Ohio Brain Injury
Program

2022 Biennial Report on the Impact of Traumatic Brain Injury on the People of Ohio

Presented by the Ohio Brain Injury Program and the Ohio Brain Injury Advisory Committee

The Ohio State University
Wexner Medical Center

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Acknowledgements

This report was prepared by the staff of the Ohio Brain Injury Program and the Data Workgroup of the Brain Injury Advisory Committee in accordance with the requirement set forth in the Ohio Revised Code (ORC) 3335.60. The ORC states that the Brain Injury Program of Ohio will create a biennial report on the impact of brain injury on the state's population. The staff of the Ohio Brain Injury Program appreciates the work and ongoing commitment of the Brain Injury Advisory Committee members for their singular dedication and diligent efforts to the development of a program in Ohio that recognizes and serves the needs of the population affected by this life-changing injury within the state.

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We wish to acknowledge the contributions of the members of the Data Workgroup for their many hours of work in the development and preparation of this report. Team members from the Ohio Department of Health and the Department of Public Safety combined their efforts to collect and present data from their respective data sets to provide insight into the experience of Ohio's population in the occurrence of traumatic brain injury.

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We would also like to extend appreciation to Monica Lichi and Brei Miller from the Ohio Brain Injury Program and the Ohio Valley Center for Brain Injury Prevention and Rehabilitation at The Ohio State University Wexner Medical Center for their unfailing support and assistance to the workgroup in the development and preparation of this report.

Copies of this report will be distributed by the Ohio Brain Injury Program staff to members of the Ohio Brain Injury Advisory Committee as required by statute for information and review. Additional copies of this report, as well as previous reports, may be obtained by contacting **Brei Miller** at **614-293-8879** or **brei.miller@osumc.edu**.

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Introduction

This report was prepared in accordance with the requirements set forth in the Ohio Revised Code 3335.60, which states that the Brain Injury Program of Ohio will prepare a biennial report on the impact of traumatic brain injury (TBI) on the population of Ohio. The information in this report comes from data that was collected from the years 2018 and 2019.

This is the ninth such report containing data from the Ohio Trauma Registry, collected by the Ohio Department of Public Safety. It is the fourth report to include Ohio discharge diagnosis data for inpatient hospitalizations and emergency department visits (collected by the Ohio Hospital Association) and data on deaths, compiled by the Ohio Department of Health (ODH). It is the third report to include data on the prevalence of TBI in the state, collected from the Ohio Behavioral Risk Factor Surveillance System by the ODH.

Because the data sources differ substantially in methodology, the data sets differ as well so that direct comparisons and correlations are not always possible. Therefore, the data sets are presented and analyzed separately to give multiple views of the burden of TBI in Ohio. Detailed information on respective selection criteria precedes the data presentation in each section.

This report uses the Centers for Disease Control and Prevention definition of TBI: An injury caused by a bump, blow or jolt to the head, or a penetrating head injury that disrupts the normal function of the brain.

The Traumatic Brain Injury Model Systems National Data and Statistical Center provides a more detailed definition: TBI is defined as damage to brain tissue caused by an external mechanical force as evidenced by medically documented loss of consciousness or post-traumatic amnesia due to brain trauma or by objective neurological findings that can be reasonably attributed to TBI on physical examination or mental status examination.

For the purposes of this report, these definitions are considered equivalent.

Executive Summary

> *"Moderate and severe traumatic brain injury (TBI) can lead to a lifetime of physical, cognitive, emotional and behavioral changes. These changes may affect a person's ability to function in their everyday life. Despite initial hospitalization and inpatient rehabilitation services, about 50% of people with TBI will experience further decline in their daily lives or die within five years of their injury. Some of the health consequences of TBI can be prevented or reduced.* ***Attending to these lifelong issues — also known as chronic disease management — is crucial for improving the lives of persons with TBI."***

Source: Centers for Disease Control and Prevention Fact Sheet: Moderate to Severe Traumatic Brain Injury is a Lifelong Condition, www.cdc.gov/traumaticbraininjury

This report presents information on the impact of TBI on the people and the state of Ohio. It addresses multiple characteristics of the public health burden of TBI. These distinct but related elements illustrate the substantial burden for survivors, families and society at large.

Incidence: The actual number of injuries that occur in Ohio during a specific time period

- In 2019, there were 2,609 TBI-related deaths, 11,332 TBI-related hospitalizations and 113,356 TBI-related emergency department (ED) visits. (Source: Ohio Department of Health [ODH] Bureau of Vital Statistics and the Ohio Hospital Association [OHA])
- In 2019, for every 100,000 residents, 20 had a TBI-related death. During the previous 10 years, TBI-related deaths increased 16%. (Source: ODH Bureau of Vital Statistics)
- Since 2015, suicide has been the leading intent/mechanism of TBI-related death, which was largely attributed to deaths among males. (Source: ODH Bureau of Vital Statistics)
- Black non-Hispanic males had the highest rate of TBI-related deaths from 2010 to 2019. In 2019, homicide was the leading intent/mechanism among this group, accounting for 46% of TBI-related deaths. (Source: ODH Bureau of Vital Statistics)
- Unintentional falls were the second-leading intent/mechanism of TBI-related deaths and the leading intent/mechanism of TBI-related hospitalizations and ED visits. (Source: ODH Bureau of Vital Statistics and OHA)
- The largest portion of TBI-related ED visits was among young adults aged 15-24 years old (16.6%). However, older adults who are 75-84 years of age made up the largest portion of TBI-related hospitalizations (19.9%) and deaths (15.1%). Adults aged 85 years and older had the highest rate of TBI-related ED visits, hospitalizations and deaths. (Source: OHA)
- For the years 2018 and 2019, 23.3% and 25% of injuries reported were TBIs. (Source: the Ohio Trauma Registry [OTR])
- Most TBIs take place in the home. (Source: OTR)
- Falls remain the most common cause of TBI. More than twice as many TBIs occurred due to falls than from motor vehicle transport, which is the second most common cause of TBI. (Source: OTR)

Prevalence: The number of Ohioans who have sustained a TBI in their lifetime

- An estimated one in four adults in Ohio have experienced at least one TBI in their lifetime, amounting to more than 1.9 million people. Approximately 550,000 of those who reported a lifetime history of TBI also reported having a disability. (Source: Ohio Behavioral Risk Factor Surveillance System [BRFSS])
- Of the 1.3 million adults who have had at least one TBI with loss of consciousness (LOC) in their lifetime, nearly 800,000 experienced their first TBI with LOC before age 20. (Source: Ohio BRFSS)
- Almost 235,000 Ohio adults have experienced at least one moderate or severe TBI with LOC. Around 110,000 (47%) of these adults also reported having a disability. (Source: Ohio BRFSS)
- Having a history of TBI with LOC was associated with higher prevalence of disability, poor physical and mental health, chronic health conditions and smoking cigarettes compared to the overall adult population in the state. While we cannot determine if these associations are causal, they clearly convey the long-term health and social impacts of TBI on an individual beyond the initial injury. (Source: Ohio BRFSS)

Cost: The financial, societal and human costs of the injury

- The total cost of traffic crash deaths alone in Ohio in 2018 was $1.69 billion. (Source: CDC)
- In 2018 and 2019, Medicaid and Medicare were the principal sources of payment for TBI care in Ohio. (Source: OTR)
- Costs of TBI in Ohio can be significantly reduced and patient outcomes improved through systematic delivery of appropriate rehabilitation and long-term services and support.

Personal Loss: The lived experience of lives changed forever

- Brain injury caused within the context of domestic violence has gone unrecognized because of complex factors with unique physical, emotional, cognitive and societal impacts.

The policy implications of this report are important to TBI researchers, public policy decision makers, health care providers, educators, employers and community service agencies. TBI is a chronic health condition and, as such, must be addressed according to the principles of proactive, lifelong management. Many instances of disabilities and related problems can be prevented and the overall cost of TBI reduced if systematic policies, services and rehabilitation are instituted for Ohioans.

Prologue: Traumatic Brain Injury Is Always a Personal Story

Beneath the statistics on brain injury lie countless personal stories that describe the human impacts of a moment in time that dramatically changed lives and, in many cases, futures. The most common causes of such injuries have been well documented as falls, sports injuries and motor vehicle accidents. This survivor story, however, comes from a different cause that, until recently, has gone largely unrecognized: domestic violence. Brain injury within this context brings with it additional profound implications for the individual as well as the family and further complicates timely diagnosis, successful treatment and recovery.

MARIE'S STORY OF BETRAYAL

Marie was a well-educated, professional woman with a successful career that included interesting travel, challenging assignments and collegial teamwork. At 35 years of age, she married a man who was well known and highly regarded in the community. Approximately one year into their marriage, an 11-year nightmare of abuse began that wrought dramatic changes to her health, abilities and life.

Her husband's controlling nature soon showed itself in an insistence that she, as his wife, should always submit to his orders and expectations. Early abusive behavior began with countless blows to the back of the head when he felt the need to "correct" shortcomings or errors. His "corrections" gradually increased in violence, and he often blamed her for making it necessary for him to take such harsh measures "for her own good," as it was his duty to discipline her. She sustained multiple falls as she was pushed or thrown to the floor, two instances of strangulation resulting in periods of unconsciousness and a particularly bizarre practice of driving at a high rate of speed, then suddenly applying the brakes, creating a whiplash effect.

Over the course of this 11-year period of abuse, Marie sought medical treatment for the multiplicity of signs and symptoms she experienced, which included headaches, blackout episodes, dizziness, memory loss, compromised executive functions, dizziness upon arising, sensitivity to light and sounds and, of course, obvious signs of tissue injury. She did not report the abuse episodes because of embarrassment, shame and, especially, fear — her husband had threatened physical harm to several of her relatives who were young children. In addition, the fact that her husband was well known, liked and respected in the community led her to believe that her reports of his violence would be dismissed or disbelieved. In fact, she did not even realize the link between her health problems and the repeated head injuries she received from her husband.

Without any such association, her doctors attributed her symptoms to conditions such as migraines, cardiovascular disease, autonomic nervous system disturbances, postural hypotension and depression. They treated them accordingly, with little positive result.

Marie's relief from the abuse occurred with the unexpected death of her husband. Her symptoms, however, persisted. Over the next year and a half, her symptoms continued to be a mystery until one night when she watched a hockey game and heard the story of a player who had been receiving treatment for a traumatic brain injury. It was the moment when she made the connection between years of head trauma and her persistent symptoms.

She returned to her primary care physician. Although it was difficult to share the painful reality, she described fully the extreme abuse she had undergone over many years. Her physician acknowledged that her pattern of symptoms now made more sense to him, and he initiated a variety of medical tests. Marie also wisely contacted the Ohio Domestic Violence Network for advice. They, in turn, contacted the Brain Injury Association of Ohio, which suggested referral for an evaluation by a physician specialist in physical medicine and rehabilitation.

With time, proper treatment and support, Marie is now able to hold her first permanent, full-time job in 14 years. Although she still struggles with some residual physical and mental impairments, her life is independent and purposeful in contributing to the community and making a difference again. She tells her story to remind others — especially members of the medical treatment community — that anytime someone presents with recurrent headaches, repeated injuries and vague histories, they should look deeper and explore circumstances to encourage a reluctant abused person to reach out for help.

Section 1

Ohio Department of Health Data from Death Certificates, Hospitalizations and Emergency Department Visits

Ohio Death Certificate Data

- The Ohio death certificate data in this report was provided by the Ohio Department of Health (ODH) Bureau of Vital Statistics. The analysis was conducted by the ODH Violence and Injury Epidemiology and Surveillance Section.
- The analysis was restricted to Ohio residents and includes Ohio residents who died out of the state.
- Rates were calculated by dividing the number of deaths related to traumatic brain injury (TBI) by the number of Ohio residents, based on estimates from the National Center for Health Statistics (NCHS). Where appropriate, rates were age-adjusted to the 2000 U.S. standard population.
- Injury deaths were defined as a death with an injury listed as the underlying cause of death from the International Classification of Diseases, Tenth Revision (ICD-10): V01-Y36, Y85-Y87, Y89 and *U01-*U03. From the injury death subset, TBI-related deaths included records with one of the following ICD-10 codes in any field of the multiple cause of death file: S01.0-S01.9, S02.0, S02.1, S02.3, S02.7-S02.9, S04.0, S06.0-S06.9, S07.0, S07.1, S07.8, S07.9, S09.7-S09.9, T01.0, T02.0, T04.0, T06.0, T90.1, T90.2, T90.4, T90.5, T90.8 and T90.9.

Ohio Hospitalization Data

- The Ohio hospitalization discharge data in this report was provided by the Ohio Hospital Association (OHA). The analysis was conducted by the ODH Violence and Injury Epidemiology and Surveillance Section.
- The analysis includes nonfatal hospital inpatient visits of Ohio residents in nonfederal acute care facilities in Ohio. It does not include federal hospitals, such as the Veterans Health Administration, and other federally funded rehabilitation centers and psychiatric hospitals.
- Rates were calculated by dividing the number of TBI-related hospitalizations by the number of Ohio residents, based on estimates from the NCHS. Where appropriate, rates were age-adjusted to the 2000 U.S. standard population.

- Injury hospital inpatient visits were defined as a hospital admission with an injury listed in the principal diagnosis discharge field (International Classification of Diseases, Tenth Revision, Clinical Modification [ICD-10-CM]: S00-S99, T07-T34, T36-T50 with a sixth character of 1-4 [except for T36.9, T37.9, T39.9, T41.4, T42.7, T43.9, T45.9, T47.9 and T49.9, which are included if the fifth character is 1-4], T51-T65, T66-T76, T79, O9A.2-O9A.5, T84.04 and M97). From the injury hospital subset, TBI hospital inpatient visits included records with one of the following diagnosis codes: S02.0, S02.1, S02.80, S02.81, S02.82, S02.91, S04.02, S04.03, S04.04, S06, S07.1 and T74.4. Hospital inpatient visits related to unspecified injury of the head include records that have a diagnosis code of S09.90 and no other TBI diagnoses codes (defined above). TBI and unspecified injury of the head are presented separately in Figure 14 on page 18 and together in subsequent figures and tables.

Ohio Emergency Department Visit Data

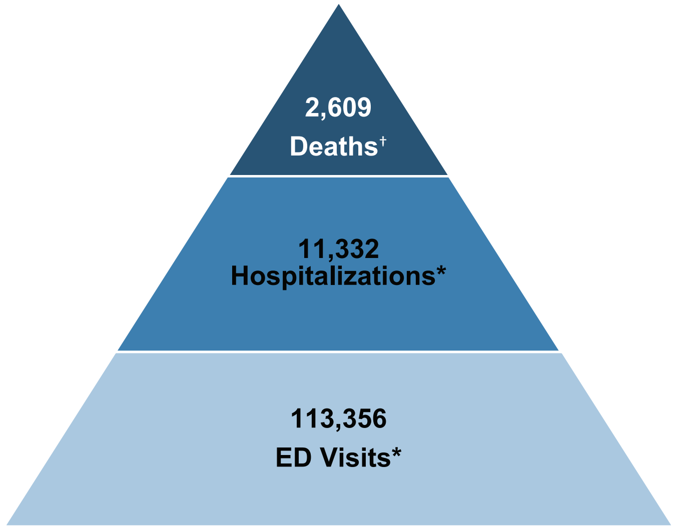
- The Ohio emergency department (ED) visit discharge data in this report was provided by the OHA. The analysis was conducted by the ODH Violence and Injury Epidemiology and Surveillance Section.
- The analysis includes nonfatal ED visits of Ohio residents in nonfederal acute care facilities in Ohio. It does not include federal hospitals and excludes ED visits that resulted in a hospital admission.
- Rates were calculated by dividing the number of TBI-related injuries by the number of Ohio residents, based on estimates from the NCHS. Where appropriate, rates were age-adjusted to the 2000 U.S. standard population.
- Injury ED visits were defined as an ED visit with an injury listed in any diagnosis discharge field (ICD-10-CM codes S00-S99, T07-T34, T36-T50 with a sixth character of 1-4 [except for T36.9, T37.9, T39.9, T41.4, T42.7, T43.9, T45.9, T47.9 and T49.9, which are included if the fifth character is 1-4], T51-T65, T66-T76, T79, O9A.2-O9A.5, T84.04 and M97) or a valid external cause code listed in any diagnosis discharge field (V00-V99, W00-X58, X71-X83, X92-Y09, Y21-Y33 and Y35-Y38). From the injury ED subset, TBI ED visits included records with one of the following diagnosis codes: S02.0, S02.1, S02.80, S02.81, S02.82, S02.91, S04.02, S04.03, S04.04, S06, S07.1 and T74.4. ED visits related to unspecified injury of the head include records that have a diagnosis code of S09.90 and no other TBI diagnoses codes (defined above). TBI and unspecified injury of the head are presented separately in Figure 18 on page 20 and together in subsequent figures and tables.

Special Note Specific to Hospitalization and ED Visit Data:

Prior to Oct. 1, 2015, the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) was used to report medical encounters in the hospital setting (e.g., hospitalizations, ED visits) when submitting electronic claims for administrative and financial transactions. Effective Oct. 1, 2015, the U.S. Department of Health and Human Services required health care organizations and providers covered by the Health Insurance Portability and Accountability Act of 1996 to use ICD-10-CM to report medical encounters. The major transition from ICD-9-CM to ICD-10-CM included a dramatic coding restructure that especially impacted injury surveillance using discharge data: The number of injury-related diagnosis codes (e.g., the TBI codes referenced above) increased from 2,600 to 43,000. Similarly, the number of injury-related external cause codes used to determine the intent (e.g., unintentional) and mechanism (e.g., fall) of an injury increased from 1,300 to 7,500. Consequently, comparisons should not be made between data before and after Oct. 1, 2015. Thus, hospitalization and ED visit trends and trend analysis spanning the transition period are not shown in this report. This transition is specific to hospitalization and ED visit data using ICD-10-CM codes; it does not impact death data, which uses ICD-10 codes.

Citation: CSTE ICD-10-CM Injury Surveillance Toolkit (Sept. 23, 2019). Toolkit Overview and Purpose. Retrieved from https://resources.cste.org/Injury-Surveillance-Methods-Toolkit/.

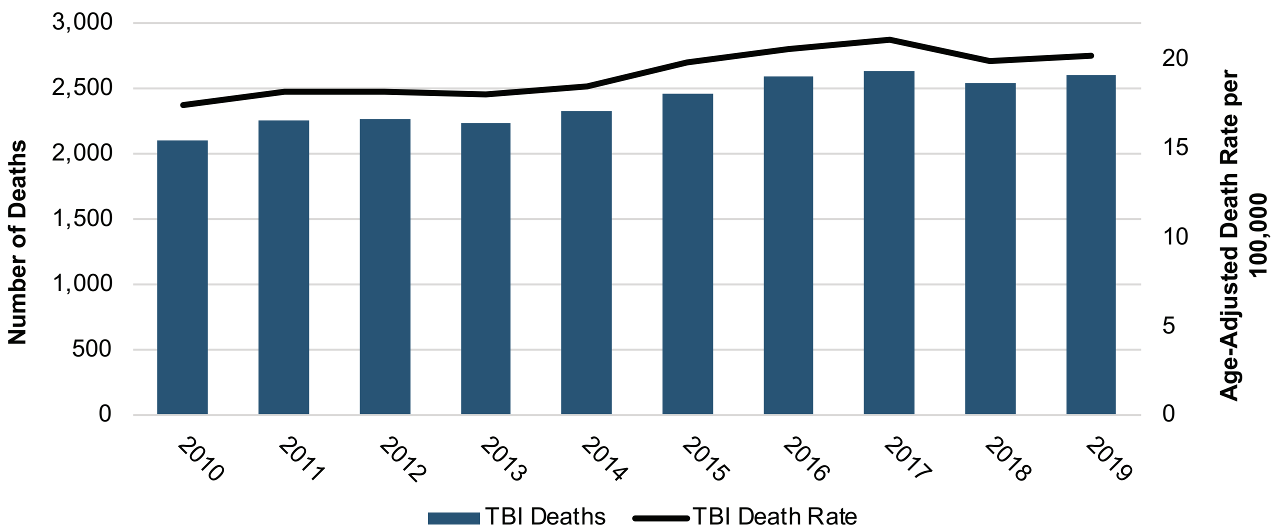
Figure 1. TBI Pyramid, Ohio, 2019



†Source: Ohio Department of Health Bureau of Vital Statistics
*Source: Ohio Hospital Association

Figure 1 depicts the number of TBI cases in 2019 among Ohioans, broken down by deaths, hospitalizations and ED visits. In 2019, there were 2,609 TBI-related deaths, 11,332 TBI-related hospitalizations and 113,356 TBI-related ED visits.

Figure 2. Number and Age-Adjusted Rate of TBI Deaths by Year, Ohio, 2010–2019



TBI is a major cause of death and disability. From 2010 to 2019, the number of TBI deaths increased 24% (from 2,104 to 2,609), and the rate of TBI deaths increased 16% (from 17.4 to 20.2 per 100,000). A rate measures the frequency of an event (in this case, a TBI death) in a given population (Ohio resident population) during a specified period of time (one year) and is typically multiplied by 100,000 population for interpretability. In 2019, for every 100,000 Ohio residents, 20 died from a TBI-related injury.

Figure 3. Age-Adjusted TBI Death Rate by County of Residence, Ohio, 2015–2019

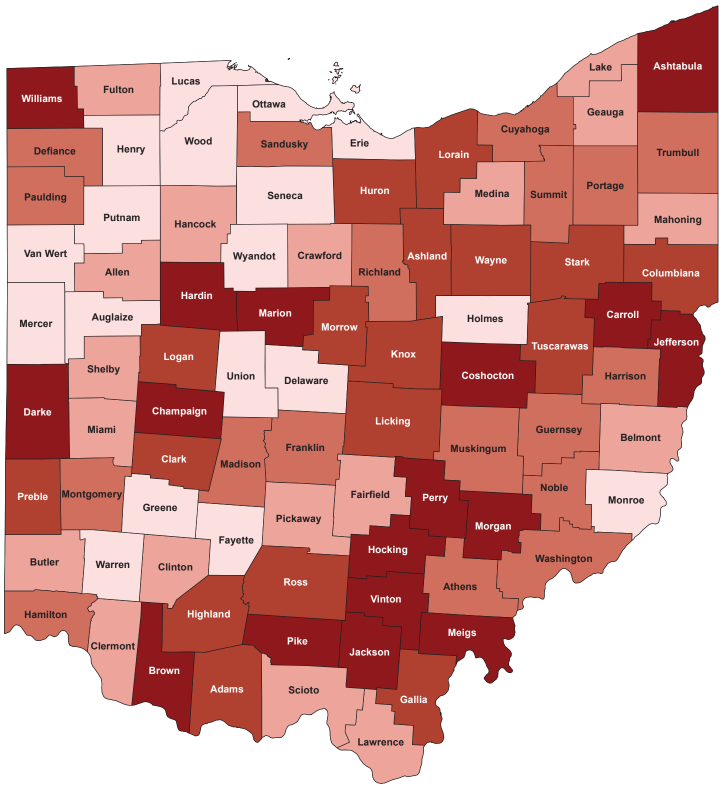


Figure 3 shows the average age-adjusted TBI death rate by county from 2015–2019. During this time period, Pike County had the highest rate in Ohio — for every 100,000 residents of Pike County, nearly 36 died from a TBI-related injury. Counties in the Appalachian region of Ohio have the highest rates of TBI deaths.

