

Traumatic Brain Injury

A traumatic brain injury (TBI) is caused by a bump, blow, jolt or penetration to the head disrupting the normal function of the brain.¹ When one or more of the following clinical signs is observed, it constitutes an alteration in brain function: a) any period of loss of, or decreased, consciousness; b) any loss of memory for events immediately before or after the injury; c) neurological deficits such as muscle weakness, loss of balance and coordination, disruption of vision, change in speech and language, or sensory loss; or d) any alteration in mental state at the time of the injury such as confusion, disorientation, slowed thinking, or difficulty concentrating.² Each year, traumatic brain injuries contribute to a substantial number of deaths and cases of permanent disability.³ In 2010, 2.5 million TBIs occurred either as an isolated injury or along with other injuries resulting in hospitalizations, emergency department (ED) visits, and death.³ The health effects resulting from a TBI can be broadly categorized into cognitive, behavioral/emotional, motor, and somatic symptoms and the severity varies.^{4,5}

How does traumatic brain injury affect the United States?

Fatal data

- Every day, 155 people in the U.S. die from injuries that include TBI. Nearly 56,800 died of TBI-related injuries in 2014.¹⁹
- The leading cause of TBI-related death among those aged 0 to 4 years was assault/homicide, including abusive head trauma by inflicted blunt impact or violent shaking, and other causes such as firearm-related injuries.³
- The highest TBI-related death rates in 2014 were found among those aged 75 years or older (78.5), 65 to 74 years (24.7), and 55 to 64 years (19.1).¹⁹
- Patients who sustained a TBI as a result of a motorcycle crash were three times as likely to die in the ED compared to those who suffered motorcycle injuries not involving a TBI.⁶
- Among adolescents and adults who received rehabilitation for TBI, 20 percent will have died at five years post-injury, and nearly 40 percent will have declined in function from the level of recovery attained one to two years post injury.⁷

Non-fatal data

- In 2014, approximately 2.53 million people were treated in and released from EDs and another 288,000 were hospitalized and discharged. These numbers underestimate the true burden of TBI because they do not account for individuals who did not receive medical care or had office-based visits.¹⁹
- The most common principal mechanisms of injury for TBI ED visits and hospitalizations were falls, being struck by or against an object and motor-vehicle crashes.¹⁹
- Although the risk factors, health effects and long-term outcomes of TBI vary by person, some persons require special considerations, including children and older adults, military service members and veterans, rural residents and incarcerated populations. Children age 0 to 4 years, adolescents age 15 to 19 years and older adults age 75 years and older are among the most likely to have a TBI-related ED visit or hospitalization.⁸

- It is estimated 7% of all sports and recreation-related injuries treated in ED from 2001-2012 were TBIs. Nearly 70% of all sports and recreational-related TBIs were reported among persons 0 to 19 years of age.¹⁵
- Males have about twice the rate of sports and recreational-related TBIs as females. The largest number of these TBIs among males occurred during football, bicycling and basketball. Among females aged 0-17, the largest number of these TBIs occurred during soccer, playground activities and basketball.²⁰

Cost data

- The estimated economic cost of TBI in 2010, including direct and indirect medical costs, is estimated to be approximately \$76.5 billion.^{16,17}
- The cost of fatal TBIs and TBIs requiring hospitalization account for roughly 90% of the total TBI medical costs.^{16,17}
- The societal and medical-care costs associated with TBI are more extensive for older adults than younger patients due to older adults needing longer hospital stays and having slower rates of functional improvement during inpatient rehabilitation.⁸
- Motorcycle crash-related hospitalizations with a TBI diagnosis had median hospital charges nearly \$9,000 greater than hospitalizations without a TBI diagnosis.⁶
- TBI may lead to long-term impairment, functional limitations and disability affecting quality of life. Approximately 60% of those of working age (16 to 60 years) who were discharged from inpatient rehabilitation following a TBI between 2001 and 2010 were still unemployed two years after their injury. However, more than a third of those who were employed were employed only in a part-time capacity.¹⁸

How does traumatic brain injury affect Indiana?

