



## Childhood Traumatic Brain Injury in Wisconsin (2019–2023)

Traumatic brain injury (TBI) occurs due to a significant blow to the head or body or an object entering the brain.<sup>1</sup> TBIs can affect how someone thinks, learns, and interacts with others. Childhood TBIs can be especially impactful as the brain is still developing.<sup>2</sup> Trends in TBI-related treat and release emergency department (ED) visits, non-fatal hospitalizations, and deaths can help identify groups of children at greater TBI risk. However, not all children receive hospital treatment, so the issue is likely broader than what is represented in this report, especially for mild TBIs. Use these data in combination with other sources, like [data from the Youth Risk Behavior Survey](#), to understand pediatric TBI trends.

### Overall findings

#### What were the most common causes of youth TBI in Wisconsin from 2019 to 2023?

- Unintentional fall was the top cause of TBI-related ED visits and the second most common cause of hospitalizations.
- Unintentional transport injury (including injury related to traffic, boats, and other forms of transportation) was the top cause of TBI-related hospitalizations and deaths, likely because motor vehicle crashes have been associated with more severe TBIs than other causes.<sup>3</sup>
- Violence, including homicide and suicide, accounted for over half of pediatric TBI-related deaths.

#### Who was most likely to experience a TBI-related injury during this period?

- **Children less than 1 and children aged 15 to 17:** Children in both age groups experienced relatively high rates of TBI-related hospitalization and death. Hospitalization was especially high among infants. Top hospitalization causes among infants were falls and assault. Prevention for both causes involves programming and support for caregivers to ensure infants and children grow up in spaces free from household hazards and abuse.<sup>4</sup> Among children ages 15 to 17, transport injury was a top cause of TBI hospitalization and death. Teens have less driving experience and may not respond to hazards quickly or effectively.<sup>5</sup> Inexperience, in combination with impaired or distracted driving, makes accidents more likely. Suicide was a leading cause of TBI death among teens as well. Firearms are the most common mechanism among TBI-related suicides.<sup>6</sup>
- **Males:** Males had higher TBI rates than females. This difference could be related to increased risk-taking behavior among males. For example, teen male drivers are more likely to be in a severe car accident than female drivers due to factors like speed or losing control of the car.<sup>7,8</sup>
- **Black children:** Hospitalization and death rates among Black children were greater than the overall rates among all children. Racist policies and practices have impacted mental health, the built environment, and access and quality of health care in communities of color, increasing risk for TBI and impacting treatment quality of subsequent care.<sup>9,10</sup>
- **Children living in rural counties:** Injury severity, transport time to the hospital, and care quality affect TBI recovery.<sup>3</sup> Rural residents may have greater challenges accessing both high-level trauma care and TBI-specific care.<sup>11</sup> Traffic injury also causes more severe injury, and seat belt use is lower in rural areas.<sup>3,12</sup> Children residing in rural areas have both higher rates of traffic injury and severe TBI injury.

## Preventing TBIs in Wisconsin

TBI prevention differs by cause. Falls can be prevented among young children by supporting parents with education and resources to create a safe home environment. Motor vehicle injury plays a large role in transportation-related TBIs. Wisconsin is working to reduce crashes through safer roads, drivers, and speeds. Finally, violence prevention requires a variety of approaches to address the root causes such as social and economic inequality, as well as trauma.<sup>13</sup> Learn more about TBI prevention on the [Wisconsin Department of Health Services website](#).



## Emergency department (ED) visits

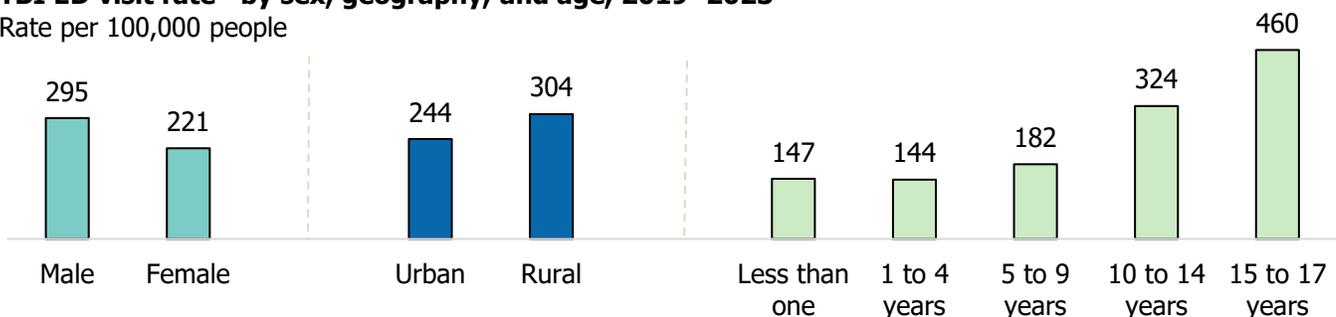
There were 16,661 pediatric (among children) TBI ED visits from 2019 to 2023 and a crude rate of 264.7 visits per 100,000 children.