Death Rates per 100,000 Population

- 10.5-16.8
- 16.9-19.3
- 19.4-22.0
- 22.1-25.1
- 25.2-36.2

Figure 4. Number of TBI Deaths by Age and Sex, Ohio, 2019

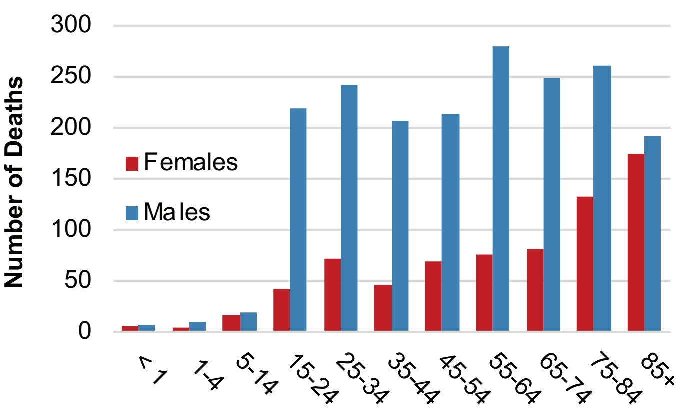
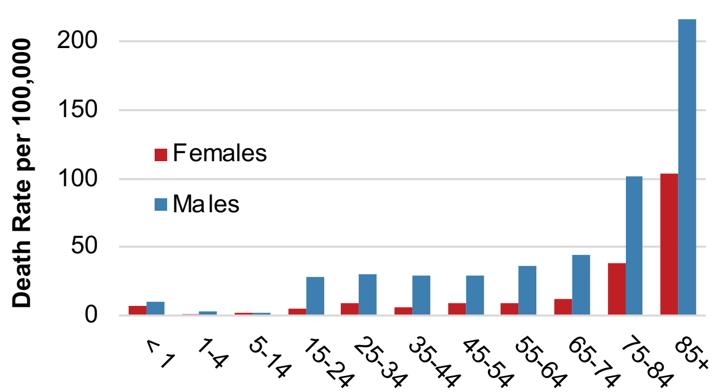


Figure 5. TBI Death Rates by Age and Sex, Ohio, 2019



Figures 4 and 5 show the number and rate of TBI deaths, respectively, among Ohioans in 2019. Males were disproportionately burdened by TBI death across the lifespan — rates were nearly three times higher among males compared to females. The TBI death rate was highest among older adults and, in both males and females, increased with age for adults 55 years old and older.

Figure 6. Number of TBI Deaths by Select Intent/Mechanism, Ohio, 2010–2019

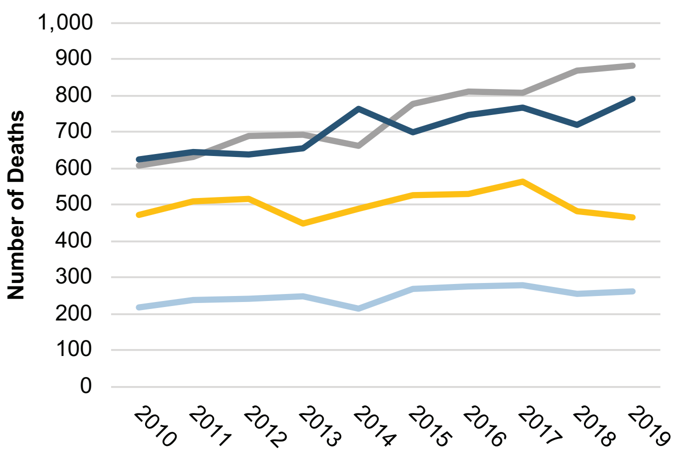
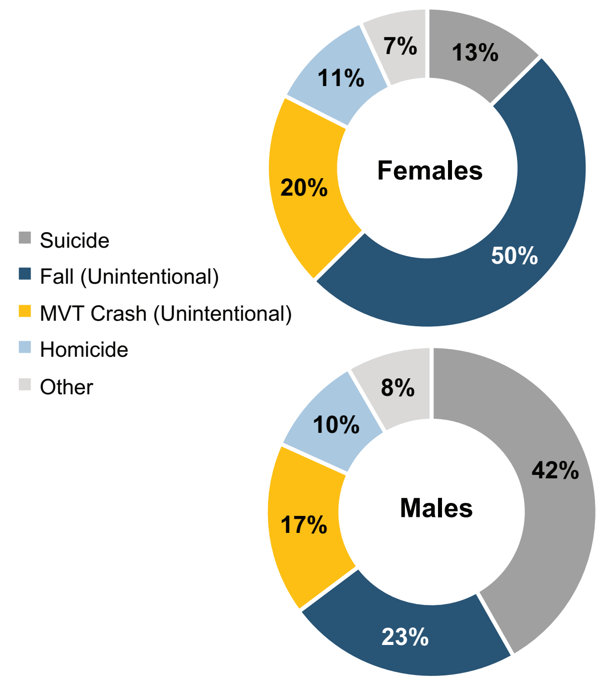
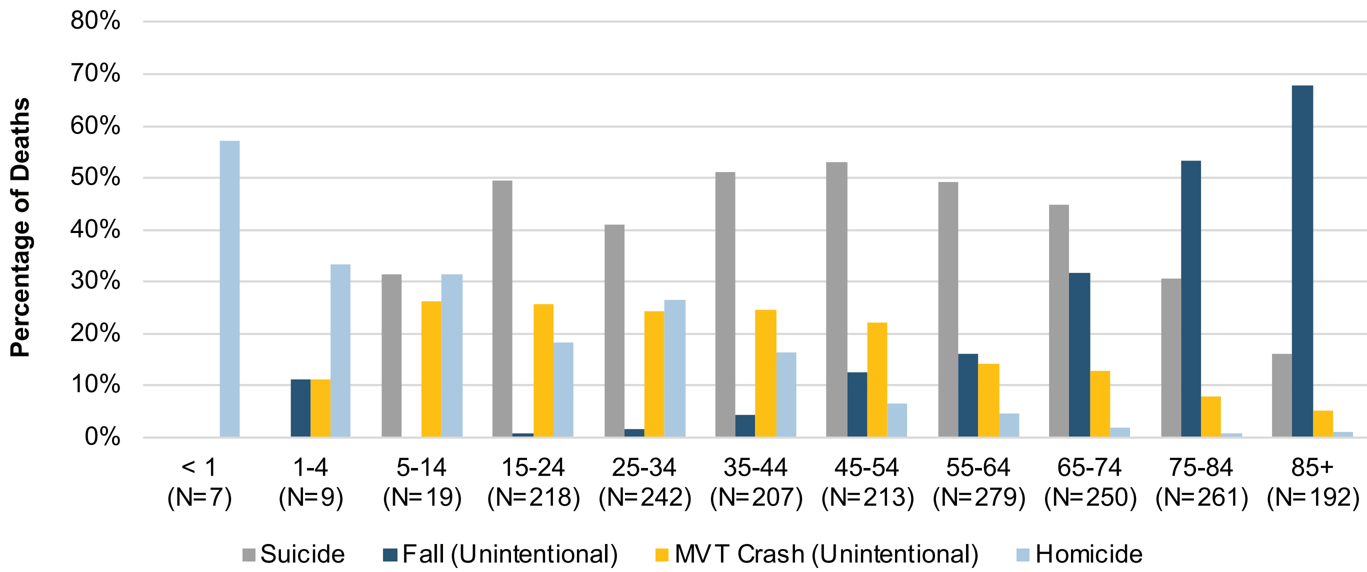


Figure 7. Percentage of TBI Deaths by Select Intent/Mechanism and Sex, Ohio, 2019



Suicide has been the leading intent/mechanism for TBI deaths among Ohioans since 2015. From 2010 to 2019, suicide-related TBI deaths increased 45% (from 607 to 882), and unintentional fall-related TBI deaths increased 27% (from 626 to 792). In 2019, unintentional falls were the leading intent/mechanism of TBI deaths (50%) among females, followed by unintentional motor vehicle traffic (MVT) crashes (20%). Among males, the largest proportion of TBI deaths was attributed to suicide (42%), followed by unintentional falls (23%).

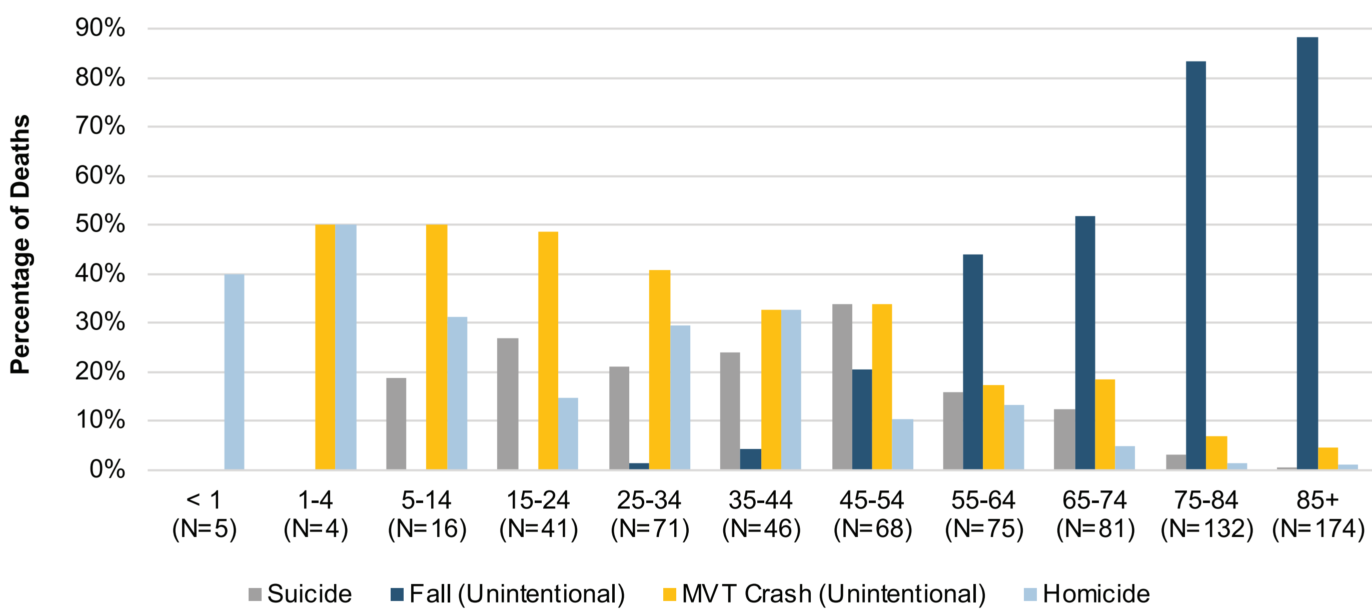
Figure 8. Percentage of TBI Deaths Among Males by Select Intent/Mechanism* and Age Group, Ohio, 2019



**Not all intent/mechanism combinations are presented. Therefore, data presented by age category may not sum to 100%.*

Suicide accounted for the largest percentage of TBI deaths among males 15 to 74 years of age. The percentage of unintentional fall-related TBI deaths increased with age, starting at 15 years of age among males and becoming the largest contributor to TBI deaths for those aged 75 years and older.

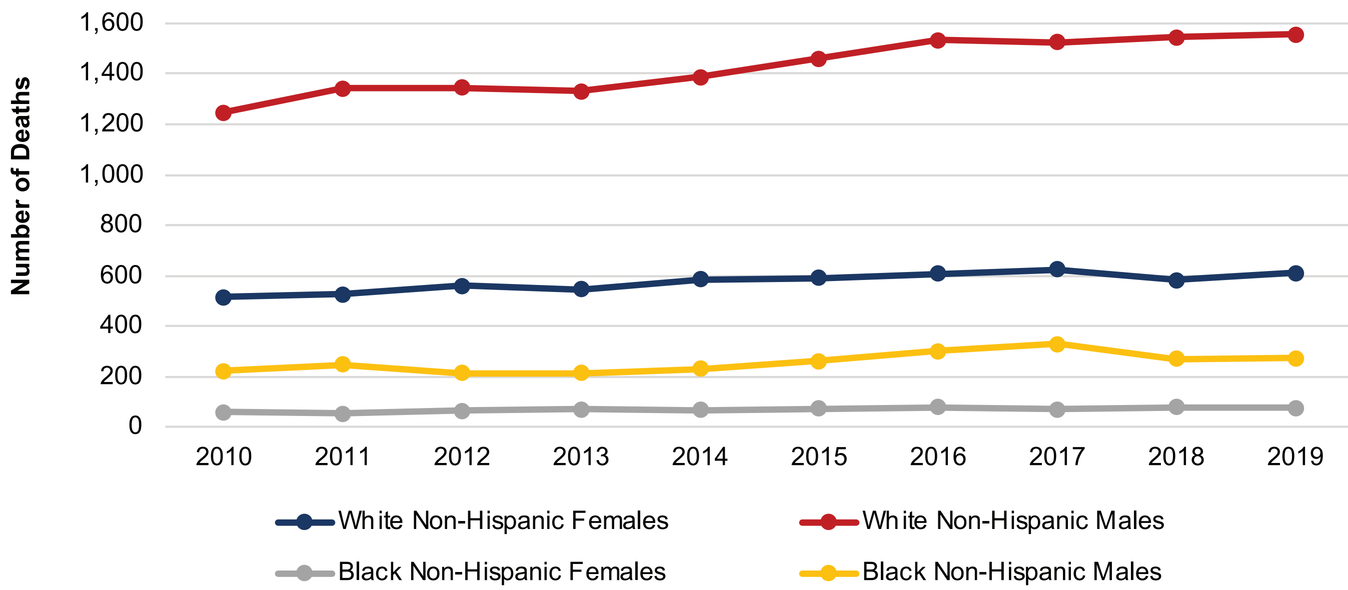
Figure 9. Percentage of TBI Deaths Among Females by Select Intent/Mechanism* and Age Group, Ohio, 2019



**Not all intent/mechanism combinations are presented. Therefore, data presented by age category may not sum to 100%.*

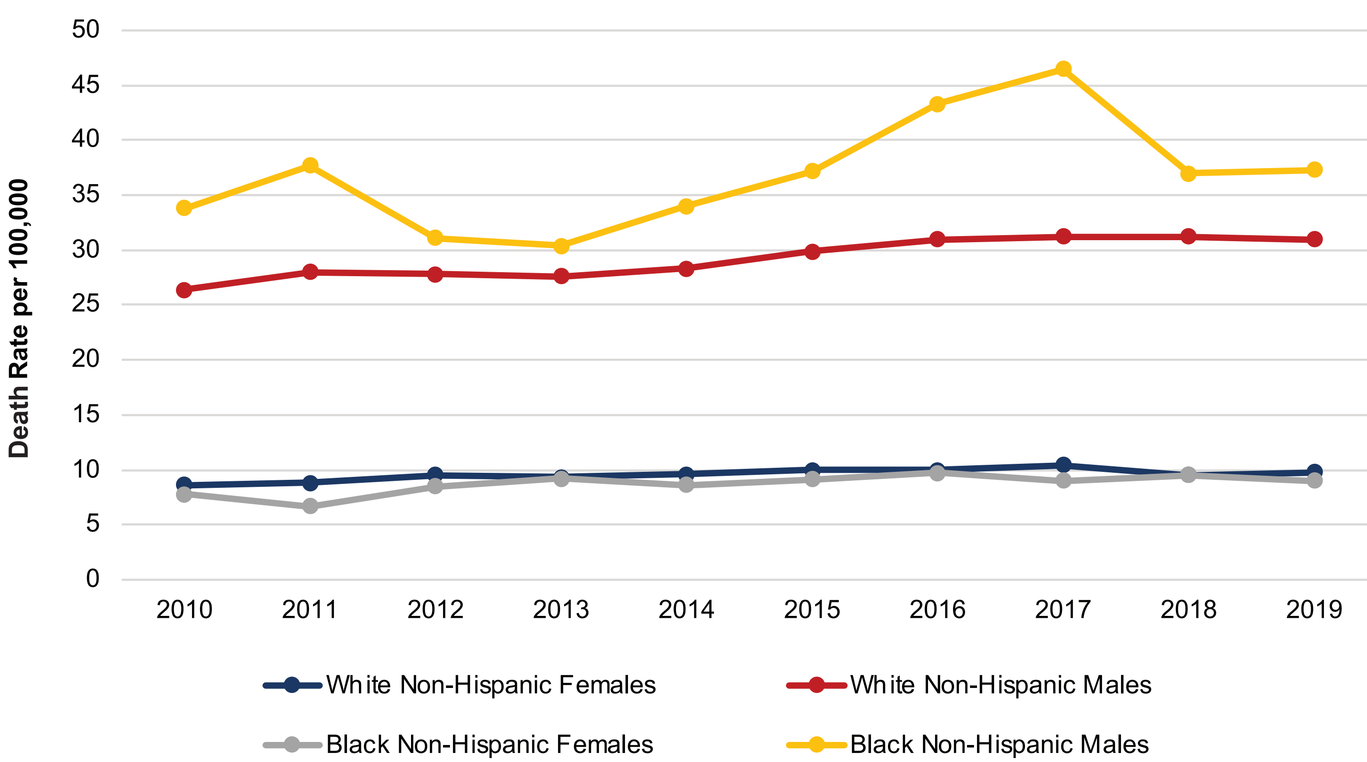
Among females 1 to 24 years of age, unintentional MVT crashes accounted for nearly half of TBI deaths. The percentage of unintentional fall-related TBI deaths increased with age starting at 25 years old among females. At 55 years of age, unintentional falls accounted for the largest percentage of TBI deaths.

Figure 10. Number of TBI Deaths by Race/Ethnicity and Sex, Ohio, 2010–2019



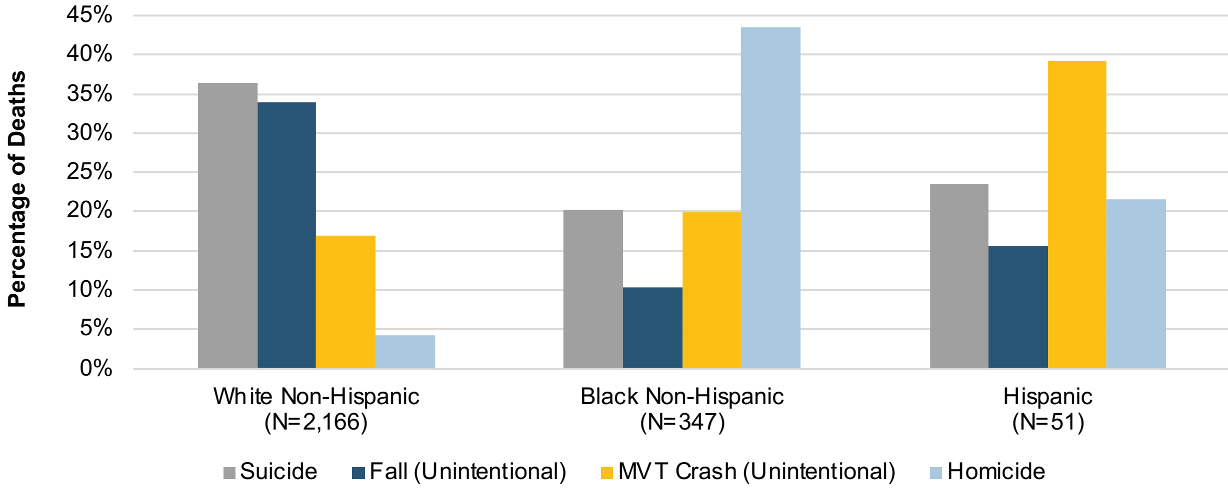
From 2010 to 2019, white non-Hispanic males had the highest number of TBI deaths. In 2019, they made up 60% of TBI deaths, compared to 39% of the total population.

Figure 11. TBI Death Rates by Race/Ethnicity and Sex, Ohio, 2010–2019



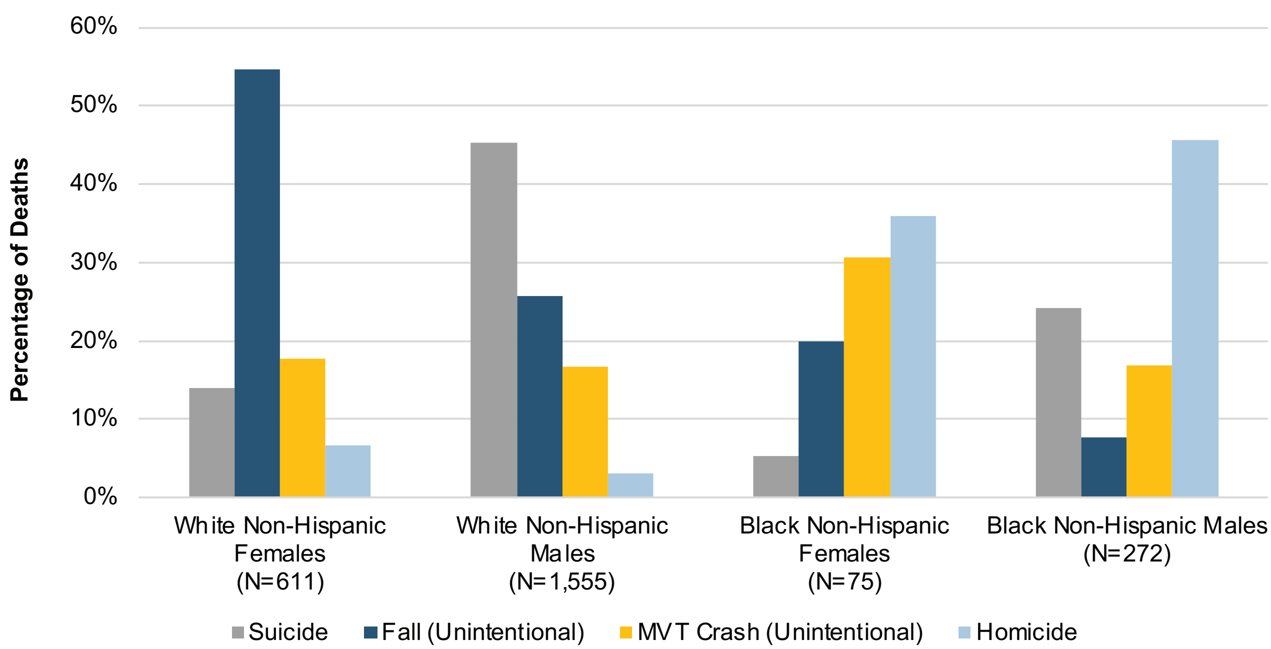
Each demographic group presented saw an overall increase in the rate of TBI deaths from 2010 to 2019. During this time period, Black non-Hispanic males had the highest rates of TBI deaths, followed by white non-Hispanic males. The rates of TBI death among white non-Hispanic females and Black non-Hispanic females were similar over time, and they had notably lower rates compared to their male counterparts.