- In 2017, 1,316 Hoosiers died of TBI-related injuries. Seventy-five percent of those who died from these injuries were men.
- Rates of TBI death increased from 16.4 per 100,000 in 2015 to 18.9 per 100,000 in 2017.
- The highest number of TBI-related deaths were among those aged 55 to 64 years.
- Suicide was the leading cause of injury among those who had a TBI-related death.
- In 2017, there were 6,681 TBI-related hospitalizations. Nearly 61 percent of the hospitalizations were among men.
- The highest rate and number of TBI-related hospitalizations were among Hoosiers aged 75 to 84 years.
- In 2017, there were 25,198 TBI-related ED visits due to TBI.
- The highest number of TBI-related ED visits were among Hoosiers aged 15-24 years.
- Unintentional falls are the leading cause of injury among those who were hospitalized or treated and released from EDs with a TBI alone or in combination with other injuries or conditions.

How do we address this problem?

Policy

- Per IC 16-41-42.2-4, the Indiana Spinal Cord and Brain Injury Fund is utilized to 1) establish and maintain a state medical surveillance registry for traumatic spinal cord and brain injuries; 2) fulfill the duties of the board; 3) fund research related to treatment and cure of spinal cord and brain injuries; 4) fund post-acute extended treatment and services for an individual with a spinal

cord injury or facilities that offer long term activity based therapy services for spinal cord injuries requiring extended post-acute care; 5) fund post-acute extended treatment and services for an individual with a brain injury or facilities that offer long term activity based therapy services for brain injuries requiring extended post-acute care; and 6) develop a statewide trauma system. The fund is expected to generate approximately \$1.6 million per year, with the majority of money generated to be allocated to research projects.

- Per IC 16-41-40-5, information and instructional materials concerning shaken baby syndrome (abusive head trauma) must be provided to a parent or guardian of each newborn upon discharge from the hospital. The informational material must explain the medical effects of abusive head trauma on infants and children and emphasize preventive measures.
- Senate Bill 234 was signed by Governor Mike Pence in 2016 to enact stronger protocols by requiring coaches to complete a certified player safety education course.

Data Collection

- The ISDH Division of Trauma and Injury Prevention conducts statewide injury surveillance through death certificates, hospitalizations and ED visits. The Indiana Trauma Registry is a repository into which statewide trauma data has been brought together to support three foundational activities: identification of the trauma population, statewide process improvement activities, and research. Information about traumatic injuries, including spinal cord and brain injuries, is captured in the Indiana Trauma Registry.
- Per CDC guidelines, a statewide report on TBIs is published on the ISDH website at: <https://www.in.gov/isdh/25396.htm>.
- State Injury Indicators Report tracks TBI hospitalizations and deaths in states to help states and the CDC Injury Center better identify and prevent TBIs. ISDH participates in the annual reporting.
- Pediatric Abusive Head Trauma: Recommended Definitions for Public Health Surveillance and Research provides standard definitions and data elements to improve the quality and consistency of data for public health surveillance purposes of abusive head trauma. Website: <http://www.cdc.gov/violenceprevention/pdf/pedheadtrauma-a.pdf>.

Programs

- The Indiana Department of Corrections received funding from the U.S. Department of Health and Human Services/ Health Resources and Services Administration to help prison staff learn to identify inmates with brain injuries and provide treatment for released offenders with TBI.
- The Indiana Statewide Trauma System Injury Prevention Plan includes facilitating opportunities for collaborative injury prevention efforts in traumatic brain injury.

Education

- There are many simple ways to reduce the chance of sustaining a TBI, which include
- The CDC Injury Center developed Heads Up to Clinicians: Addressing Concussion in Sports among Kids and Teens, a free online course developed with support from the National Football League (NFL) and CDC Foundation, teaches health care professionals how to recognize and manage concussion in young athletes. Website: <http://www.cdc.gov/HeadsUp/providers/training/index.html>
- The Journal of Head Trauma Rehabilitation released a special issue highlighting work from CDC and CDC's partners to prevent traumatic brain injury (TBI) and to help people better recognize, respond, and recover if a TBI occurs. Website: <http://journals.lww.com/headtraumarehab/toc/2015/05000>.

- The CDC HEADS UP Concussion and Helmet Safety App provides information for parents and coaches to instantly access concussion safety information to spot a potential concussion, respond if an athlete has a concussion or other serious brain injury, and help an athlete safely return to school and play. Website: http://www.cdc.gov/headsup/resources/app.html?s_cid=headsup_govd106.
- Association of State and Territorial Health Officials (ASTHO) Resources for Preventing Traumatic Brain Injuries provides links to TBI factsheets and prevention guides for specific populations, including infants, active military and veterans, and older adults. Website: <http://www.astho.org/Programs/Prevention/Injury-and-Violence-Prevention/Preventing-Traumatic-Brain-Injury/Preventing-Traumatic-Brain-Injuries/>.

