. *Brain Imaging Behav* 2021; 15(2): 475–503.
 52. Canadian CT and head injury/trauma rule, MDCalc, <https://www.mdcalc.com/canadian-ct-head-injury-trauma-rule> (accessed 29 July 2021).
 53. Ala A, Shams Vahdati S, Ghaffarad A, et al. National emergency X-radiography utilization study guidelines versus Canadian C-Spine guidelines on trauma patients, a prospective analytical study. *PLoS ONE* 2018; 13(11): e0206283.
 54. Smith LGF, Milliron E, Ho M-L, et al. Advanced neuroimaging in traumatic brain injury: an overview. *Neurosurg Focus* 2019; 47(6): E17.
 55. Lee B and Newberg A. Neuroimaging in traumatic brain imaging. *Neurorx* 2005; 2(2): 372–383.
 56. Haider MN, Patel KS, Willer BS, et al. Symptoms upon postural change and orthostatic hypotension in adolescents with concussion. *Brain Inj* 2021; 35(2): 226–232.