Figure 12. Percentage of TBI Deaths by Race/Ethnicity and Intent/Mechanism, Ohio, 2019



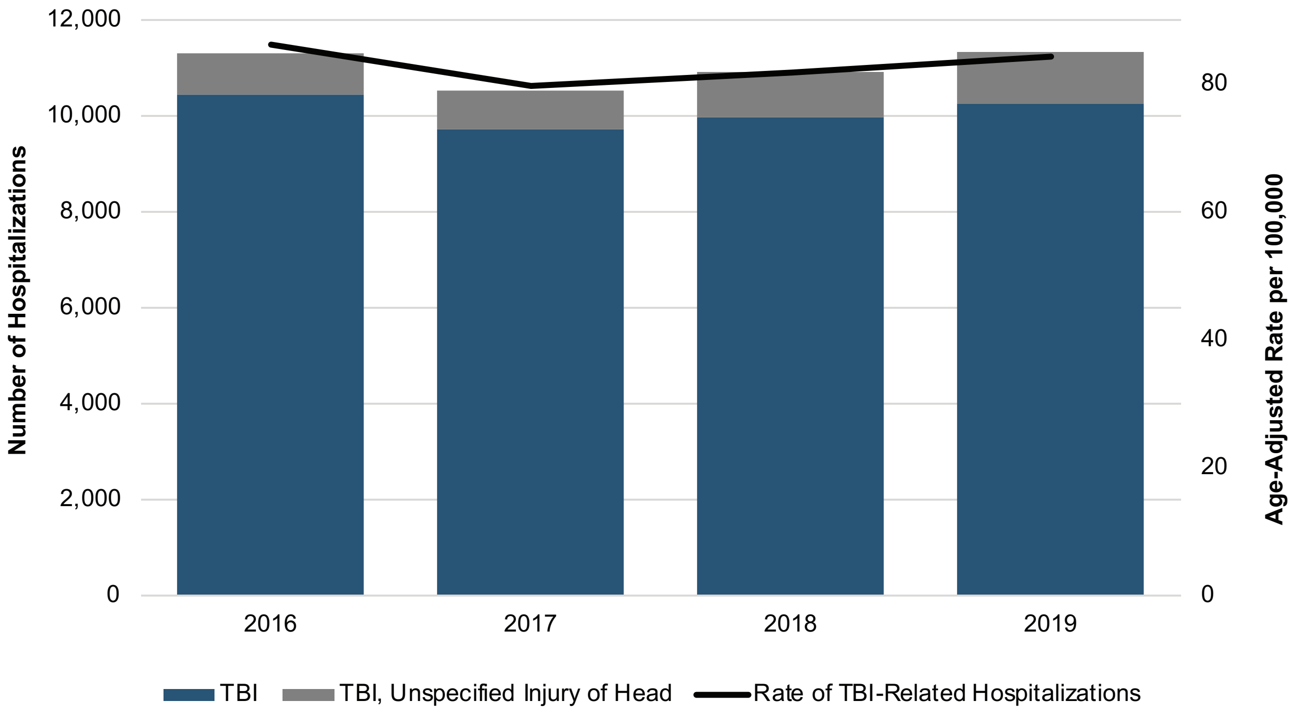
Among white non-Hispanic Ohioans, the leading intent/mechanism of TBI deaths was suicide, followed by unintentional falls (36% and 34%, respectively). Homicide was the leading intent/mechanism of TBI death among Black non-Hispanic Ohioans, accounting for 44% of TBI deaths compared to 22% among Hispanic Ohioans and 4% among white non-Hispanic Ohioans. Among Hispanic Ohioans, unintentional MVT crashes were the leading intent/mechanism of TBI death, accounting for 39% of deaths.

Figure 13. Percentage of TBI Deaths by Sex, Race/Ethnicity, and Intent/Mechanism, Ohio, 2019



Among white non-Hispanic females, unintentional falls accounted for the majority of TBI deaths (55%). Among white non-Hispanic males, the largest portion of TBI deaths was attributed to suicide (45%). Homicide was the leading intent/mechanism of TBI deaths among both male and female Black non-Hispanic Ohioans, accounting for 46% and 36% of TBI deaths, respectively.

Figure 14. Number of TBI-Related Hospitalizations by Year, Ohio, 2016–2019



TBI includes diagnoses codes S02.0, S02.1, S02.80, S02.81, S02.82, S02.91, S04.02, S04.3, S04.04, S06, S07.1 and T74.4.

TBI, Unspecified Injury of Head includes diagnosis code S09.90.

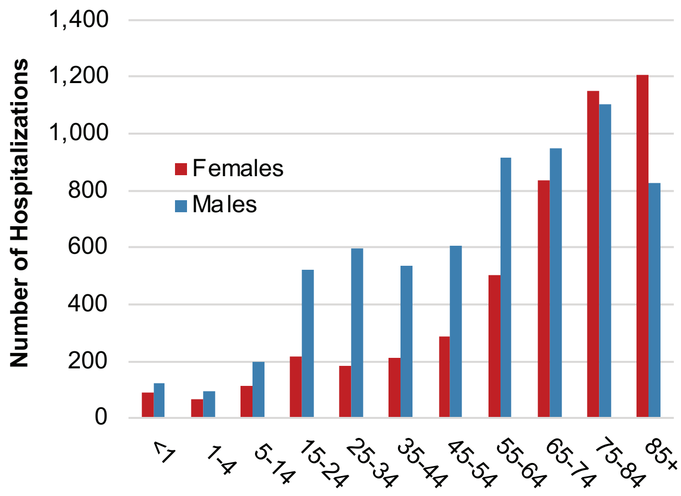
Figure 14 includes Ohio residents and excludes fatal cases. The numbers represent all visits, not unique individuals.

Source: Ohio Hospital Association, discharge diagnoses data. Analysis conducted by the Ohio Department of Health Violence and Injury Epidemiology and Surveillance Section.

Previously, the ICD-9-CM-based surveillance definition for TBI-related hospitalizations included the head injury unspecified code (959.01). National guidelines to define TBI-related hospitalizations following the transition are still being tested, but they currently propose to examine TBI and "TBI, unspecified injury of the head" (S09.90) separately. Therefore, the numbers for TBI and TBI, unspecified injury of the head are presented separately in Figure 14 for comparison. They are combined in the age-adjusted rate presented in Figure 14 and in all other figures and tables for conciseness.

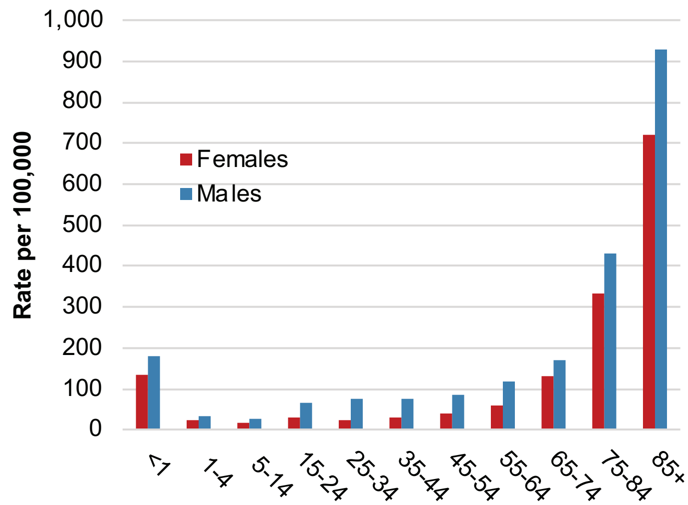
Figure 14 shows the number and rate of TBI-related hospitalizations by year, from 2016 to 2019. These data include Ohio residents and exclude fatal cases. Overall, in 2016, there were 11,318 TBI-related hospitalizations (10,444 TBI visits and 874 TBI, unspecified injury of the head visits). The number of overall TBI-related hospitalizations decreased to 10,535 in 2017. However, since 2017, the number and rate of overall TBI-related hospitalizations have increased by 8% and 6%, respectively. In 2019, there were 11,332 TBI-related hospitalizations (10,265 TBI visits and 1,067 TBI, unspecified injury of the head visits) and 84 TBI-related hospitalizations per 100,000 Ohioans.

Figure 15. Number of TBI-Related Hospitalizations by Age and Sex, Ohio, 2019



Source: Ohio Hospital Association.

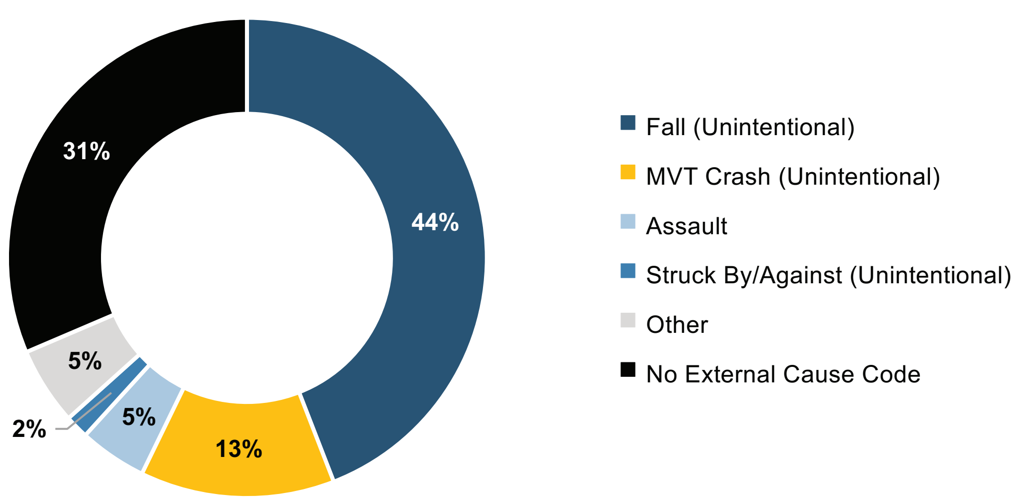
Figure 16. Rate of TBI-Related Hospitalizations by Age and Sex, Ohio, 2019



Source: Ohio Hospital Association.

Figures 15 and 16 show the number and rate of TBI-related hospitalizations, respectively, by age and sex in Ohio in 2019. Prior to 75 years of age, males had a higher number of TBI-related hospitalizations than their female counterparts. Among adults aged 75 years and older, females contributed most hospitalizations. Males had a higher rate of TBI-related hospitalizations across the lifespan. TBI-related hospitalization rates were lowest for both females and males between the ages of 5 and 14 years old (14.3 per 100,000 and 28.9 per 100,000, respectively). Rates were highest among adults 75 years old and older.

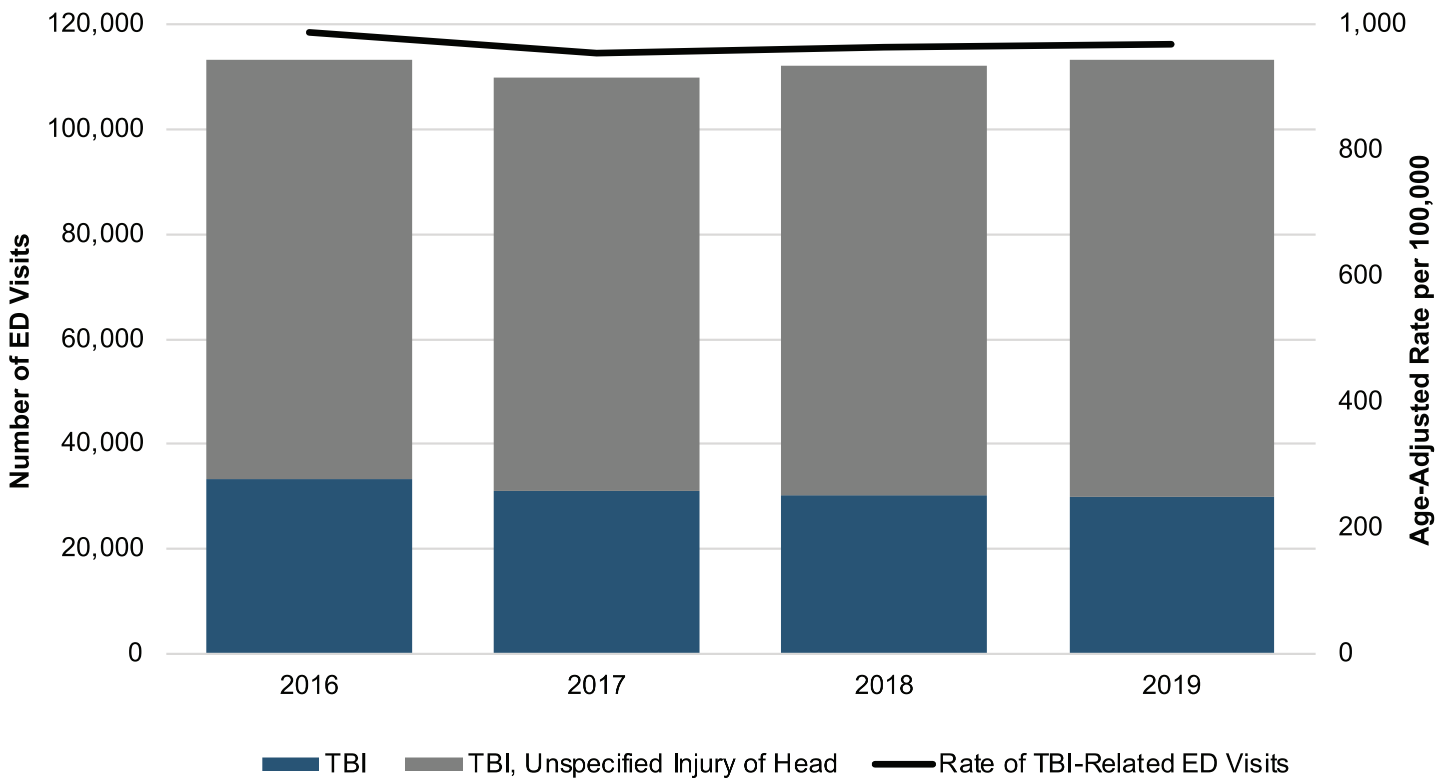
Figure 17. Percentage of TBI-Related Hospitalizations by Intent/Mechanism, Ohio, 2019



Source: Ohio Hospital Association.

In 2019, unintentional falls were the leading intent/mechanism of TBI-related hospitalizations, accounting for 44% of visits. Unintentional MVT crashes accounted for 13% of visits, followed by assault (5%). In 31% of hospitalizations, an external cause code (which is used to determine the intent and mechanism of an injury) was not reported.

Figure 18. Number of TBI-Related Emergency Department Visits by Year, Ohio, 2016–2019



TBI includes diagnoses codes S02.0, S02.1, S02.80, S02.81, S02.82, S02.91, S04.02, S04.3, S04.04, S06, S07.1 and T74.4.

TBI, Unspecified Injury of Head includes diagnosis code S09.90.

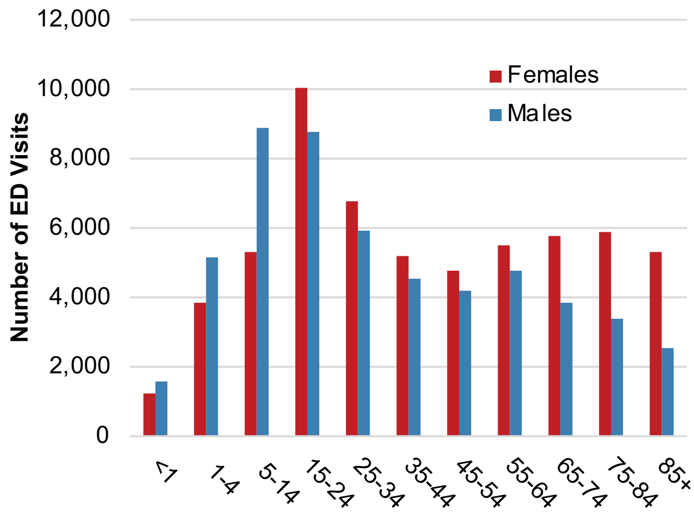
Figure 18 includes Ohio residents and excludes fatal and hospital admitted cases. The numbers represent all visits, not unique individuals.

Source: Ohio Hospital Association, discharge diagnoses data. Analysis conducted by the Ohio Department of Health Violence and Injury Epidemiology and Surveillance Section.

Previously, the ICD-9-CM-based surveillance definition for TBI-related ED visits included the head injury unspecified code (959.01). National guidelines to define TBI-related ED visits following the transition are still being tested, but they currently propose to examine TBI and "TBI, unspecified injury of the head" (S09.90) separately. Therefore, the numbers for TBI and TBI, unspecified injury of the head are presented separately in Figure 18 for comparison. They are combined in the age-adjusted rate present in Figure 18 and in all other figures and tables for conciseness.

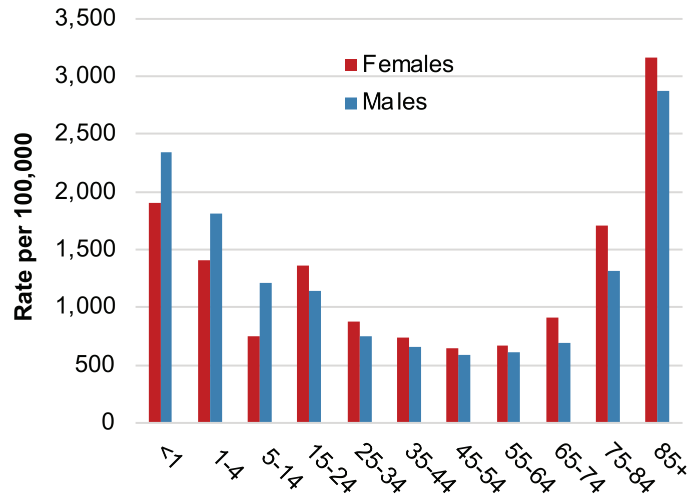
Figure 18 shows the number and rate of TBI-related ED visits by year, from 2016 to 2019. These data include Ohio residents and exclude hospital-admitted and fatal cases. Overall, TBI-related ED visits are largely attributed to visits for TBI, unspecified injury of the head (depicted in gray). The overall TBI-related ED visits decreased from 2016 to 2017, and while visits for TBI, unspecified injury of the head increased from 2017 to 2019, TBI visits (depicted in blue) continued to decrease through 2019. In 2019, there were 113,356 TBI-related ED visits (29,913 TBI visits and 83,443 TBI, unspecified injury of the head visits) and nearly 970 TBI-related ED visits per 100,000 Ohioans.

Figure 19. Number of TBI-Related Emergency Department Visits by Age and Sex, Ohio, 2019



Source: Ohio Hospital Association.

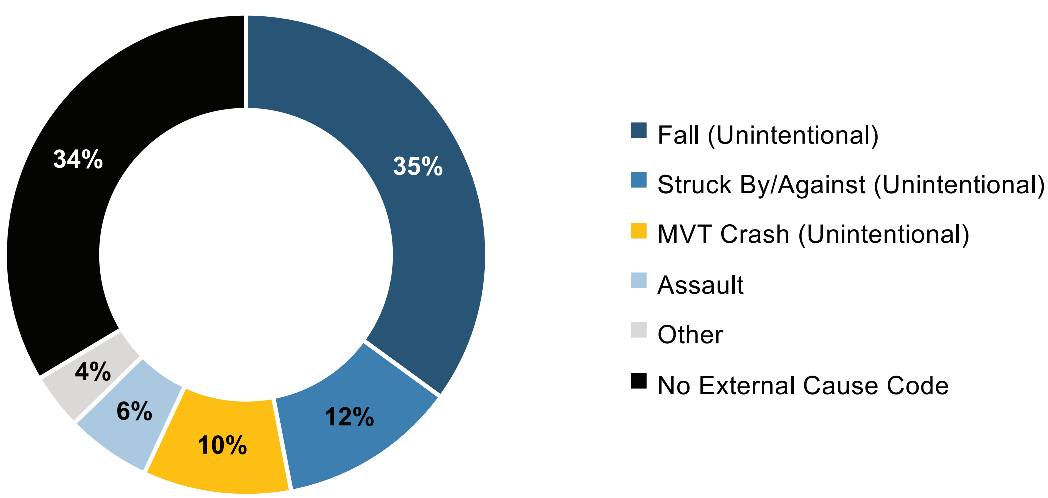
Figure 20. Rate of TBI-Related Emergency Department Visits by Age and Sex, Ohio, 2019



Source: Ohio Hospital Association.

Figures 19 and 20 show the number and rate of TBI-related ED visits, respectively, by age and sex. For younger age groups (0 to 14 years old), males had a higher number and rate of TBI-related ED visits than their female counterparts. Among Ohioans aged 15 years and older, females had a higher number and rate of ED visits. The rate of TBI-related ED visits was highest at either end of the age spectrum, peaking among adults 85 years of age and older, followed by children less than 1 year old. The rate was lowest for both females and males between the ages of 45 and 54 years old (652.6 per 100,000 and 585.4 per 100,000, respectively).

Figure 21. Percentage of TBI-Related Emergency Department Visits by Intent/Mechanism, Ohio, 2019



Source: Ohio Hospital Association.

In 2019, unintentional falls were the leading intent/mechanism of TBI-related ED visits, accounting for 35% of visits. Unintentional struck by/against accounted for 12% of visits, followed by unintentional MVT crashes (10%). In 34% of TBI-related ED visits, an external cause code (which is used to determine the intent and mechanism of an injury) was not reported.

Table 1. Number and Rate of TBI-Related Emergency Department Visits, Hospitalizations, and Deaths by Demographic Characteristics, Ohio, 2019

Demographic Characteristics	% of Ohio Population	Emergency Department Visits*		Hospitalizations*		Deaths†	
		N (% Distribution)	Rate§	N (% Distribution)	Rate§	N (% Distribution)	Rate§
Total		113,356	969.5	11,332	84.3	2,609	20.2
Age							
<1 year	1.1	2,847 (2.5)	2,132.8	212 (1.9)	158.8	12 (0.5)	9.0
1 – 4 years	4.8	9,011 (7.9)	1,616.8	160 (1.4)	28.7	13 (0.5)	2.3
5 – 14 years	12.3	14,213 (12.5)	986.8	313 (2.8)	21.7	35 (1.3)	2.4
15 – 24 years	12.9	18,819 (16.6)	1,248.6	735 (6.5)	48.8	259 (9.9)	17.2
25 – 34 years	13.3	12,721 (11.2)	818.4	784 (6.9)	50.4	313 (12.0)	20.1
35 – 44 years	12.0	9,726 (8.6)	695.8	747 (6.6)	53.4	253 (9.7)	18.1
45 – 54 years	12.4	8,967 (7.9)	619.4	894 (7.9)	61.8	281 (10.8)	19.4
55 – 64 years	13.7	10,306 (9.1)	642.2	1,419 (12.5)	88.4	354 (13.6)	22.1
65 – 74 years	10.2	9,625 (8.5)	809.3	1,783 (15.7)	149.9	330 (12.6)	27.7
75 – 84 years	5.1	9,268 (8.2)	1,542.6	2,254 (19.9)	375.2	393 (15.1)	65.4
85+ years	2.2	7,852 (6.9)	3,063.9	2,031 (17.9)	792.5	366 (14.0)	142.8
Sex							
Female	51.0	59,682 (52.7)	974.2	4,862 (42.9)	63.2	713 (27.3)	9.8
Male	49.0	53,665 (47.3)	957.9	6,470 (57.1)	107.2	1,896 (72.7)	31.7
Race/Ethnicity							
White, Non-Hispanic	79.4	84,188 (74.3)	903.4	9,261 (81.7)	80.9	2,166 (83.0)	19.8
Black, Non-Hispanic	13.6	19,750 (17.4)	1,229.9	1,412 (12.5)	92.2	347 (13.3)	22.3
Hispanic	4.0	4,141 (3.7)	910.1	286 (2.5)	84.2	51 (2.0)	12.4

* Source: Ohio Hospital Association

† Source: Ohio Department of Health Bureau of Vital Statistics

Rates presented for age groups are age-specific. Rates presented for total, sex and race/ethnicity are age-adjusted to the 2000 U.S. standard population. Rates are calculated per 100,000 population.