Measures: Healthy People 2020:

- Injury and Violence Prevention (IVP)-2 Reduce fatal and non-fatal traumatic brain injuries.

Additional Resources

- ISDH Division of Trauma and Injury Prevention: <http://www.in.gov/isdh/19537.htm>
- Indiana Special Emphasis Report on TBI: <http://www.in.gov/isdh/25396.htm>
- Brain Injury Association of Indiana: <http://biaindiana.org/>
- ASTHO Resources for Preventing Traumatic Brain Injuries: <http://www.astho.org/Programs/Prevention/Injury-and-Violence-Prevention/Preventing-Traumatic-Brain-Injury/Preventing-Traumatic-Brain-Injuries/>
- CDC Traumatic Brain Injury: <http://www.cdc.gov/traumaticbraininjury/>
- National Center for Injury Prevention and Control, CDC: <http://www.cdc.gov/concussion>
- CDC's Heads Up to Concussion: <http://www.cdc.gov/concussion/headsup/index.html>
- CDC Injury Center and the American College of Emergency Physicians (ACEP)'s Updated Mild Traumatic Brain Injury Management Guideline for Adults to improve clinical management and to reduce adverse health outcomes among TBI patients. Website: http://www.cdc.gov/concussion/HeadsUp/clinicians_guide.html
- Heads up to Clinicians: Concussion Training: <http://www.cdc.gov/concussion/HeadsUp/clinicians/index.html>
- CDC's Report to Congress on Traumatic Brain Injury Epidemiology and Rehabilitation: Recommendations for Addressing Critical Gaps. Website: http://www.cdc.gov/traumaticbraininjury/pdf/TBI_Report_to_Congress_Epi_and_Rehab-a.pdf
- CDC's Report to Congress on Traumatic Brain Injury in the United States: Understanding the Public Health Problem among Current and Former Military Personnel. Website: http://www.cdc.gov/traumaticbraininjury/pubs/congress_military.html
- HRSA Traumatic Brain Injury Program: <http://mchb.hrsa.gov/programs/traumaticbraininjury/>
- National Center on Shaken Baby Syndrome: <http://www.dontshake.org/>

References

1. Marr, A.L., and Coronado, V.G. (Eds.). (2004). Central nervous system injury surveillance data submission standards-2002. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control.
2. Menon, D.K., Schwab, K., Wright, D.W., Maas, A.I., and Demographics and Clinical Assessment Working Group of the International and Interagency Initiative toward Common Data Elements for Research on Traumatic Brain Injury and Psychological Health. (2010). Position statement: Definition of traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 91(11), 1637-1640. Retrieved from <http://www.sciencedirect.com/science/article/pii/S0003999310006507>.
3. Taylor CA, Bell JM, Breiding MJ, Xu L. Traumatic Brain Injury–Related Emergency Department Visits, Hospitalizations, and Deaths — United States, 2007 and 2013. *MMWR Surveill Summ* 2017;66(No. SS-9):1–16. DOI: <http://dx.doi.org/10.15585/mmwr.ss6609a1>. Retrieved from https://www.cdc.gov/mmwr/volumes/66/ss/ss6609a1.htm?s_cid=ss6609a1_e#suggestedcitation.
4. Riggio, S. & Wong, M. (2009). Neurobehavioral sequelae of traumatic brain injury. *Mount Sinai Journal of Medicine*, 76(2), 163–172. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1002/msj.20097/abstract>.
5. Walker, W.C., and Pickett, T.C. (2007). Motor impairment after severe traumatic brain injury: A longitudinal multicenter study. *Journal of Rehabilitation Research and Development*, 44(7), 975-982. Retrieved from <http://www.rehab.research.va.gov/jour/07/44/7/Walker.html>.
6. Harmon, K.J., Marshall, S.W., Proescholdbell, S.K., Naumann, R.B., & Waller, A.E. (2015). Motorcycle Crash-Related Emergency Department Visits and Hospitalizations for Traumatic Brain Injury in North Carolina. *J Head Trauma Rehabilitation*, 30(3): 175-184. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/25955704>.
7. Corrigan, J.D., Cuthbert, J.P., Harrison-Felix, C., Whiteneck, G.G., Bell, J.M., Miller, A.C., Coronado, V.C., Pretz, C.R. (2014). US population estimates of health and social outcomes 5 years after rehabilitation for traumatic brain injury. *Journal of Head Trauma and Rehabilitation*, 29 (6), E1-9. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/24495919>.
8. Centers for Disease Control and Prevention. (2014). Report to Congress on Traumatic Brain Injury in the United States: Epidemiology and Rehabilitation. National Center for Injury Prevention and Control; Division of Unintentional Injury Prevention. Atlanta, GA. Retrieved from http://www.cdc.gov/traumaticbraininjury/pdf/TBI_Report_to_Congress_Epi_and_Rehab-a.pdf.
9. Zaloshnja, E., Miller, T., Langlois, J.A., & Selassie, A.W. (2008). Prevalence of long-term disability from traumatic brain injury in the civilian population of the United States, 2005. *The Journal of Head Trauma Rehabilitation*, 23(6), 394-400. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/19033832>.
10. Kaye, H.S. (1997). Disability watch: The status of people with disabilities in the United States. San Francisco, CA: Disability Statistics Center, Institute for Health and Aging, University of California at San Francisco. Retrieved from <http://eric.ed.gov/?id=ED417540>.
11. Johnstone, B., Nossaman, L.D., Schopp, L.H., Holmquist, L., and Rupright, S.J. (2002). Distribution of services and supports for people with traumatic brain injury in rural and urban Missouri. *Journal of Rural Health*, 18(1), 109-117. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/12043749>.