Race/ethnicity categories are mutually exclusive. Hispanic includes any race. Categories may not total 100% due to missing demographic data.

In 2019, the age-adjusted rate of TBI-related ED visits was 969.5 per 100,000, the age-adjusted rate of TBI-related hospitalizations was 84.3 per 100,000 and the age-adjusted rate of TBI-related deaths was 20.2 per 100,000. While TBI-related ED visits were more likely to be female (52.7%), males made up a larger proportion of TBI-related hospitalizations (57.1%) and deaths (72.7%). This suggests males had more severe TBIs when compared to females. Overall, males had a higher age-adjusted rate for TBI-related hospitalizations and deaths — more than 1.7 times and three times the hospitalization and death rate, respectively, when compared to females. While the largest proportion of TBI-related ED visits was among young adults aged 15 to 24 years old (16.6%), older adults aged 75 to 84 years old made up the largest proportion of TBI-related hospitalizations (19.9%) and deaths (15.1%). Older adults aged 85 years and older had the highest rate of TBI-related ED visits, hospitalizations and deaths. Black non-Hispanic Ohioans had the highest rate of TBI-related ED visits, hospitalizations and deaths.

Summary

The number and rate of TBI-related deaths among Ohioans increased from 2010 to 2019, and TBI continues to be a public health problem.

As the data in this report show, the intent and mechanism of TBI-related deaths vary by demographic group, requiring multifaceted solutions to address and reverse the rising trend. From 2015 to 2019, Appalachian counties had the highest average age-adjusted rate of TBI-related deaths. Pike County had the highest rate in Ohio — for every 100,000 residents, 36 died from a TBI-related injury.

Since 2015, suicide has been the leading intent/mechanism of TBI-related death among Ohioans. This was largely attributed to deaths among males. In 2019, 42% of TBI-related deaths among males were attributed to suicide, which was a leading intent/mechanism for TBI-related deaths among white non-Hispanic males and the second-leading intent/mechanism among Black non-Hispanic males.

When compared to other demographic groups, Black non-Hispanic males had the highest rate of TBI-related death from 2010 to 2019. In 2019, homicide was the leading intent/mechanism among both Black non-Hispanic males and females, accounting for 46% and 36% of TBI-related deaths, respectively.

Unintentional falls were the second-leading intent/mechanism of TBI-related deaths overall and the leading intent/mechanism of TBI-related hospitalizations and ED visits. TBI-related ED visits were more likely to be female (52.7%). However, males made up a larger proportion of TBI-related hospitalizations (57.1%) and deaths (72.7%).

While the largest portion of TBI-related ED visits was among young adults aged 15 to 24 years old (16.6%), older adults aged 75 to 84 years of age made up the largest portion of TBI-related hospitalizations (19.9%) and deaths (15.1%). Adults 85 years old and older had the highest rate of TBI-related ED visits, hospitalizations and deaths.

Section 2

Ohio Trauma Registry Data from the Ohio Department of Public Safety Division of Emergency Medical Services

The Ohio Trauma Registry (OTR) data supplied for this report represents that which is current as of August 2021. It primarily includes OTR data from 2018 through 2019. Certain tables include data from 2015 to 2017.

The Ohio Trauma Acute Care Registry

The Ohio Trauma Acute Care Registry (TACR) is Ohio's data system for sustained traumatic injuries that arrive at an Ohio facility. The system collects injury, care, hospital status and discharge status data on patients with traumatic injuries. Data are reported by trauma hospitals, acute care hospitals and free-standing emergency departments that receive patients with traumatic injuries. The Ohio TACR is maintained by the Division of Emergency Medical Services (EMS) at the Ohio Department of Public Safety. Trauma brain injury data for this report were extracted and analyzed from this data system.

Trauma Inclusion Criteria

Trauma Patient Definition

To ensure consistent data collection across the state of Ohio and to follow the National Trauma Data Standard, a trauma patient is defined as a patient sustaining a traumatic injury and meeting the patient inclusion criteria described below.

Patient Inclusion Criteria

To be included in the Ohio TACR:

- The patient must have incurred at least one of the injury diagnostic codes defined in the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) no more than 30 days prior to presentation for initial treatment:
  - » J70.5 with character modifier of A ONLY (Respiratory conditions due to smoke inhalation — initial encounter)

- » S00-S99 with seventh character modifier of A, B or C ONLY (Injuries to specific body parts – initial encounter)
- » T07 (Unspecified multiple injuries)
- » T14 (Injury of unspecified body region)
- » T20-T28 with seventh character modifier of A ONLY (Burns by specified body parts – initial encounter)
- » T30-T32 (Burns by total body surface area percentage)
- » T33 with character modifier of A ONLY (Superficial frostbite – initial encounter)
- » T34 with character modifier of A ONLY (Frostbite with tissue necrosis – initial encounter)
- » T67 with character modifier of A ONLY (Effects of heat and light – initial encounter)
- » T68 with character modifier of A ONLY (Hypothermia – initial encounter)
- » T69 with character modifier of A ONLY (Other effects of reduced temperature – initial encounter)
- » T70.4 with character modifier of A ONLY (Effects of high-pressure fluids – initial encounter)
- » T70.8 with character modifier of A ONLY (Other effects of air pressure and water pressure – initial encounter)
- » T70.8 with character modifier of A ONLY (Other effects of air pressure and water pressure – initial encounter)
- » T70.9 with character modifier of A ONLY (Effects of air pressure and water pressure, unspecified – initial encounter)
- » T71 with character modifier of A ONLY (Asphyxiation – initial encounter)
- » T74.1 with character modifier of A ONLY (Physical abuse, confirmed – initial encounter)
- » T74.4 with character modifier of A ONLY (Shaken infant syndrome – initial encounter)
- » T75.0 with character modifier of A ONLY (Effects of lightning – initial encounter)
- » T75.1 with character modifier of A ONLY (Unspecified effects of drowning and nonfatal submersion – initial encounter)
- » T75.4 with character modifier of A ONLY (Electrocution – initial encounter)
- » T79.A1-T79.A9 with seventh character modifier of A ONLY (Traumatic compartment syndrome – initial encounter)

- The patient MUST ALSO:
  - » On initial presentation for treatment of an injury be admitted to a hospital or hospital observation unit as defined by a physician order regardless of the length of stay; AND/OR
  - » Be transferred via EMS transport (including air ambulance) from one hospital (or free-standing emergency department) to another hospital regardless of the patient's length of stay or admission status; AND/OR
  - » Have an outcome of death resulting from the traumatic injury (independent of hospital admission or hospital transfer status)

Patient Exclusion Criteria

Patients with these isolated ICD-10-CM codes are excluded from the Ohio TACR:

- S72.00-S72.14 (Fracture of head/neck of femur ONLY IF age > 70 AND it resulted from slipping, tripping, stumbling or a same-level fall, which are codes W01.0, W18.30, W18.31 and W18.39)
- S00, S10, S20, S30, S40, S50, S60, S70, S80, S90 (Abrasion or contusion injuries – patients with abrasion or contusion injuries who were transferred in/out for treatment of injuries or died because of injuries would be included in the registry)
- Seventh character modifiers of D through S (Late effects)

Traumatic Brain Injury Selection Criteria

Injuries are identified as traumatic brain injuries (TBIs) based on their reported Abbreviated Injury Scale (AIS) pre-dot codes. The AIS is a trauma injury classification system that describes the injury and its severity. The pre-dot code consists of the six digits that occur before a decimal point, which indicate body region, anatomical structure and level of injury.[1] The post-dot code (also known as the severity score) consists of the digit after the decimal that indicates the injury's severity. TBIs are defined as injuries that have one of these AIS pre-dot codes:

- Equal to 113000
- Between 120199 and 123099
- Between 130202 and 132699
- Between 140202 and 140299
- Between 140402 and 140499
- Between 140602 and 140699
- Equal to 140799
- Between 161000 and 161013

1. The Abbreviated Injury Scale (AIS): A brief introduction. The Trauma Audit & Research Network. https://www.tarn.ac.uk/content/downloads/72/coding.pdf. Accessed Aug. 4, 2022.

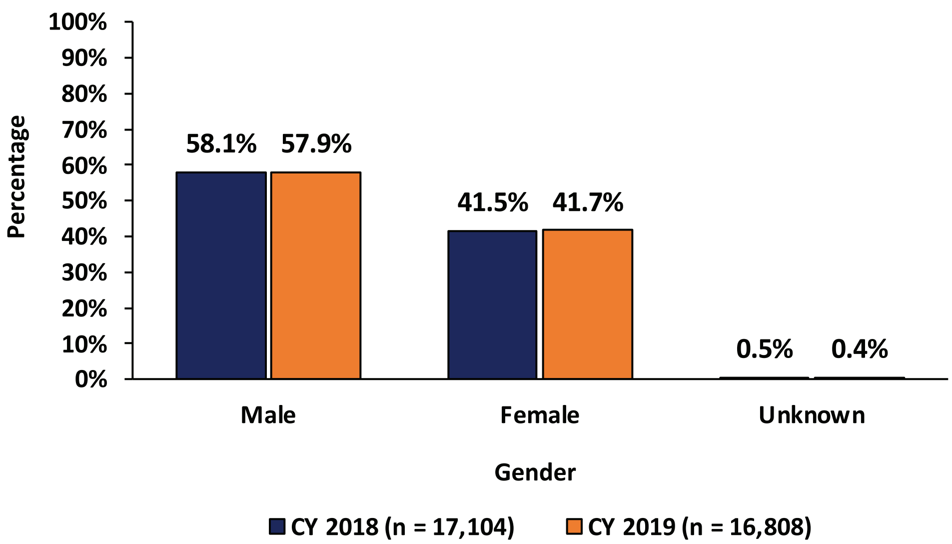
Morbidity Data

Table 1. Number and Percentage of TBIs by Year, Ohio Trauma Registry, Calendar Years 2015-2019

Year	Traumatic Brain Injuries	Total Injuries Reported	%
2015	16,573	67,487	24.6
2016	18,176	71,941	5.3
2017	16,800	68,308	24.6
2018	17,104	68,402	25.0
2019	16,808	72,078	23.3

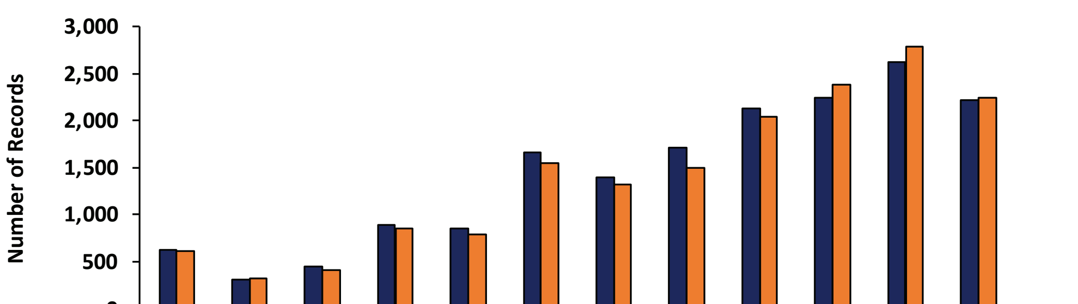
For the years 2015 to 2019, TBIs reported to the OTR comprised about 23.3 – 25.3% of the total number of injuries reported to the registry.

Figure 1. Percentage of TBIs by Gender and Year, Ohio Trauma Registry, Calendar Years 2018-2019



For both calendar years (CYs), the majority of patients with TBI were male (CY 2018: 58.1%; CY 2019: 57.9%).

Figure 2. Number of TBIs by Age Group and Year, Ohio Trauma Registry, CY 2018-CY 2019

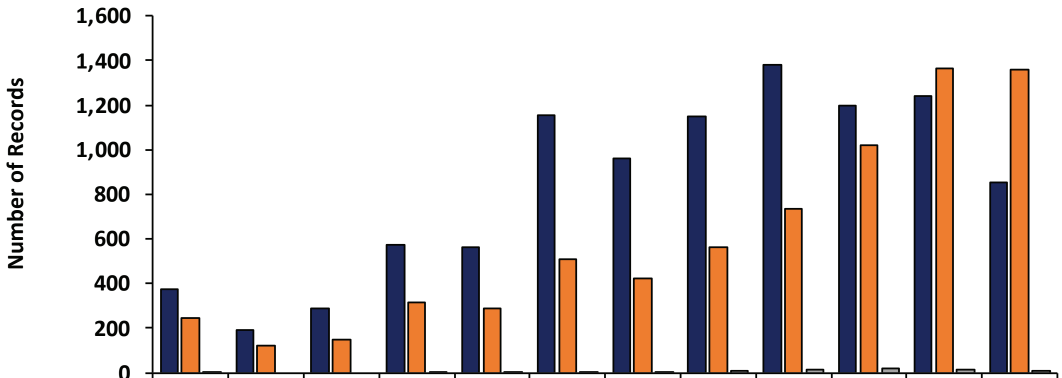


	0 - 4	5 - 9	10 - 14	15 - 19	20 - 24	25 - 34	35 - 44	45 - 54	55 - 64	65 - 74	75 - 84	85+	Not Valued
CY 2018 (n = 17,104)	622	314	442	894	854	1,666	1,390	1,718	2,127	2,240	2,618	2,219	0
CY 2019 (n = 16,808)	608	327	408	853	795	1,554	1,315	1,500	2,040	2,381	2,788	2,238	1

Age Group

In both CY 2018 and CY 2019, TBIs occurred most frequently within the 75 to 84 age group (CY 2018: 2,618; CY 2019: 2,788).

Figure 3. Number of TBIs by Age Group and Gender, Ohio Trauma Registry, CY 2018 (n = 17,104)

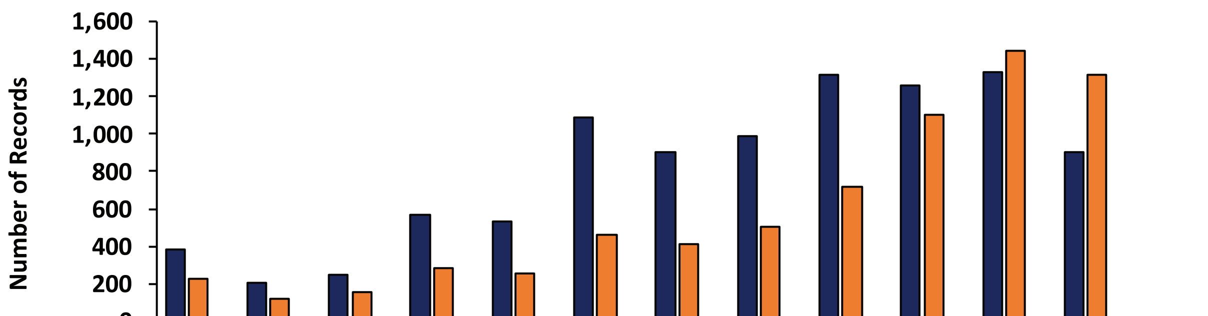


	0 - 4	5 - 9	10 - 14	15 - 19	20 - 24	25 - 34	35 - 44	45 - 54	55 - 64	65 - 74	75 - 84	85+
Male (n = 9,931)	376	194	291	574	561	1,154	960	1,151	1,379	1,200	1,239	852
Female (n = 7,093)	244	120	151	318	291	508	425	561	735	1,020	1,363	1,357
Unknown (n = 80)	2	0	0	2	2	4	5	6	13	20	16	10

Age Groups

Among males, TBIs occurred most frequently across the 25 to 84 age categories. Among females, TBIs grow to peak at ages above 75.

Figure 4. Number of TBIs by Age Group and Gender, Ohio Trauma Registry, CY 2019 (n = 16,808)

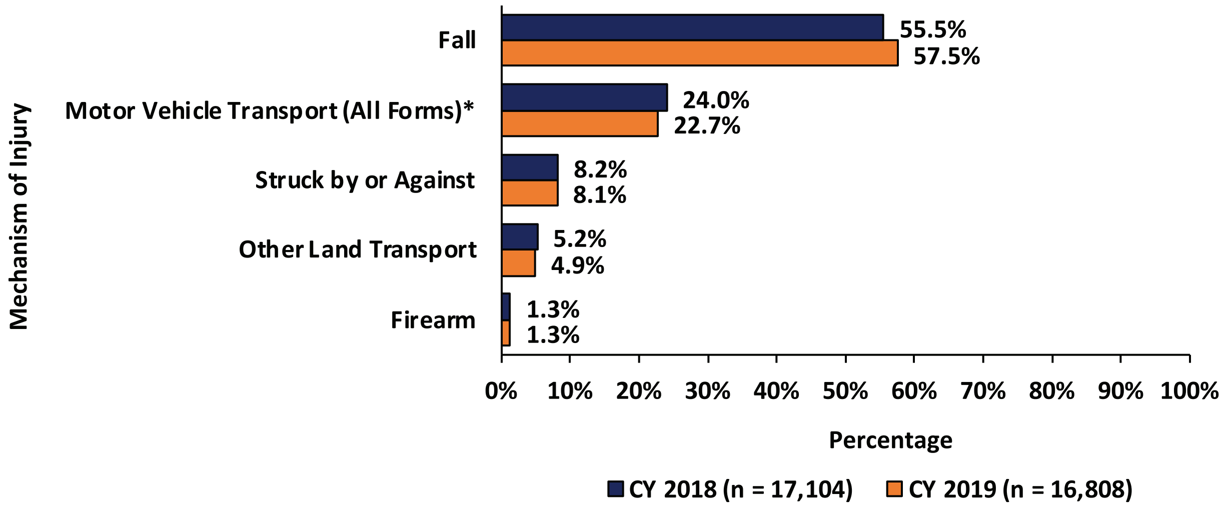


	0 - 4	5 - 9	10 - 14	15 - 19	20 - 24	25 - 34	35 - 44	45 - 54	55 - 64	65 - 74	75 - 84	85+	Not Valued
Male (n = 9,352)	380	206	250	569	533	1,085	901	992	1,317	1,258	1,331	906	1
Female (n = 6,834)	228	120	158	281	258	463	410	505	719	1,106	1,443	1,316	0
Unknown (n = 71)	0	1	0	3	4	6	4	3	4	17	14	16	0

Age Groups

For both men and women, a similar trend is seen as noted in CY 2018 (Figure 3).

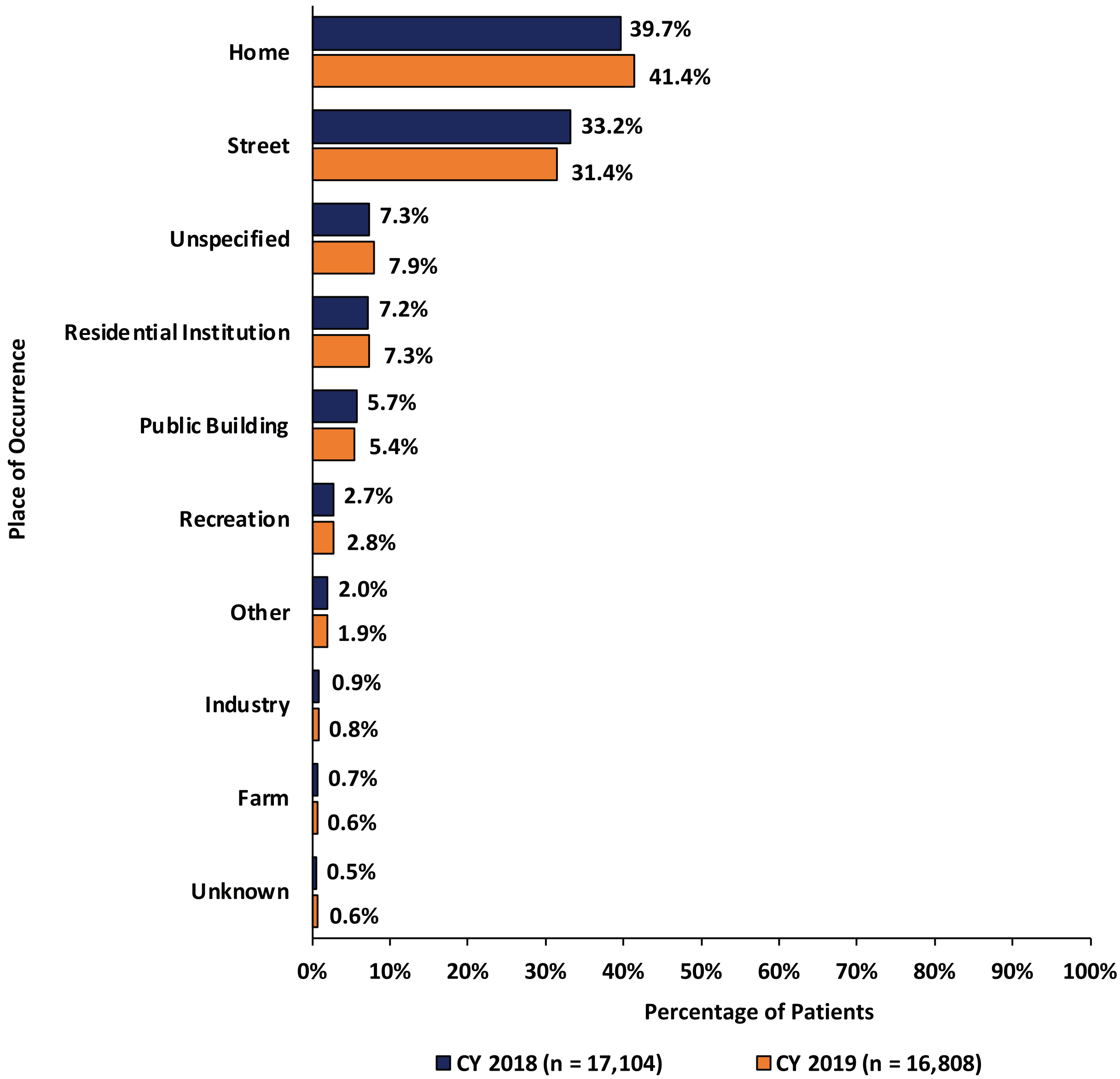
Figure 5. Top 5 Mechanisms of Injury for TBIs, Ohio Trauma Registry, CY 2018-CY 2019



* TBIs involving motor vehicle transport include forms where the injury occurred to an occupant of the motor vehicle, a pedestrian, a motorcyclist, a pedal cyclist, other or unspecified.

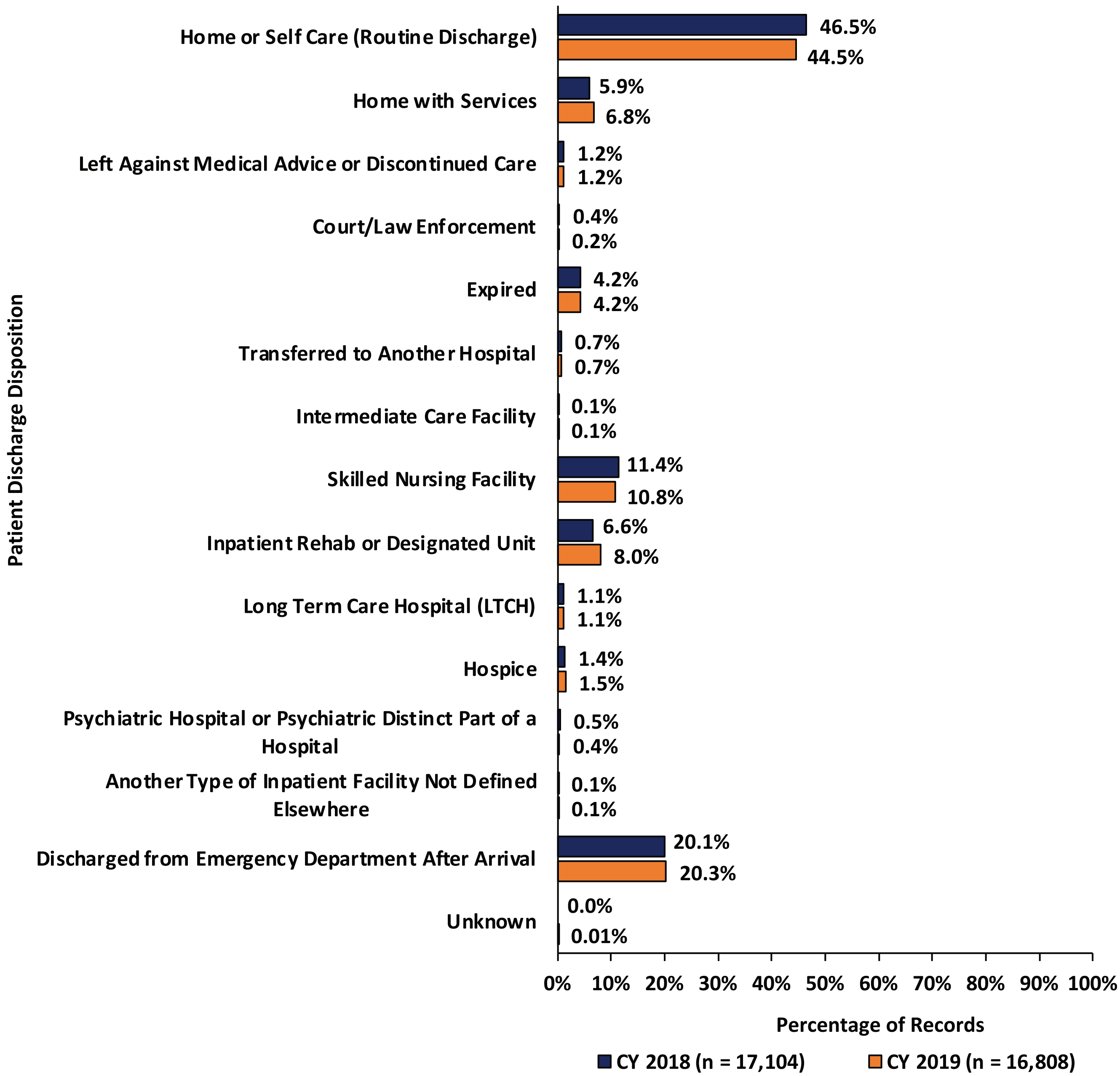
For both calendar years, the top two mechanisms account for about 80% of injuries. The most frequent injury mechanism among patients with TBI was falls (CY 2018: 55.5%; CY 2019: 57.5%), followed by injuries sustained by motor vehicle transport incidents (CY 2018: 24.0%; CY 2019: 22.7%).

Figure 6. Percentage of TBIs by Place of Occurrence and Year, Ohio Trauma Registry, CY 2018–CY 2019



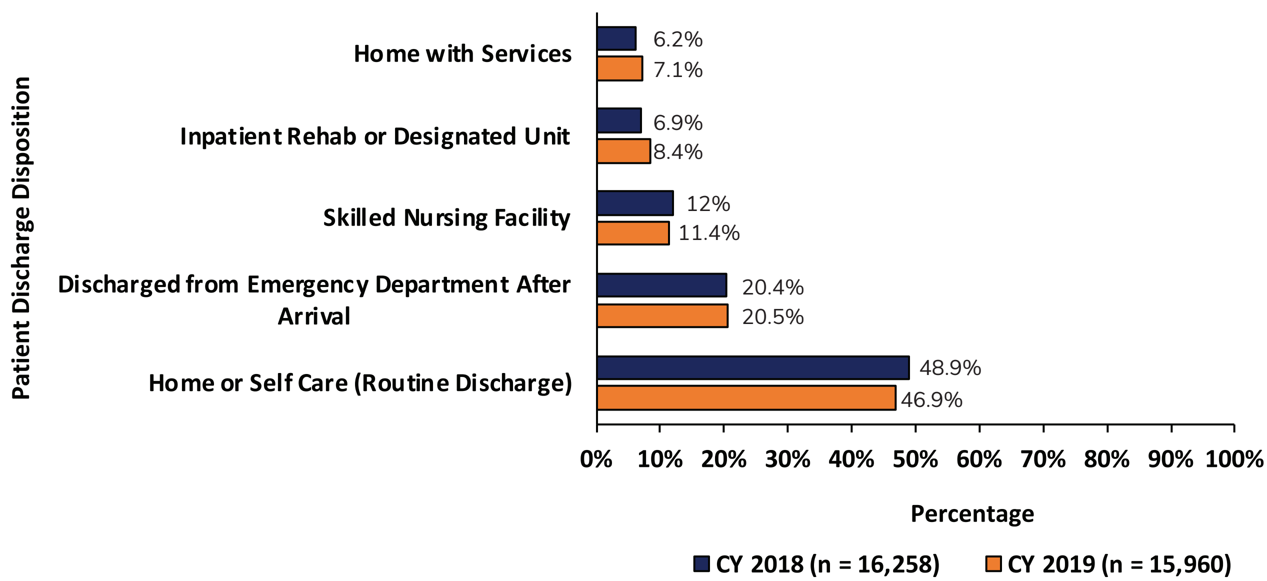
Across all calendar years, the most common place of occurrence for TBIs was home (CY 2018: 39.7%; CY 2019: 41.4%), followed by street (CY 2018: 33.2%; CY 2019: 31.4%).

Figure 7. Percentage of TBIs by Patient Discharge Disposition, All Patients, Ohio Trauma Registry, CY 2018–CY 2019



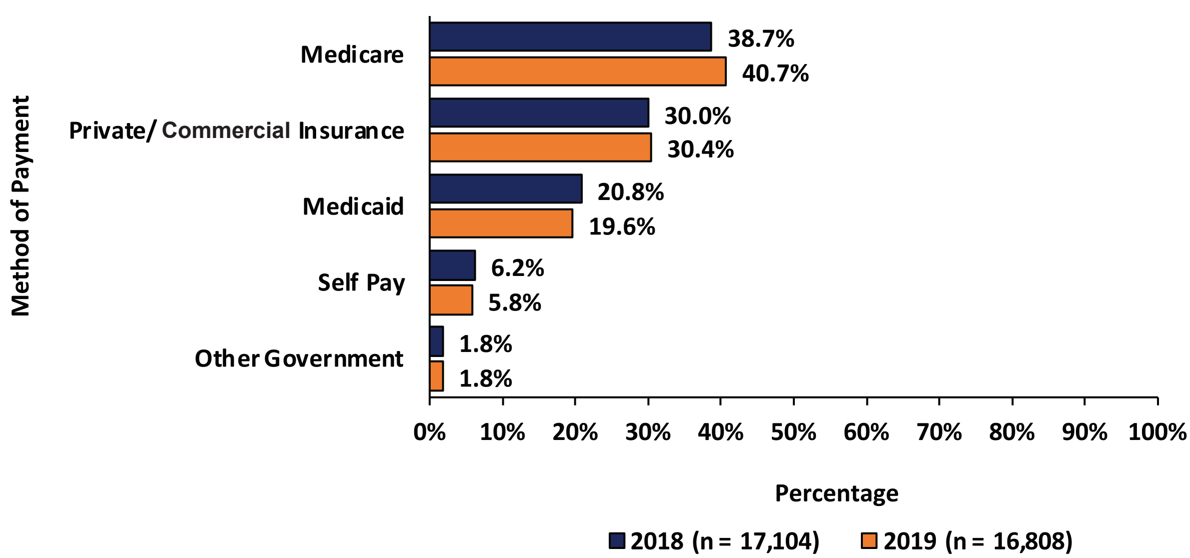
For both calendar years, the most common patient discharge disposition for TBIs, regardless of discharge status, was home/self-care (CY 2018: 46.5%; CY 2019: 44.5%). This means the patient was sent home without any additional services. Of similar disposition, another 20% were discharged from the emergency department after arrival.

Figure 8. Top 5 Patient Discharge Dispositions for TBIs, Patients Alive at Time of Discharge, Ohio Trauma Registry, CY 2018–CY 2019



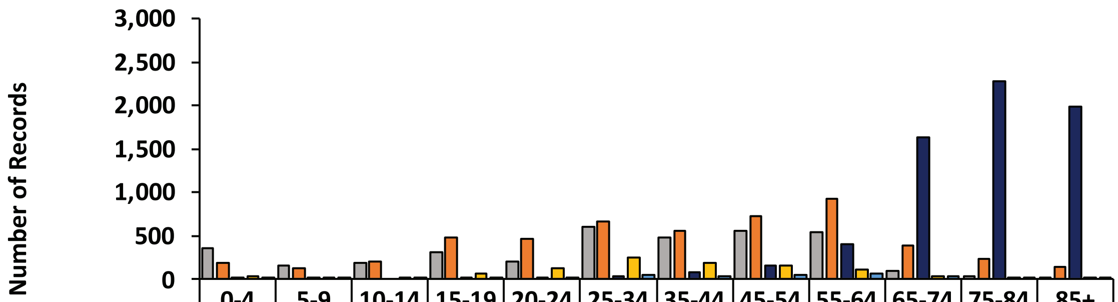
Across all calendar years, most patients with TBI were sent home without any additional services as a routine discharge (CY 2018: 48.9%; CY 2019: 46.9%).

Figure 9. Top 5 Methods of Payment for Care Among Patients With TBI, Ohio Trauma Registry, CY 2018–CY 2019



For both CY 2018 and 2019, the most common method of payment for care was Medicare (CY 2018: 38.7%; CY 2019: 40.7%), followed by private/commercial insurance (CY 2018: 30.0%; CY 2019: 30.4%).

Figure 10. Select Methods of Payment for Care Among Patients With TBI by Age Category, Ohio Trauma Registry, CY 2018 (n = 16,671)

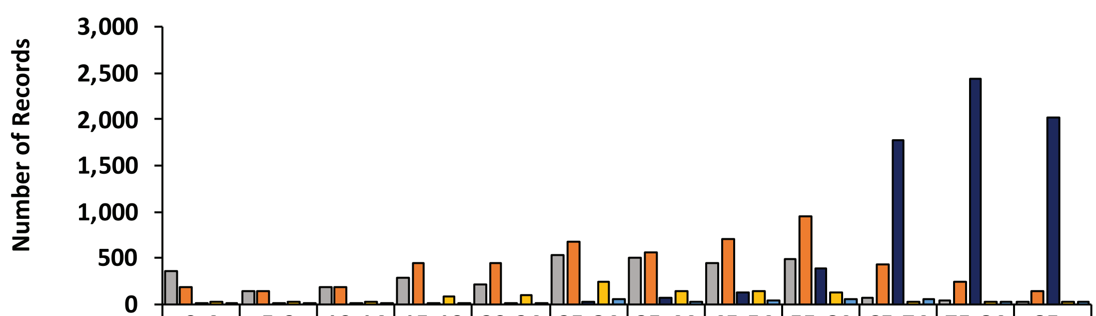


	0-4	5-9	10-14	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75-84	85+
Medicaid	361	152	188	318	209	600	478	554	550	93	33	16
Private/Commercial Insurance	194	130	212	475	462	663	563	732	929	385	238	151
Medicare	2	2	0	5	4	38	90	163	403	1,642	2,286	1,990
Self Pay	37	19	28	63	129	255	183	158	117	39	12	18
Other Government	6	1	5	8	17	52	34	50	62	42	14	11

Age Group

During CY 2018, patients with TBI who were 65 years old and older were more likely to use Medicare as their method of payment. Patients who were younger than 5 most commonly used Medicaid as their method of payment.

Figure 11. Select Methods of Payment for Care Among Patients With TBI by Age Category, Ohio Trauma Registry, CY 2019 (n = 16,511)

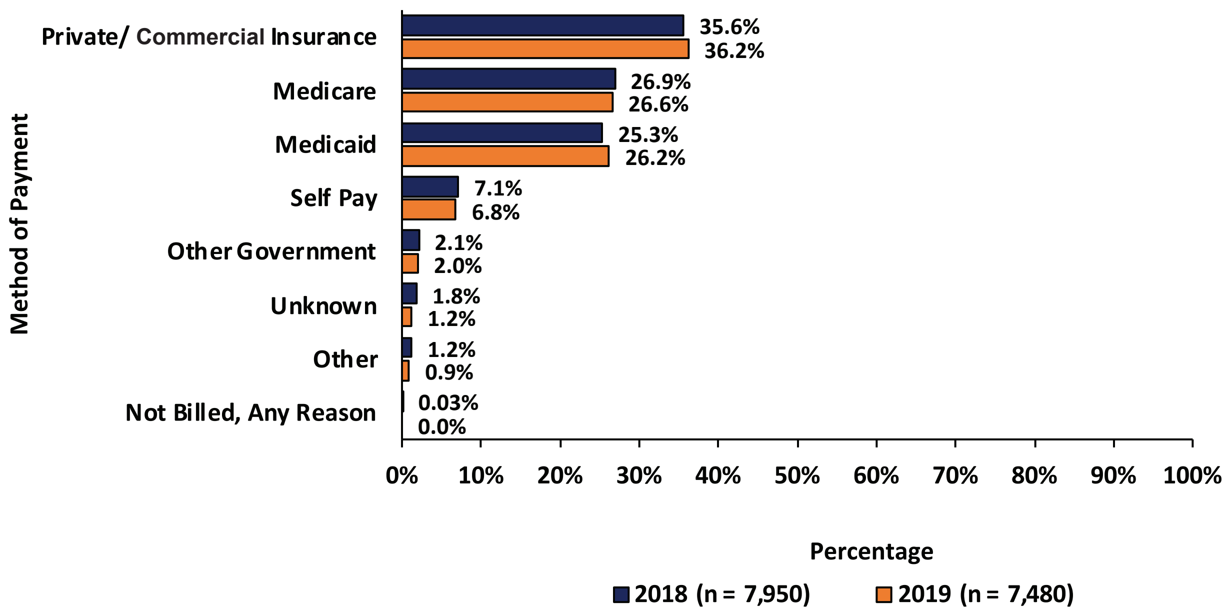


	0-4	5-9	10-14	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75-84	85+
Medicaid	361	141	182	290	213	527	495	446	492	74	39	27
Private/Commercial Insurance	188	147	187	450	444	677	562	706	943	424	242	137
Medicare	1	1	2	2	6	23	68	125	390	1,767	2,436	2,025
Self Pay	27	21	20	78	103	235	143	144	125	30	26	19
Other Government	5	2	6	14	10	50	18	44	48	60	25	18

Age Group

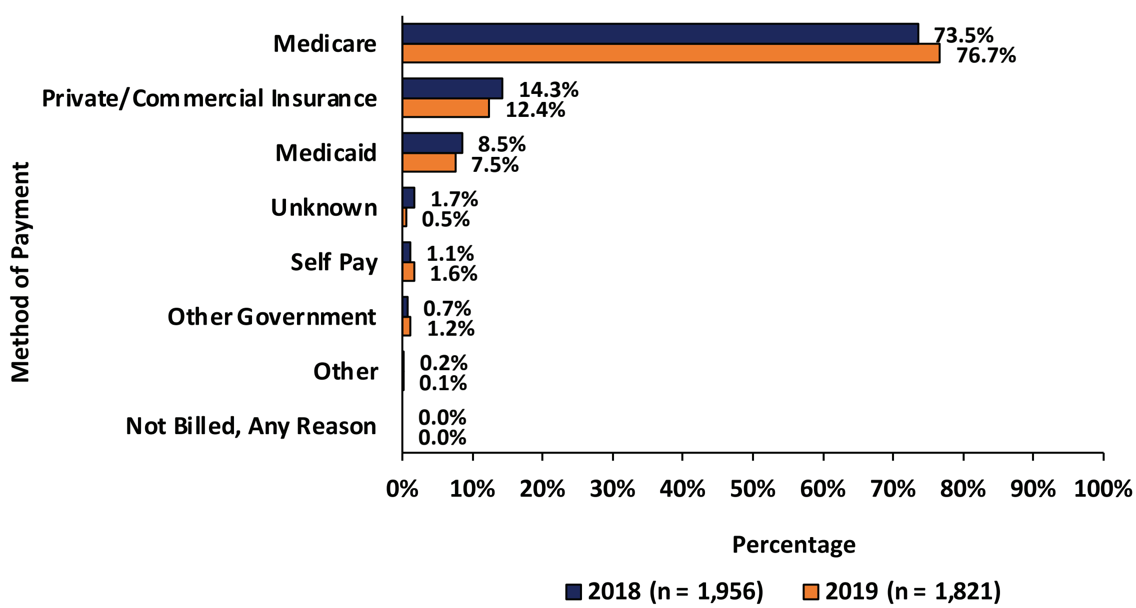
During CY 2019, patients with TBI who were 65 years old and older were more likely to use Medicare as their method of payment. Patients who were younger than 5 most commonly used Medicaid.

Figure 12. Methods of Payment for Care Among Patients With TBI Who Were Discharged Home Without Services, Ohio Trauma Registry, CY 2018–CY 2019



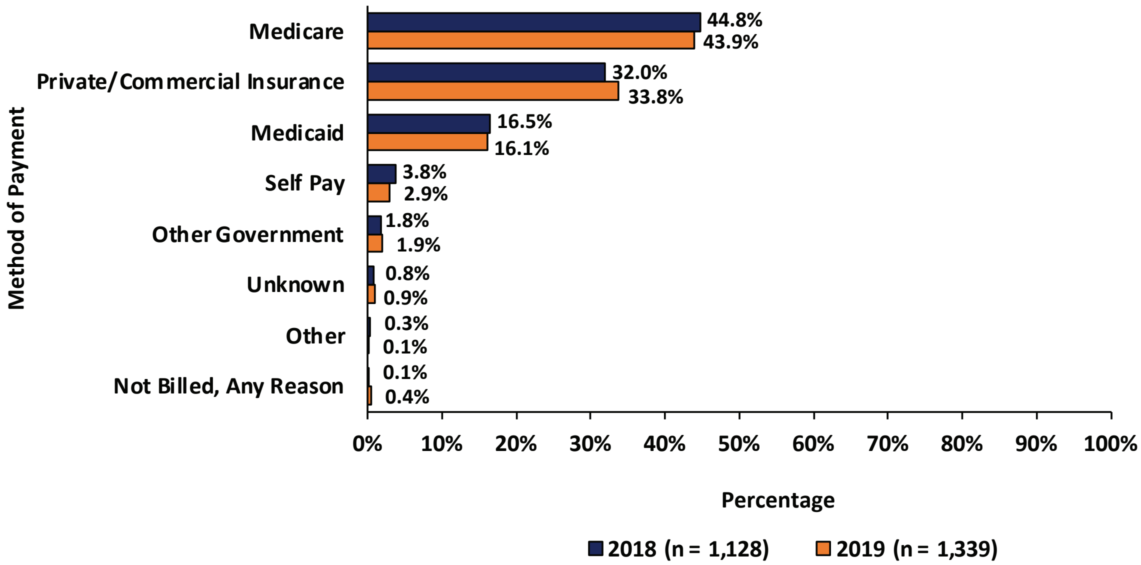
For both CY 2018 and 2019, the most common method of payment for care for patients with TBI who were discharged home without services was private/commercial insurance (CY 2018: 35.6%; CY 2019: 36.2%).

Figure 13. Methods of Payment for Care Among Patients With TBI Who Were Discharged to a Skilled Nursing Facility, Ohio Trauma Registry, CY 2018–CY 2019



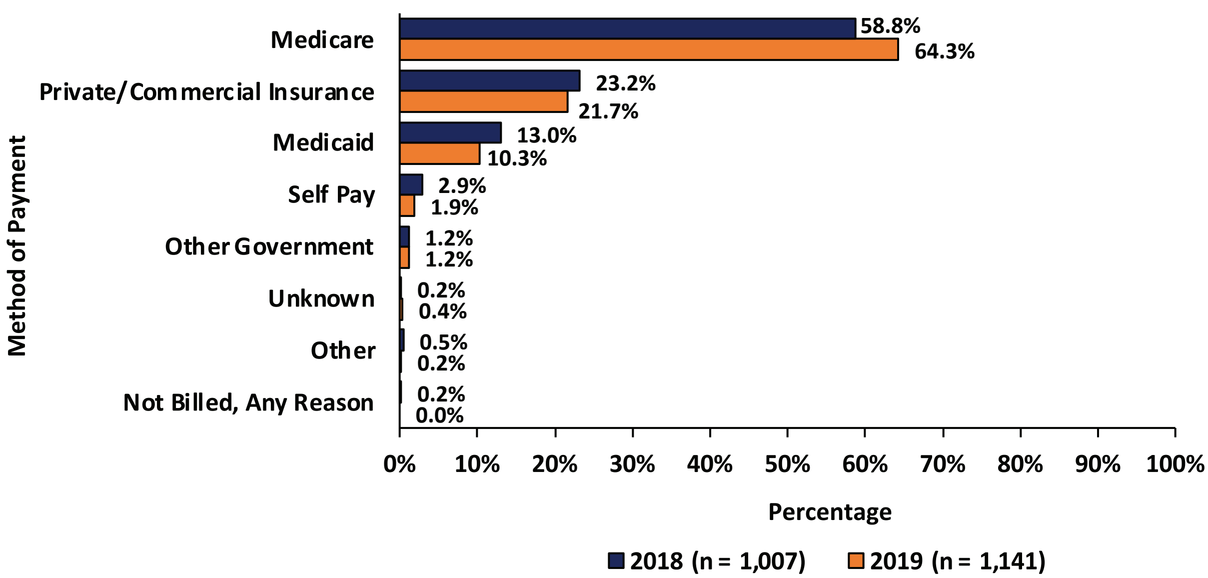
For both CY 2018 and 2019, the most common method of payment for care for patients with TBI who were discharged to a skilled nursing facility was Medicare (CY 2018: 73.5%; CY 2019: 76.7%).