12. Murphy, J. (2004). Care of the patient with traumatic brain injury: Urban versus rural challenges. *Topics in Emergency Medicine*, 26(3), 231-236. Retrieved from http://journals.lww.com/aenjournal/Abstract/2004/07000/Care_of_the_Patient_With_Traumatic_Brain_Injury_.6.aspx.
13. CDC, NIH, DOD, and VA Leadership Panel. (2013). Report to Congress on Traumatic Brain Injury in the United States: Understanding the Public Health Problem among Current and Former Military Personnel. Centers for Disease Control and Prevention (CDC), the National Institutes of Health (NIH), the Department of Defense (DOD), and the Department of Veterans Affairs (VA). Retrieved from http://www.cdc.gov/traumaticbraininjury/pdf/Report_to_Congress_on_Traumatic_Brain_Injury_2013-a.pdf.
14. Shiroma, E.J., Ferguson, P.L., & Pickelsimer, E. (2012). Prevalence of traumatic brain injury in an offender population: a meta-analysis. *J Head Trauma Rehabilitation*, 27(3):E1-10. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/20339132>.
15. Coronado, V.G., Haileyesus, T., Cheng, T.A., Bell, J.M., Haarbauer-Krupa, J., Lionbarger, M.R., ... Gilchrist, J. (2015) Trends in Sports- and Recreation-Related Traumatic Brain Injuries Treated in US Emergency Departments: The National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP) 2001-2012. *J Head Trauma Rehabilitation*, 30(3): 195-197. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/25955705>.
16. Finkelstein, E., Corso, P., Miller, T. and associates. (2006). *The Incidence and Economic Burden of Injuries in the United States*. New York (NY): Oxford University Press. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2652974/>.
17. Coronado, V.G., Faul, M., McGuire, L.C., Sugerman, D. & Pearson, W.S. (2012). *Epidemiology of TBI. Brain Injury Medicine. Principles and Practice*, 2nd edition.
18. Cuthbert, J. P., Harrison-Felix, C., Corrigan, J. D., Bell, J. M., Haarbauer-Krupa, J.K., Miller, A. C. (2015). Unemployment in the United States After Traumatic Brain Injury for Working-Age Individuals: Prevalence and Associated Factors 2 Years Postinjury. *J Head Trauma Rehabilitation*, 30(3): 160-174. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/25955703>.
19. Centers for Disease Control and Prevention (2019). *Surveillance Report of Traumatic Brain Injury-related Emergency Department Visits, Hospitalizations, and Deaths – United States, 2014*. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. Retrieved from <https://stacks.cdc.gov/view/cdc/78062>
20. Sarmiento, K., Thomas, K. E., Daugherty, J., Waltzman, D., Haarbauer-Krupa, J. K., Peterson, A. B., ... Breodong, M. J. (2019). Emergency department visits for sports- and recreation-related traumatic brain injuries among children – United States, 2010-2016. *Morbidity and Mortality Weekly Report*, 68(10), 237-242