Figure 14. Methods of Payment for Care Among Patients With TBI Who Were Discharged to an Inpatient Rehab Facility or Designated Unit, Ohio Trauma Registry, CY 2018–CY 2019



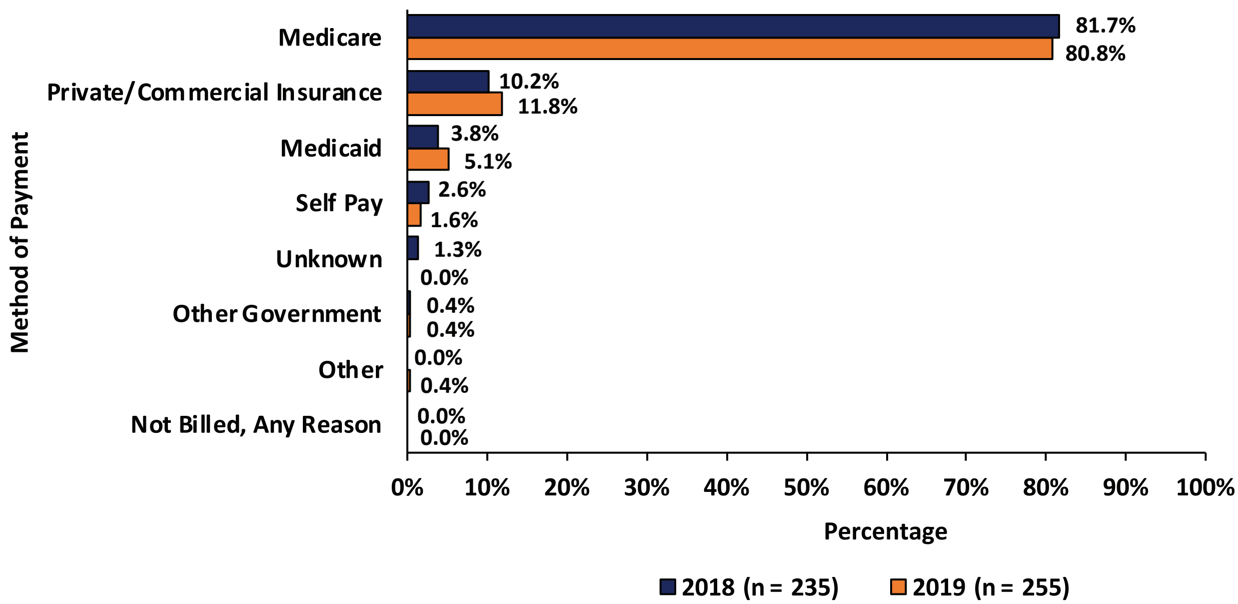
For both CY 2018 and 2019, the most common method of payment for care for patients with TBI who were discharged to a skilled nursing facility was Medicare (CY 2018: 44.8%; CY 2019: 43.9%).

Figure 15. Methods of Payment for Care Among Patients With TBI Who Were Discharged Home With Services, Ohio Trauma Registry, CY 2018–CY 2019



For both CY 2018 and 2019, the most common method of payment for care for patients with TBI who were discharged home with additional services was Medicare (CY 2018: 58.8%; CY 2019: 64.3%).

Figure 16. Methods of Payment for Care Among Patients With TBI Who Were Discharged to Hospice, Ohio Trauma Registry, CY 2018–CY 2019



For both CY 2018 and 2019, the most common method of payment for care for patients with TBI who were discharged to hospice was Medicare (CY 2018: 81.7%; CY 2019: 80.8%).

The Injury Severity Score (ISS) is an assessment of the patient's injury severity. The score is based on the AIS, another scoring system for injury severity. When a patient is injured, each area of the body is assigned an AIS score depending on the injury severity. An ISS is calculated by squaring the AIS score from the three most severely injured body areas and adding them together. An ISS can range from 0 to 75.2. The higher the ISS score, the more severe the injury.

Table 2. Injury Severity Score (ISS) and Length of Hospital Stay Among Patients With TBI, Ohio Trauma Registry, CY 2018

ISS Group	1 Day	2 Days	3 Days	4 Days	5 Days	6 Days	7 Days	8+ Days	Not Recorded	Total Number of Records
1 – 8	3,946	1,032	457	278	148	111	71	180	65	6,288
9 – 15	2,524	947	600	443	279	222	154	537	73	5,779
16 – 24	787	368	319	258	223	168	131	643	48	2,945
25+	615	168	141	117	127	99	74	709	39	2,089
Not Calculable	2	1	0	0	0	0	0	0	0	3
Total	**7,874**	**2,516**	**1,517**	**1,096**	**777**	**600**	**430**	**2,069**	**225**	**17,104**

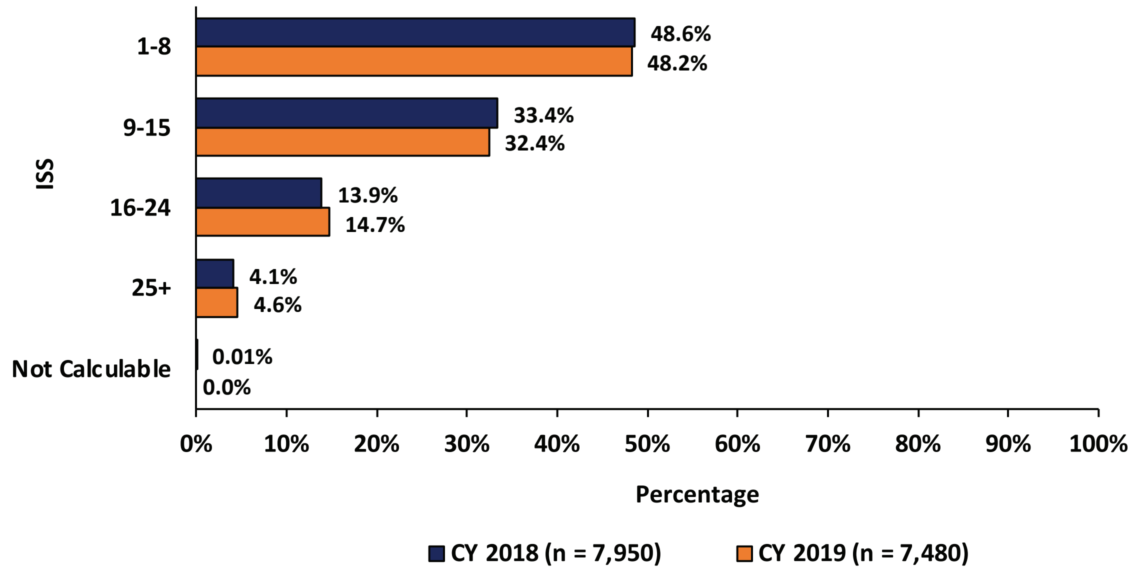
Table 3. Injury Severity Score (ISS) and Length of Hospital Stay Among Patients With TBI, Ohio Trauma Registry, CY 2019

ISS Group	1 Day	2 Days	3 Days	4 Days	5 Days	6 Days	7 Days	8+ Days	Not Recorded	Total Number of Records
1 – 8	3,719	996	471	272	178	111	90	218	7	6,062
9 – 15	2,504	846	590	399	291	199	139	511	3	5,482
16 – 24	839	356	354	301	204	162	126	611	2	2,955
25+	691	166	171	148	120	100	103	808	2	2,309
Not Calculable	0	0	0	0	0	0	0	0	0	0
Total	**7,753**	**2,364**	**1,586**	**1,120**	**793**	**572**	**458**	**2,148**	**14**	**16,808**

Across all calendar years, patients with TBI who had an ISS of 25+ had a higher frequency of hospital stays lasting eight days or longer compared to other scores. The majority of TBIs with an ISS between 1 and 8 only stayed a single day at the hospital.

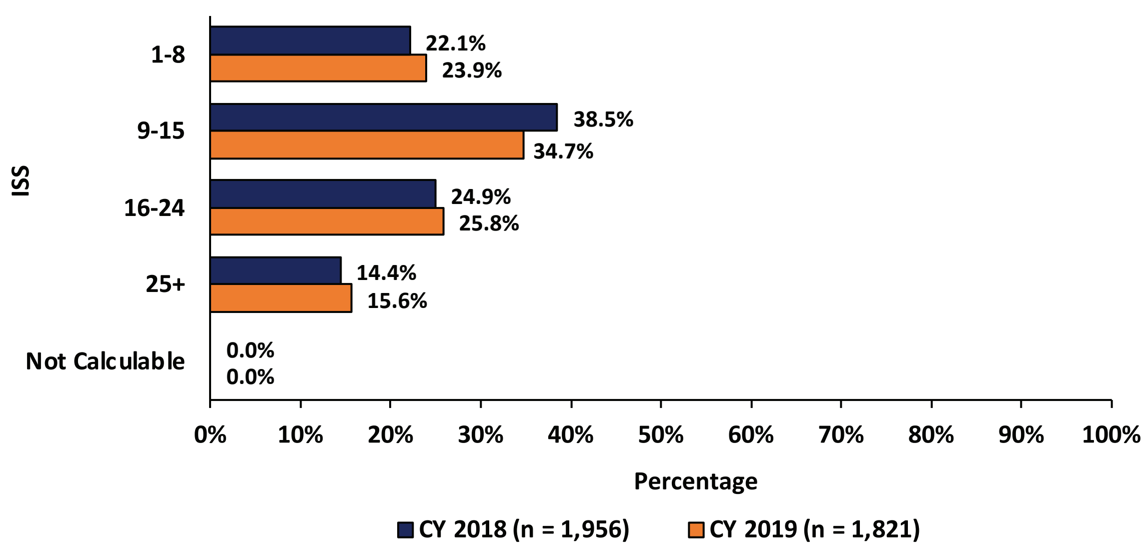
Injury Severity Score. NSW Institute of Trauma and Injury Management. https://aci.health.nsw.gov.au/networks/institute-of-trauma-and-injury-management/data/injury-scoring/injury_severity_score. Accessed Aug. 4, 2022.

Figure 17. Injury Severity Scores (ISSs) for Patients With TBI Who Were Discharged Home Without Services, Ohio Trauma Registry, CY 2018–CY 2019



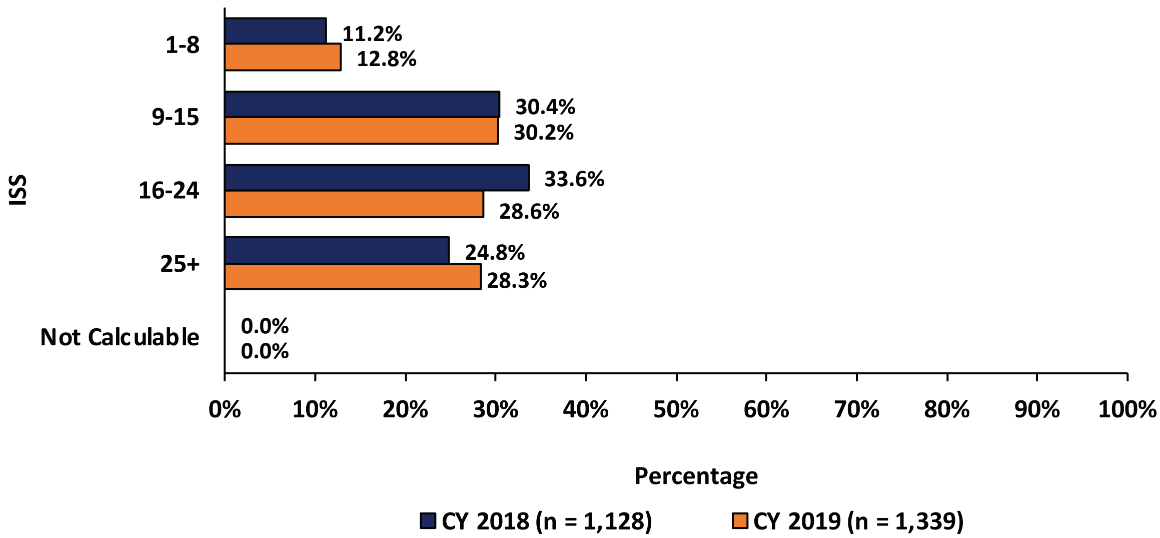
For both CY 2018 and CY 2019, patients with TBI who were discharged home without services were most likely to have an ISS between one and eight (CY 2018: 48.6%; CY 2019: 48.2%).

Figure 18. Injury Severity Scores (ISSs) for Patients With TBI Who Were Discharged to a Skilled Nursing Facility, Ohio Trauma Registry, CY 2018–CY 2019



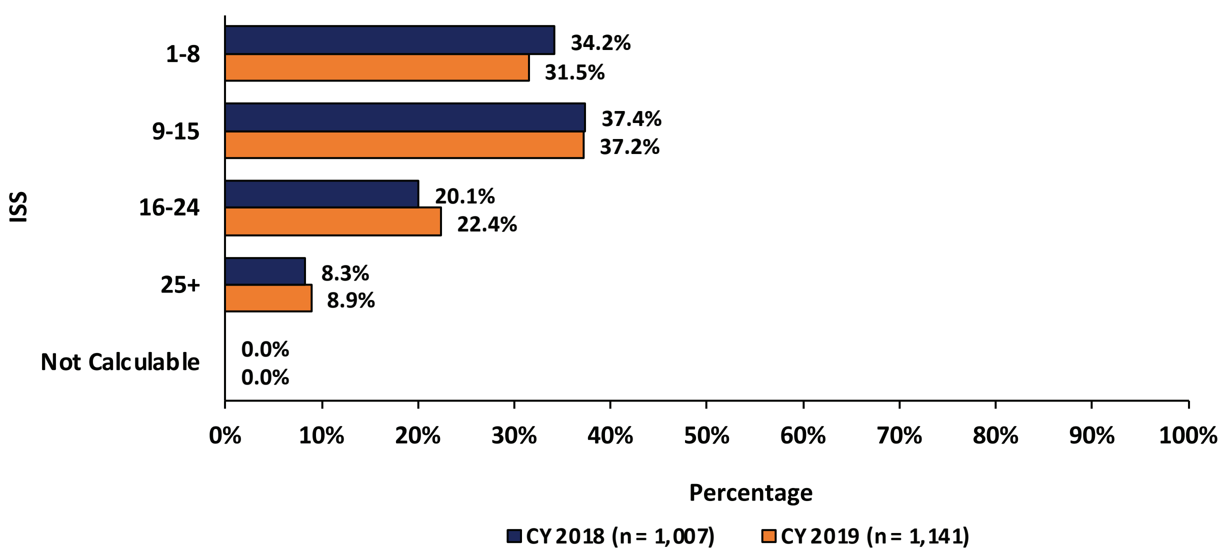
For both CY 2018 and CY 2019, patients with TBI who were discharged to a skilled nursing facility were most likely to have an ISS between 9 and 15 (CY 2018: 38.5%; CY 2019: 34.7%), followed by an ISS between 16 and 24 (CY 2018: 24.9%; CY 2019: 25.8%).

Figure 19. Injury Severity Scores (ISSs) for Patients With TBI Who Were Discharged to an Inpatient Rehab Facility or Designated Unit, Ohio Trauma Registry, CY 2018–CY 2019



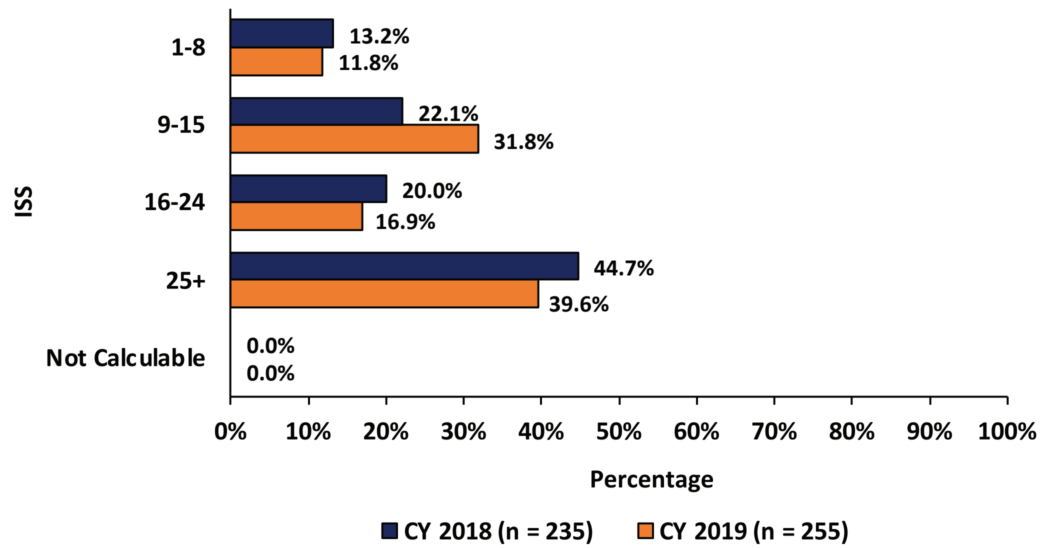
In CY 2018, patients with TBI who were discharged to an inpatient rehab facility or designated unit were most likely to have an ISS between 16 and 24 (33.6%), followed by an ISS between 9 and 15 (30.4%). In CY 2019, patients with TBI who were discharged to an inpatient rehab facility or designated unit were most likely to have an ISS between 9 and 15 (30.2%), followed by an ISS between 16 and 24 (28.6%).

Figure 20. Injury Severity Scores (ISSs) for Patients With TBI Who Were Discharged Home With Services, Ohio Trauma Registry, CY 2018–CY 2019



For both CY 2018 and CY 2019, patients with TBI who were discharged home with services were most likely to have an ISS between 9 and 15 (CY 2018: 37.4%; CY 2019: 37.2%), followed by an ISS between 1 and 8 (CY 2018: 34.2%; CY 2019: 31.5%).

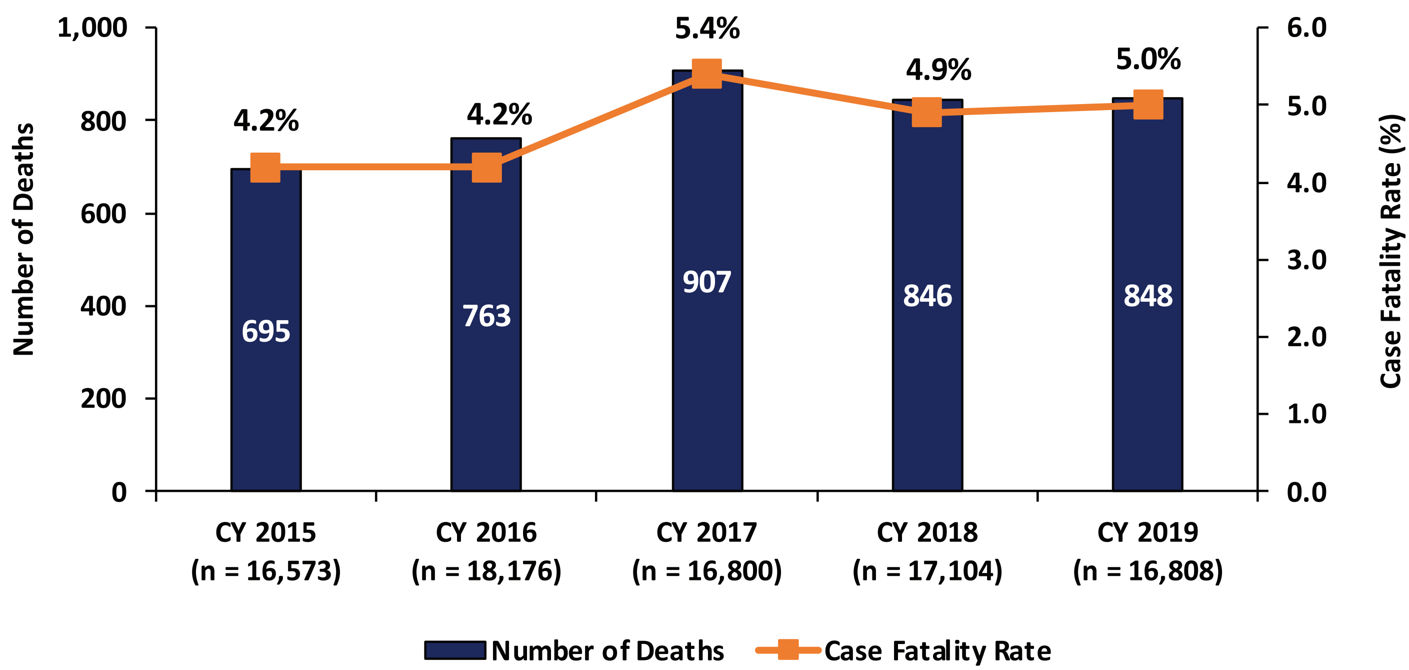
Figure 21. Injury Severity Scores (ISSs) for Patients With TBI Who Were Discharged to Hospice, Ohio Trauma Registry, CY 2018–CY 2019



For both CY 2018 and CY 2019, patients with TBI who were discharged to hospice were most likely to have an ISS of 25+ (CY 2018: 44.7%; CY 2019: 39.6%), followed by an ISS between 9 and 15 (CY 2018: 22.1%; CY 2019: 31.8%).

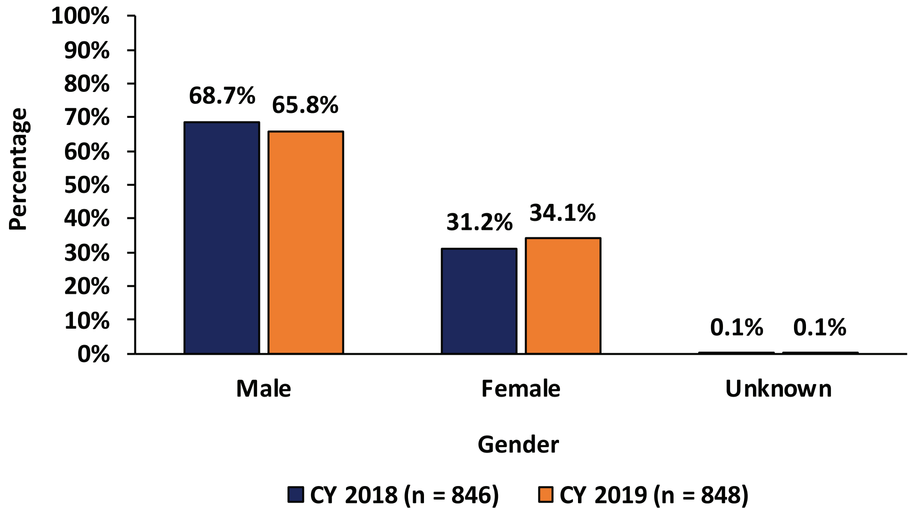
Mortality Data

Figure 22. Number of Deaths and Case Fatality Rates Among Patients With TBI by Year, Ohio Trauma Registry, CY 2015-CY 2019



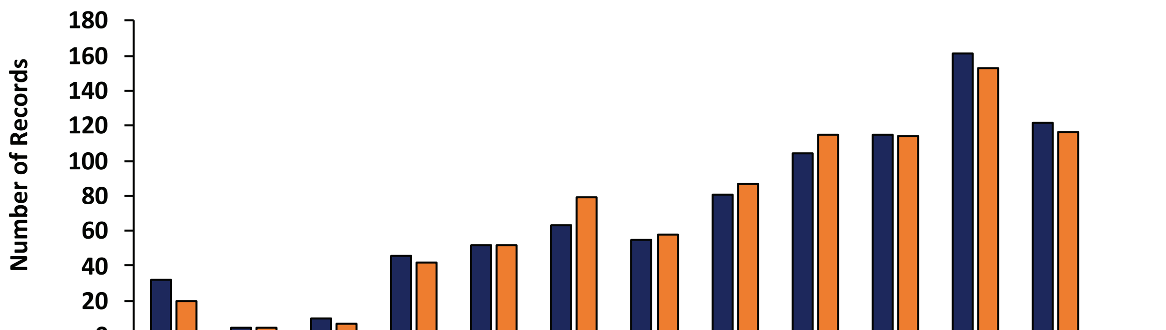
There were 17,104 TBI records in CY 2018 and 16,808 in CY 2019. There were 846 deaths among TBI records in CY 2018 and 848 in CY 2019. The case fatality rate among patients with TBI increased from CY 2015 to CY 2019 – from 4.2% to 5.0%.

Figure 23. Percentage of TBI Deaths by Gender and Year, Ohio Trauma Registry, CY 2018-CY 2019



For both calendar years, males made up the majority of TBI deaths (CY 2018: 68.7%; CY 2019: 65.8%).

Figure 24. Number of TBI Deaths by Age Category and Year, Ohio Trauma Registry, CY 2018-CY 2019



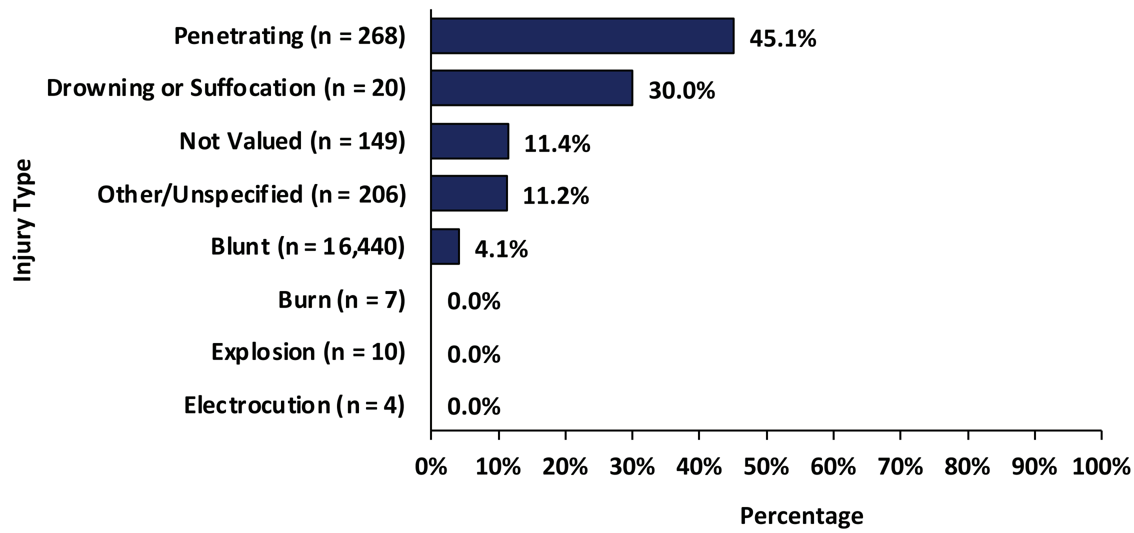
	0 - 4	5 - 9	10 - 14	15 - 19	20 - 24	25 - 34	35 - 44	45 - 54	55 - 64	65 - 74	75 - 84	85+	Not Valued
CY 2018 (n = 846)	32	5	10	46	52	63	55	81	104	115	161	122	0
CY 2019 (n = 848)	20	5	7	42	52	79	58	87	115	114	153	116	0

Age Category

CY 2018 (n = 846) CY 2019 (n = 848)

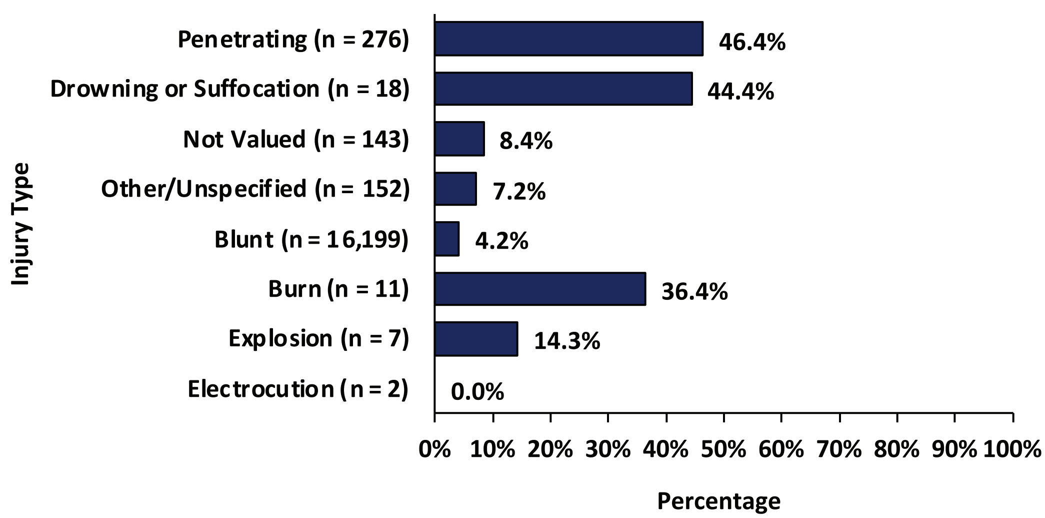
In both CY 2018 and CY 2019, TBI deaths occurred most frequently within the 75 to 84 age group (CY 2018: 161; CY 2019: 153).

Figure 25. Case Fatality Rates Among Patients With TBI by Injury Type, Ohio Trauma Registry, CY 2018 (n = 17,104)



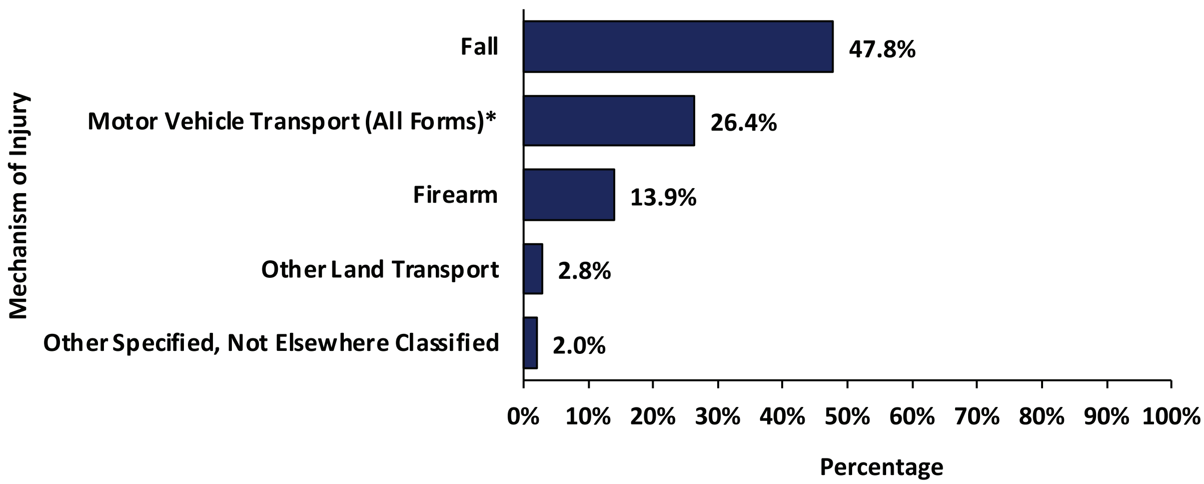
Among patients with TBI in CY 2018, the injury type with the highest case fatality rate was penetrating injuries (45.1%).

Figure 26. Case Fatality Rates Among Patients With TBI by Injury Type, Ohio Trauma Registry, CY 2019 (n = 16,808)



Among patients with TBI in CY 2019, the injury type with the highest case fatality rate was penetrating injuries (46.4%).

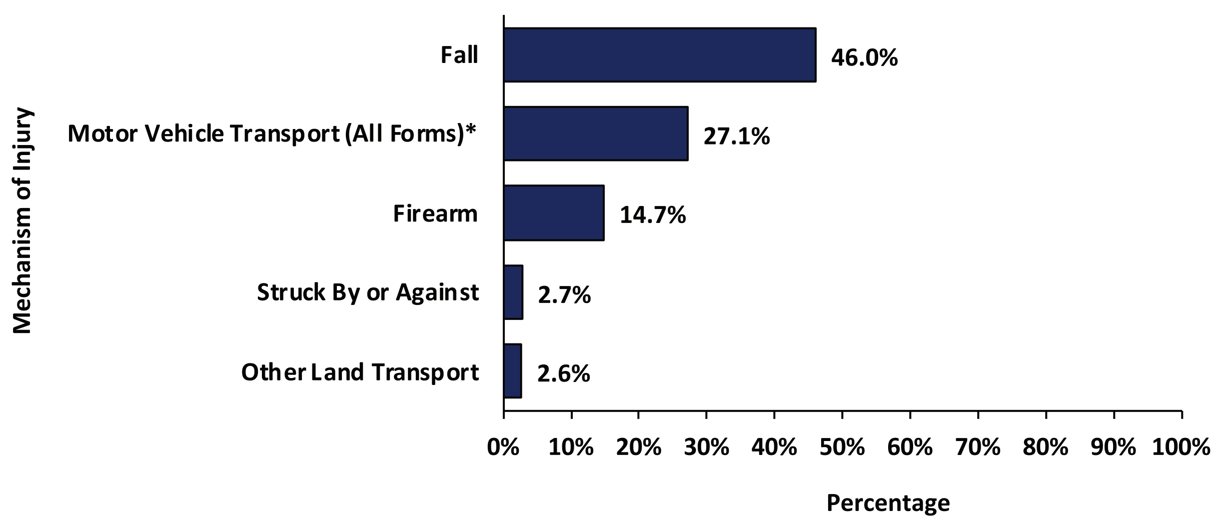
Figure 27. Top 5 Mechanisms of Injury for TBI Deaths, Ohio Trauma Registry, CY 2018 (n = 846)



* TBIs involving motor vehicle transport include forms where the injury occurred to an occupant of the motor vehicle, a pedestrian, a motorcyclist, a pedal cyclist, other or unspecified.

In CY 2018, the most frequent injury mechanism among TBI deaths was falls (47.8%), followed by injuries sustained by motor vehicle transport incidents (26.4%).

Figure 28. Top 5 Mechanisms of Injury for TBI Deaths, Ohio Trauma Registry, CY 2019 (n = 848)



* TBIs involving motor vehicle transport include forms where the injury occurred to an occupant of the motor vehicle, a pedestrian, a motorcyclist, a pedal cyclist, other or unspecified.

In CY 2019, the most frequent injury mechanism among TBI deaths was falls (46.0%), followed by injuries sustained by motor vehicle transport incidents (27.1%).

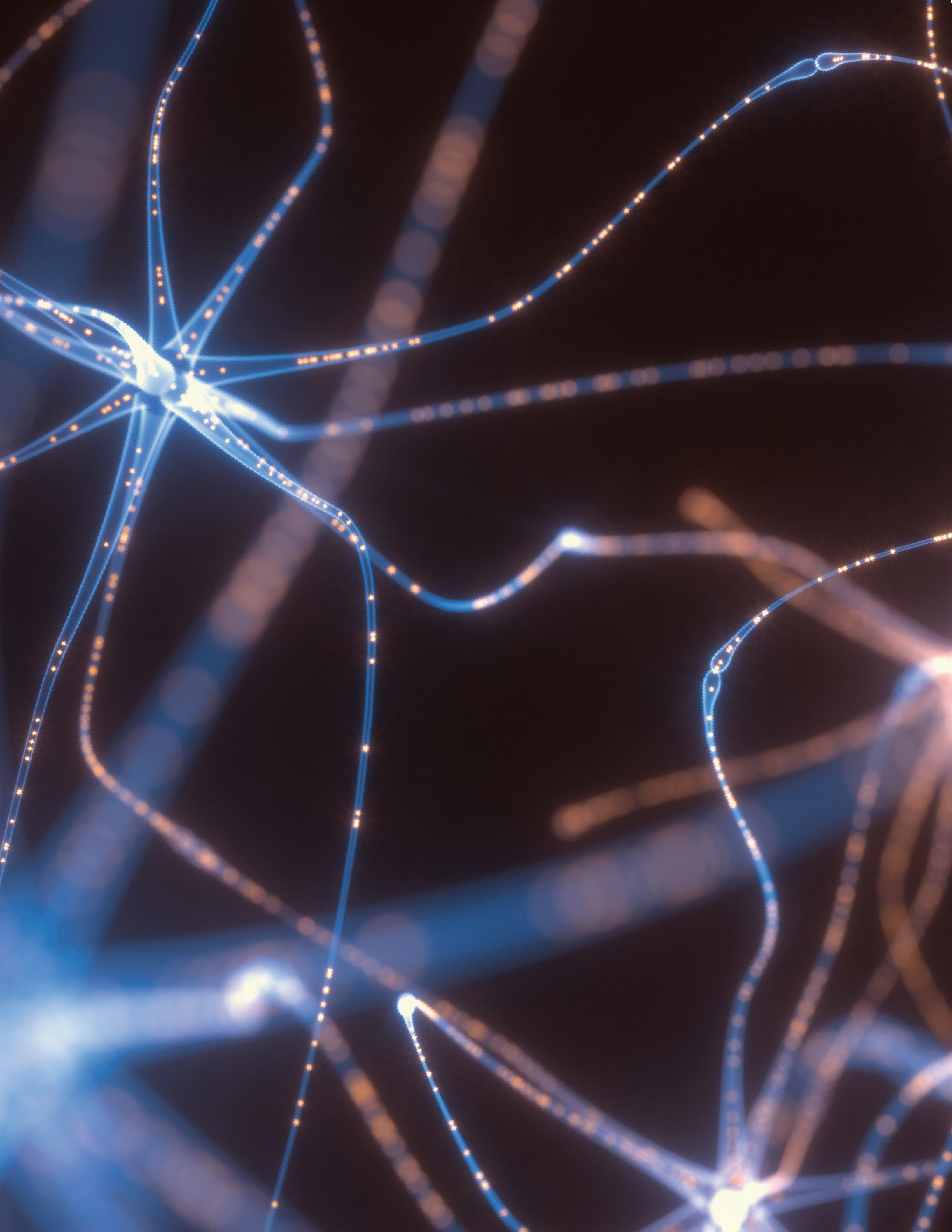
Summary

From 2018 to 2019, 23.3-25.3% of injuries reported to the OTR were TBIs. There are clear trends presented among the TBIs — the majority of TBIs are among males, are caused by falls and most frequently occur in the 75 to 84 age category. They most frequently occur in the home, and patients are most frequently discharged home without needing additional services. Patients who are not discharged home without needing services more frequently have an ISS of 9 or above.

For both years, more than 50% of patients with TBI use either Medicare or Medicaid as their method of payment. The most common method of payment is Medicare, because a larger percentage of TBIs occur in older age groups. Medicare also is the most common method of payment for patients who are either discharged home with services or discharged to another facility or unit.

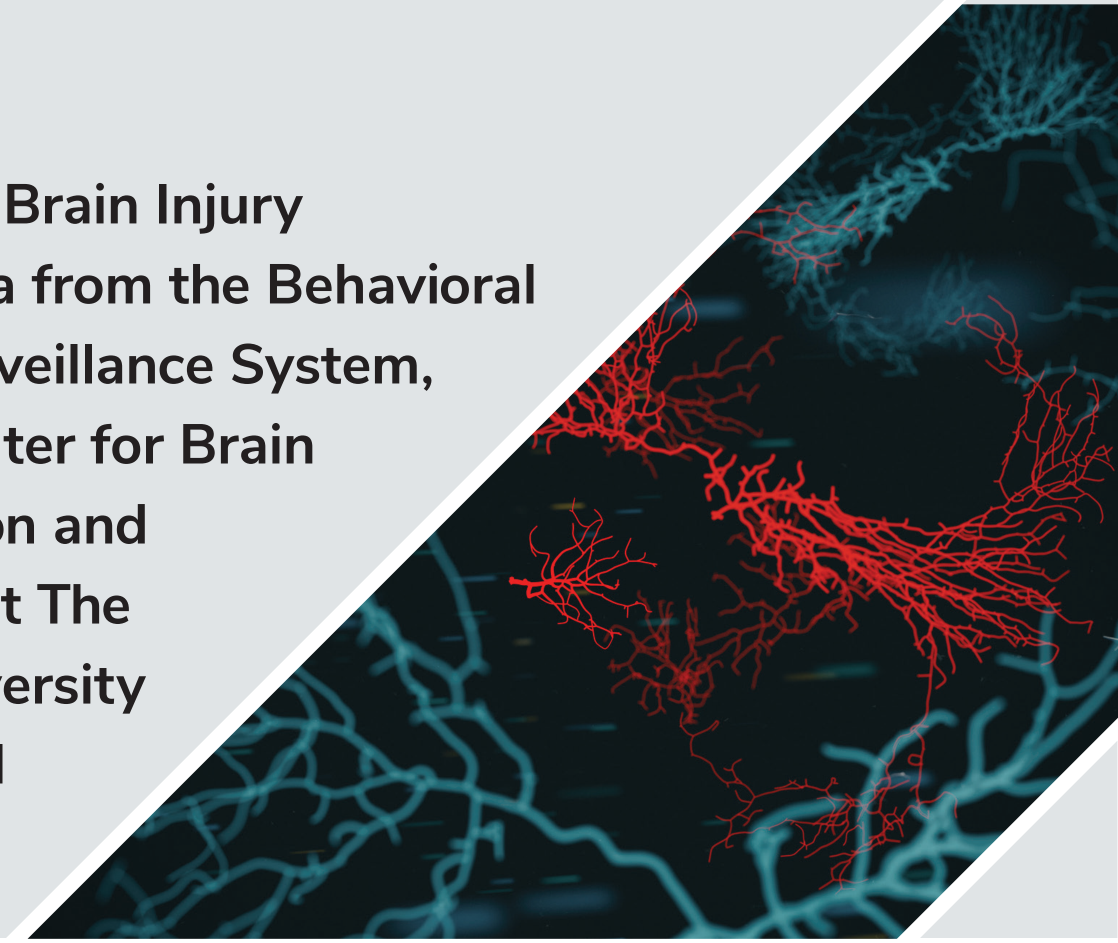
Patients most frequently spend one day at the hospital following their TBI. However, patients who were discharged to a skilled nursing facility, an inpatient rehab facility or designated unit or hospice were more likely to have a hospital stay of eight days or more.

Deaths among patients with TBI occur more frequently among males and within the 75 to 84 age group. The highest case fatality rates are for penetrating injuries, while falls remain the most common mechanism of injury.



Section 3

Ohio Traumatic Brain Injury Prevalence Data from the Behavioral Risk Factor Surveillance System, Ohio Valley Center for Brain Injury Prevention and Rehabilitation at The Ohio State University Wexner Medical Center



Ohio Behavioral Risk Factor Surveillance System Data

The Behavioral Risk Factor Surveillance System (BRFSS) is an annual cross-sectional telephone survey developed by the Centers for Disease Control and Prevention. The survey collects information at the state level regarding health risk behaviors among non-institutionalized adults aged 18 years and older. The BRFSS uses complex weighting processes (design weight and iterative proportional fitting) to make generalizations from the sample to the state population. The Ohio BRFSS is conducted by the Ohio Department of Health.

Beginning in 2014, the Ohio BRFSS included a traumatic brain injury (TBI) module. This module was adapted from The Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID), which was developed by the Ohio Valley Center for Brain Injury Prevention and Rehabilitation. The TBI module was included to provide vital information about lifetime prevalence of TBI in the Ohio adult population. The TBI module was subsequently included in the 2016 survey and continues to be included each survey year.

The Ohio BRFSS consists of modules that are asked of all respondents in addition to modules that are asked of only a group of respondents. These randomly assigned groups are known as Splits, and they are used in the survey design to increase the number of modules that can be assessed without lengthening the questionnaire for respondents. For the 2018 and 2019 BRFSS surveys, the TBI module was included in Split 2 for both years.

- This report's analysis includes data from the 2018-2019 Ohio BRFSS.
  - Due to an error in survey logic flow on the 2019 survey, only 2018 data could be used to accurately categorize respondents who have experienced a TBI without loss of consciousness (LOC).

  - » Both 2018 and 2019 survey data are used to categorize respondents who have experienced a TBI with LOC.
- The data were reweighted based on the proportion of the sample size from each year.
  - » 2018, Split 2 = 3,810 respondents; 2019, Split 2 = 4,081 respondents
- Our analysis accounts for the complex survey design and excludes “missing,” “don’t know/not sure” and “refused” responses.

Data from the lifetime history of the TBI module of the BRFSS has produced significant insight into the prevalence of TBI in Ohio and the impact of injuries over time in terms of long-term disability, behavioral problems, employment and quality of life.

Table 1a. Lifetime Prevalence of TBI With Loss of Consciousness (LOC) Among Adults 18+ Years by Demographic Characteristics, 2018–2019

Demographic Characteristics	Overall Sample Population	TBI With Loss of Consciousness (LOC)	
	Ohio Estimate (% Distribution)	Ohio Estimate	Estimated %
Total	**7,817,897**	**1,308,737**	**16.7**
Sex			
Female	4,035,237 (51.6)	498,161	12.3
Male	3,782,660 (48.4)	810,576	21.4
Age			
18 – 24	966,586 (12.4)	135,029	14.0
25 – 34	1,260,543 (16.1)	192,665	15.3
35 – 44	1,198,834 (15.3)	253,756	21.2
45 – 54	1,202,528 (15.4)	250,706	20.8
55 – 64	1,398,156 (17.9)	242,881	17.4
65+	1,791,251 (22.9)	233,701	13.0
Race/Ethnicity			
White, Non-Hispanic	6,280,579 (81.5)	1,069,946	17.0
Black, Non-Hispanic	873,142 (11.3)	98,054	11.2
Other	551,102 (7.2)	106,205	19.3
Marital Status			
Married	3,927,699 (50.2)	613,971	15.6
Never Married	2,248,954 (28.8)	358,886	16.0
All Else	1,641,244 (21.0)	335,881	20.5
# Children Living in Household			
0	5,136,473 (66.2)	823,190	16.6
1	1,055,193 (13.6)	210,316	19.9
2	897,361 (11.6)	136,944	15.3
3+	672,279 (8.7)	126,967	18.9
Highest Level of Education Completed			
<High School (HS)	816,029 (10.5)	144,834	17.7
HS Diploma or GED Diploma	2,543,221 (32.6)	404,727	15.9
Some College	2,431,901 (31.2)	468,044	19.2
College Degree or More	2,001,362 (25.7)	283,599	14.2
Employment Status			
Employed/Self-Employed	4,394,141 (56.5)	728,113	16.6
Unemployed	360,278 (4.6)	76,492	21.2
Retired	1,652,384 (21.2)	221,632	13.4
Unable to Work	600,895 (7.7)	189,683	31.6
Homemaker	345,539 (4.4)	34,618	10.0
Student	426,642 (5.5)	51,042	12.0
Annual Household Income			
<$15,000	591,971 (8.8)	143,795	24.3
$15,000 - $24,999	1,173,392 (17.4)	223,770	19.1
$25,000 - $34,999	717,520 (10.7)	110,971	15.5
$35,000 - $49,999	988,336 (14.7)	141,489	14.3
$50,000+	3,258,825 (48.4)	544,231	16.7

Analysis excludes respondents who had missing, don't know/not sure and refused responses.
Source: Ohio BRFSS, including module on lifetime history of TBI (2018 and 2019, Split 2).

Table 1b. Lifetime Prevalence of Total TBI Among Adults 18+ Years by Demographic Characteristics, 2018 Only

Demographic Characteristics	Overall Sample Population	Total TBI (Year 2018 Only)*	
	Ohio Estimate (% Distribution)	Ohio Estimate	Estimated %
Total	**7,992,966**	**1,933,162**	**24.2**
Sex			
Female	4,138,123 (51.8)	757,663	18.3
Male	3,854,843 (48.2)	1,175,499	30.5
Age			
18 – 24	968,347 (12.1)	273,368	28.2
25 – 34	1,270,507 (15.9)	296,029	23.3
35 – 44	1,225,210 (15.3)	350,674	28.6
45 – 54	1,240,615 (15.5)	408,331	32.9
55 – 64	11,438,171 (18.0)	319,974	22.2
65+	1,850,115 (23.1)	284,786	15.4
Race/Ethnicity			
White, Non-Hispanic	6,459,914 (81.9)	1,616,544	25.0
Black, Non-Hispanic	885,697 (11.2)	160,561	18.1
Other	544,986 (6.9)	122,343	22.4
Marital Status			
Married	4,030,962 (50.4)	843,894	20.9
Never Married	2,229,268 (27.9)	567,318	25.4
All Else	1,732,736 (21.7)	521,950	30.1
# Children Living in Household			
0	5,143,377 (64.5)	1,116,752	21.7
1	1,168,230 (14.7)	377,463	32.3
2	937,084 (11.8)	253,574	27.1
3+	722,404 (9.1)	184,253	25.5
Highest Level of Education Completed			
<High School (HS)	857,479 (10.7)	209,031	24.4
HS Diploma or GED Diploma	2,616,167 (32.8)	585,608	22.4
Some College	2,516,421 (31.5)	653,549	26.0
College Degree or More	1,996,683 (25.0)	484,581	24.3
Employment Status			
Employed/Self-Employed	4,539,555 (57.1)	1,176,878	25.9
Unemployed	390,935 (4.9)	121,623	31.1
Retired	1,702,196 (21.4)	269,236	15.8
Unable to Work	563,928 (7.1)	230,677	40.9
Homemaker	350,602 (4.4)	36,438	10.4
Student	406,181 (5.1)	87,860	21.6
Annual Household Income			
<$15,000	612,261 (8.7)	226,347	37.0
$15,000 - $24,999	1,266,616 (18.0)	343,231	27.1
$25,000 - $34,999	822,757 (11.7)	175,288	21.3
$35,000 - $49,999	991,013 (14.1)	223,231	22.5
$50,000+	3,342,43 (47.5)	838,882	25.1

* Combines TBI without LOC and TBI with LOC. Only data from the 2018 BRFSS survey year was used for Total TBI due to a survey logic flow error in the lifetime history of TBI module for the 2019 questionnaire. Analysis excludes respondents who had missing, don't know/not sure and refused responses.
Source: Ohio BRFSS, including module on lifetime history of TBI (2018, Split 2).

Table 2. Lifetime Prevalence of TBI Among Adults 18+ Years by Geographic Region of Residence, Ohio, 2018 – 2019

Region	Ohio Sample	Severity of TBI				All TBI With LOC	Age at First TBI With Loss of Consciousness (LOC)	
		TBI With No LOC (2018 Only)¥	<5 Min LOC	5-30 Min LOC	>30 Min LOC		<20 Years	≥20 Years
	Ohio Estimate (% Distribution)	%	%	%	%	%	%	%
Total	**7,817,897**	**9.5**	**8.4**	**3.2**	**3.0**	**16.7**	**10.2**	**6.6**
Region 1	475,727 (6.1)	-	8.8	-	-	17.5	9.5	8.0
Region 2	248,349 (3.2)	9.4	8.3	-	-	16.1	9.5	6.7
Region 3	350,998 (4.5)	11.3	10.0	-	-	19.9	8.7	10.0
Region 4	1,190,169 (15.2)	12.1	7.5	-	2.5	15.2	9.2	6.0
Region 5	954,377 (12.2)	-	10.8	3.2	-	20.7	15.1	5.2
Region 6	569,526 (7.3)	-	10.0	3.4	3.3	19.4	12.2	7.5
Region 7	231,572 (3.0)	13.3	9.3	-	-	16.1	9.8	5.7
Region 8	1,062,387 (13.6)	-	7.3	3.5	2.6	14.8	9.1	5.9
Region 9	759,727 (9.7)	12.6	7.2	-	-	16.4	9.8	6.9
Region 10	1,085,726 (13.9)	-	7.3	2.7	2.6	13.6	8.2	6.0
Region 11	232,352 (3.0)	21.2	8.6	2.6	-	17.8	9.8	7.6
Region 12	261,315 (3.3)	-	11.2	3.3	3.2	19.4	11.9	7.2
Region 13	196,937 (2.5)	-	6.9	-	-	16.5	9.8	6.6
Region 14	198,734 (2.5)	-	7.3	5.0	3.7	17.5	8.7	7.1

¥ Only data from the 2018 BRFSS survey year was used for TBI with no LOC due to a survey logic flow error in the lifetime history of TBI module for the 2019 questionnaire.

*Includes respondents ≥ 20 years of age.

Analysis excludes respondents who had missing, don't know/not sure and refused responses.

– Data suppressed when denominator < 50 or when the RSE > 30.

Source: Ohio BRFSS, including module on lifetime history of TBI (2018 and 2019, Split 2).

Region 1: Defiance, Fulton, Henry, Lucas, Paulding, Williams, Wood

Region 2: Allen, Auglaize, Hancock, Hardin, Mercer, Putnam, Van Wert

Region 3: Crawford, Erie, Huron, Ottawa, Richland, Sandusky, Seneca, Wyandot

Region 4: Cuyahoga, Geauga, Lake, Lorain

Region 5: Ashland, Holmes, Medina, Stark, Summit, Wayne

Region 6: Ashtabula, Columbiana, Mahoning, Portage, Trumbull

Region 7: Delaware, Knox, Marion, Morrow, Union

Region 8: Fairfield, Franklin, Licking, Madison, Pickaway

Region 9: Champaign, Clark, Darke, Greene, Logan, Miami, Montgomery, Preble, Shelby

Region 10: Butler, Clermont, Clinton, Hamilton, Warren

Region 11: Adams, Brown, Fayette, Highland, Pike, Ross, Scioto

Region 12: Coshocton, Guernsey, Morgan, Muskingum, Noble, Perry, Tuscarawas

Region 13: Belmont, Carroll, Harrison, Jefferson, Monroe, Washington

Region 14: Athens, Gallia, Hocking, Jackson, Lawrence, Meigs, Vinton

Table 3. Prevalence of Current Health Conditions and Behaviors Among All Adults and Adults With a Lifetime History of TBI by Severity of TBI and Age at First TBI With Loss of Consciousness (LOC), Ohio, 2018–2019

Current Health Condition/ Behavior	Overall Adult Population	Lifetime History of TBI						
		Severity of TBI				All TBI With LOC	Age at First TBI With LOC*	
		TBI With No LOC (2018 Only)¥	<5 Min LOC	5-30 Min LOC	>30 Min LOC		<20 Years	≥20 Years
	%	%	%	%	%	%	%	%
Any Disability	29.8	37.4	33.7	54.8	47.0	41.9	37.2	47.1
Hearing	7.5	9.7	5.8	15.3	14.7	10.6	10.5	11.0
Vision	5.2	12.3	4.1	12.2	--	8.0	8.8	5.7
Cognition	12.2	23.9	16.7	27.7	23.6	21.4	17.8	24.9
Mobility	15.8	18.3	16.9	28.6	25.7	22.6	17.8	27.9
Self-Care	4.1	--	--	11.4	7.9	8.2	6.9	9.7
Independent Living	7.9	16.4	14.4	22.5	16.4	16.9	15.4	17.8
Fair or Poor Health vs (Great/ Good Health)	19.1	21.2	21.6	42.5	40.2	32.2	27.6	38.4
1 – 7 Days of Physical Health Not Good	21.0	18.4	24.5	23.3	25.2	23.2	26.4	19.4
8 – 30 Days of Physical Health Not Good	17.0	20.6	21.0	34.2	29.5	26.6	21.8	32.2
1 – 7 Days of Poor Health Keeping From Activities	22.1	20.2	21.1	26.2	23.7	22.1	25.8	16.1
8 – 30 Days of Poor Health Keeping From Activities	22.2	25.2	26.8	38.3	38.9	35.6	32.4	38.2
Chronic Health Problem*	45.5	52.8	44.2	61.5	58.7	51.9	47.3	56.1
Binge Drinking†	16.3	11.6	21.0	23.1	14.0	20.0	19.1	21.8
Heavy Drinking§	7.0	--	7.7	16.3	8.6	9.0	8.3	9.7
Smoke (Cigarettes)	20.9	24.0	21.5	36.4	22.9	25.0	22.8	28.7
Depressive Disorder	20.4	30.1	29.7	35.8	38.5	33.4	35.0	29.7
Mental Health Not Good¶	24.9	36.7	31.9	44.6	38.8	36.4	35.6	35.4

¥ Only data from the 2018 BRFSS survey year was used for TBI with no LOC due to a survey logic flow error in the lifetime history of TBI module for the 2019 questionnaire.

* Includes respondents ≥ 20 years of age.

Chronic Health Problem includes heart attack; angina or coronary heart disease; stroke; asthma; skin cancer; other types of cancer; chronic obstructive pulmonary disease, emphysema or chronic bronchitis; some form of arthritis, rheumatoid arthritis, gout, lupus or fibromyalgia; and kidney disease and diabetes (not pregnancy-related).

† Binge Drinking is defined as males having five or more drinks on one occasion and females having four or more drinks on one occasion, in the past 30 days.

§ Heavy Drinking is defined as males having more than 14 drinks per week and females having more than seven drinks per week, in the past 30 days.

¶ Mental Health Not Good reflects mental health reported as not good on more than five days in the past 30 days.

Analysis excludes respondents who had missing, don't know/not sure and refused responses.

– Data suppressed when denominator < 50 or when the RSE > 30.

Source: Ohio BRFSS, including module on lifetime history of TBI (2018 and 2019, Split 2).

Summary of Findings from the 2018-2019 Ohio BRFSS

- An estimated 1.9 million (24.2%) adults in Ohio have had at least one TBI in their lifetime. Nearly 1.3 million (16.7%) have had at least one TBI with LOC.
- Close to 800,000 adults in Ohio had their first TBI with LOC before age 20.
- Having a household income of less than $25,000 and being unemployed or unable to work was associated with higher prevalence of lifetime history of TBI.
- Around 550,000 Ohio adults reported having both a disability and a history of TBI with LOC.
- Among the 235,000 (3.0%) Ohio adults who have a history of moderate to severe TBI (> 30 minutes LOC), 110,000 (47.0%) also reported having a current disability.
- Disability due to cognitive problems and limited mobility are more associated with a history of TBI than other causes of disability.
- Adults with a history of TBI with LOC had higher prevalence of disability, poor physical and mental health, chronic health conditions and smoking cigarettes compared to the overall adult population in the state.
- Having a depressive disorder was more prevalent among respondents who had their first TBI with LOC before the age of 20, while having a disability, poor physical health, chronic illness and smoking cigarettes were more prevalent among respondents who had their first TBI with LOC at age 20 or older.

These findings indicate a relationship between lifetime history of TBI and poor health and social outcomes, such as disability, poor physical and mental health, the inability to work and lower household income. While we cannot determine if these associations are causal, they clearly convey the long-term health and social impacts of TBI on an individual beyond the initial injury.

Section 4

The Costs of Traumatic Brain Injury: Can They Be Reduced?

This biennial report once again presents the harsh realities of the human toll taken by traumatic brain injury (TBI) in the state of Ohio. Beyond the statistics, however, lies the fact that a brain injury is not a broken arm with a simple treatment and recovery course. Rather, brain injuries cause profound physiological changes, with the potential to impact every major body system.

TBIs are both unpredictable and variable. Therefore, the costs associated with them go far beyond the immediate injury/post-injury period. Unfortunately, it is difficult to assess the true long-term economic consequences of TBIs. Multiple providers and payers are involved, and they do not work together to track the costs of care. This means the entire cost of short- and long-term TBI care cannot be calculated.

Many of the survivors of TBI are not able to return to work or school. Or they live without financial assistance or without prolonged health and social services and supports. The most common cost drivers for TBI treatment and care include:

- Durable medical equipment
- Long-term care placement
- Loss of earning capability for survivor and caregiver
- Lost wages
- Medical care and treatment
- Medications
- Personal caregiver
- Rehabilitation
- Special education
- Wage replacement

Given the lifelong needs of those living with TBI, it can be a costly prospect corresponding to residual impairments as well as the difficulties of its long-lasting effects. The broad-spectrum impact of TBI raises the questions:

- Are the dollars well spent?
- How can they be better spent toward improved outcomes?
- What are the best strategies to conserve and preserve limited resources needed for the betterment of all services?

Are the dollars well spent?
A study published by the Centers for Disease Control and Prevention (CDC) in the journal *Medical Care* placed the total annual cost of nonfatal TBIs at more than $40.6 billion for the year 2016. This included health care costs of $10.1 billion to private insurance, $22.5 billion to Medicare and $8 billion to Medicaid.[1] The CDC has placed the 2018 total cost of Ohio's traffic crash deaths alone at $1.69 billion annually. Despite this massive outlay of spending, the CDC reports the following five-year post-injury outcomes for people 16 years of age and older who received inpatient rehabilitation for a primary diagnosis of TBI:[2]

DIED	BECAME WORSE	STAYED THE SAME	IMPROVED
22%	30%	22%	26%

Even acknowledging the vast disparities of prognoses and potentials for optimal recovery, such outcomes are far from any measure of success. They reflect the flaws in the health care system and service delivery that create disjointed care pathways, contradictory incentives and obstacles to access.

How can allocated funds be better spent for improved outcomes?
In the two past biennial brain injury reports, the Ohio Brain Injury Program and the Ohio Brain Injury Advisory Committee have described three effective strategies for improving the cost-benefit equation in TBI care. These strategies remain the cornerstones for improving treatment outcomes and long-term well-being. They work by preventing or decreasing avoidable complications of TBI. This then lowers the associated lifetime health care costs; increases independence, self-care and employment; and decreases excess societal costs. The human costs are also decreased, as both individuals and their families are ensured an improved quality of life.

What are the best strategies for conserving and preserving necessary limited TBI care resources?

There are **three** major effective strategies for promoting cost-effective long-term TBI care:

1. Adhere to the treatment guidelines developed by the Brain Trauma Foundation (BTF).
A study published in *The Journal of Trauma: Injury, Infection, and Critical Care* undertook an extensive review of the literature using surveillance systems and national surveys reflecting attention to a wide set of variables such as age at injury, severity, treatment components, length of stay and wage loss determination.[3] The study compared the lifetime costs of care when following the BTF guidelines with the lifetime costs of care when using other treatments. It concluded that adherence to the BTF guidelines would result in an annual cost savings of:

- $262 million in medical costs
- $43 billion in rehabilitation costs
- $3.84 billion in lifetime societal costs

A subsequent study published in the *Journal of Neurosurgery* compared the costs of aggressive treatment of severe TBI following the BTF guidelines with that of a more typical "comfort care" protocol that is inconsistent with the BTF guidelines. The study concluded that the aggressive care treatment plan is not only more effective for patients of all ages but would be less costly, with a lifetime care cost of $1,264,000 versus $1,361,000.[4]

Although it has been many years since the BTF guidelines were first released, they are not used in the regular path for care. This raises the important question of why there is incomplete compliance with the highly regarded BTF guidelines. Physician training, hospital administrative requirements/awareness, insurance coverage or limitations of financing mechanisms may all play a part. Rigorous research into these "whys" will help promote widespread implementation of these guidelines, improving outcomes and lowering costs.

2. Utilize post-acute TBI rehabilitation.

Previous biennial brain injury reports have documented studies that are supportive of the cost-benefit advantage of early and targeted rehabilitation for survivors of TBI.[5,6]

An extensive quality improvement analysis from the UK Rehabilitation Outcome Collaborative (UKROC) has produced a comprehensive model of cost-effective rehabilitation. The model is designed to structure care that is tailored to individual needs and delivered in a timely manner.

UKROC's foundational studies found that, of 9,000 neurosurgical bed occupancy days, an absence of organized, acute rehabilitation led to 72% of patients with TBI remaining in neurosurgical beds they did not need. The organization also cited a Norwegian study showing that patients who received tailored, organized rehabilitative care had better functional outcomes.[7]

Another study from the Brain Injury Rehabilitation Trust in the U.K. released these conclusions:

"Cost-benefits of up to £1.13 million were demonstrated for individuals admitted to rehabilitation within a year of sustaining a brain injury and of up to £0.86 million for those admitted more than 1 year after injury. Functional gains and reductions in levels of care required upon discharge were maintained 6 months later. These results demonstrate that post-acute neurobehavioural rehabilitation can have a positive impact on the lives of individuals with brain injury and that the associated costs are off-set by significant savings in the longer-term."[8]

In the United States, brain injury rehabilitation services have been a required benefit in the state of Texas since 2001, and medical plans are prohibited from denying coverage. A state-mandated review of the plan's associated costs was undertaken to understand the impact of premiums on individual plans. Findings for the period from October 2013 through September 2014 showed that a total of 7,588,788 claims for mandated rehabilitation services was paid over the period, which comprised 0.24% of total claims paid during that time. The average added annual premium cost for single coverage was $20.61 and $49.80 for family coverage. This minimal impact on insurance health premium costs in the state of Texas helped to reduce the effect of the unrecognized, ongoing societal costs of TBI.[9]

It should be clear that the delivery of proper TBI rehabilitation services — provided in a timely and seamless manner — creates efficiencies of care. Not only does it conserve scarce resources, but it results in better outcomes, reducing long-term societal and human costs. Barriers to implementation of this strategy include:

- Financing mechanisms are inadequate or so disjointed that they prevent streamlined care (specifically for post-hospital, rehabilitation coverage).
- Availability of services is unevenly distributed, so resources are not available in many areas.

3. Develop specific and individualized community supports and service coordination.

Recognized as a chronic disease, the course of TBI shows that long-term well-being depends on the availability of specific measures that supply the survivor with resources to maintain health, avoid or treat complications, prevent or minimize disabilities and enable independence. The resources to accomplish these ends are often unknown or inaccessible to the survivor and their family. Therefore, for all practical purposes, they are unavailable to them.

Inspiring work done by Lance Trexler and team at Indiana University was reported in the 2017 biennial brain injury report.[10] That study showed a 64% return-to-work rate for survivors of TBI who received community-based support services versus a 40-50% return-to-work rate among those who did not. Researchers continue to find evidence that demonstrates the value of coordinated community-based supports. The evidence shows that providing support services is a cost-effective strategy that improves long-term outcomes, reducing both the human and financial loss caused by TBI.

An international study published in the *Archives of Physical Medicine and Rehabilitation* compared the impact of such supports. The study looked at two matched samples: one from an Australian cohort and one from the United States' TBI Model Systems National Database. The Australian participants received routine access to community-based supports, while the U.S. sample received only minimal services after leaving the hospital. After a two-year follow-up, the Australian group was more likely to be employed, married and living independently. The group had greater income, community involvement and access to health care.[11]

Another recent study examined the impact of state programs and services on outcomes five years after injury. John Corrigan, PhD, and colleagues with the Ohio Valley Center for Brain Injury Prevention and Rehabilitation concluded that persons living in those states with better long-term services and supports (LTSS) had significantly more community involvement and achieved a higher level of life. Better LTSS allowed for more personal choice and greater flexibility when accessing home- and community-based service waivers. There was further indication that state resources for persons with brain injury produced higher levels of community participation as time passed from the day their injury was first treated.[12]

While the benefits of community-based services and supports continue to be demonstrated, their delivery is undermined by a failure in the system to link them with those in need. Resource facilitation provides that link. Resource facilitation is an evidence-based, cost-effective practice designed to support the survivor in meeting the challenges of TBI. With the help of skilled and knowledgeable professionals, survivors assess their needs, goals and aspirations. They are then referred to the appropriate community services that they need.

In 2021, the Ohio Brain Injury Program launched the **Ohio Brain Injury Connection**. The program is designed to assist individuals who have experienced brain injuries and their families. This person-centered resource facilitation program is set up to partner with individuals to:

- Navigate the often-baffling world of health and social services
- Gain self-knowledge
- Develop skills and self-advocacy abilities
- Use their knowledge to formulate a long-term plan for achieving their future goals

The program became fully operational in January 2022. It quickly received referrals from various community agencies as they encountered survivors of TBI and their families with more complex needs than they could address. The promise of helping Ohioans achieve a better quality of life after TBI is closer when guidance aids successful access to support services.

In Conclusion

TBI is serious and costly, often entailing long-term health implications, disabilities and major adjustments. Its impact has far-reaching effects on individuals and their families as well as on society.

The economic costs of addressing the scope of TBI impacts are high. Dollars are spent through various public and private sources and sectors. In conclusion:

- While it is undeniable that lives are being saved, we are not as successful at rebuilding quality of life. Research would indicate that we are not meeting the goal of appropriate care for TBI consistently and broadly.
- Improved outcomes will be a function of the ability of a range of stakeholders — from public policy makers to health care providers, financing agents, researchers, social service providers, employers and the public. By working together to recognize the complex components of TBI, stakeholders can develop solutions that remove inadequacies of care, improve knowledge and training, fix disjointed services and unnecessary delays in care and stop misallocated funds.
- The strategies described throughout this section point the way to advancing the components of TBI treatment, rehabilitation and long-term services. They seek to improve supports for better care while reducing inefficiencies and obstacles to recovery. They are, no doubt, a beginning and only part of the ultimate solution. However, they are fundamental to the most basic concerns of dealing with the segments of care involved, from the acute through the chronic stages of TBI.

The public health burden of TBI requires that the state of Ohio continue to support the effort to maintain vigorous study and programs. At the same time, the state should work to implement the proven strategies described here as well as to expand the study of other mechanisms that promote access to care for all survivors of TBI. The costs to the state are too great to be dismissed and are not being addressed through current paths for greater care.

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