- **TBI ED visit rates increased significantly from 2019 to 2023** (age-adjusted rate: 285 visits per 100,000 children to 299 visits per 100,000 children).
- **Children 15 to 17 years old** experienced a significantly higher ED visit rate than all other age groups.
- **Males** experienced a significantly higher ED visit rate than females.
- **Children from rural counties** experienced a significantly higher TBI ED visit rate than those from urban counties.
- **Black and white children** experienced significantly higher rates of TBI ED visits than the overall rate among children.

Most children (83.5%) visited the ED for mild TBIs, meaning the injury caused shorter-term loss of consciousness, disorientation, or memory loss. Thirteen and a half percent of ED visits were for moderate TBIs, indicating longer-term symptoms and slightly more severe injury. Less than one percent visited for a TBI due to an object entering the brain, also called a penetrating injury (see Appendix for details). Ninety-seven percent of TBI ED visits involved an intracranial injury, while 4% involved a skull fracture. These two types of injuries are not mutually exclusive and can be diagnosed at the same time.

### TBI ED visit rate\* by sex, geography, and age, 2019–2023

Rate per 100,000 people

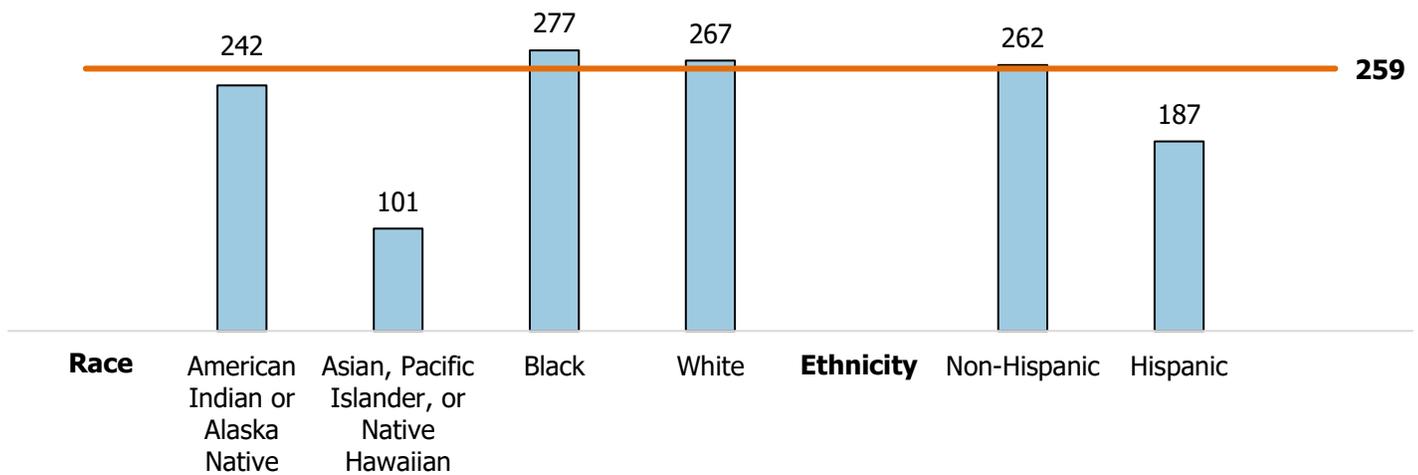


\*Rates for both sexes and urban/rural children are age-adjusted

### TBI ED visit rate by race and ethnicity, 2019–2023

Age adjusted rate per 100,000

— Rate among all children



In comparison with the overall rate of pediatric TBI ED visits, Black and white children experienced significantly higher ED visit rates. Asian, Pacific Islander, or Native Hawaiian children visited the ED for TBI at significantly lower rates than children overall. The rate among American Indian or Alaska Native children was not significantly different than the overall rate. The rate among Hispanic children was significantly lower than the overall rate, while the rate for non-Hispanic children was not significantly different from the overall rate. Unfortunately, ED care for TBI is not always the same for every child. For example, Black children who visit the ED for head trauma are less likely to get imaging done than white children.<sup>14</sup>

Socioeconomic factors, like insurance, can affect decisions about care after a TBI and make ED visits for mild injuries more common. For example, not all children have access to a specialist or primary care provider after sustaining a concussion. Children from neighborhoods with less economic and educational opportunities or who are on public insurance are more likely to visit the ED for a concussion than a specialist or primary care provider.<sup>14</sup> This may affect the quality of the care they receive for a TBI.<sup>14</sup> Ensuring all children receive adequate care and follow-up after a mild TBI or concussion is important to support recovery and reduce negative TBI outcomes.

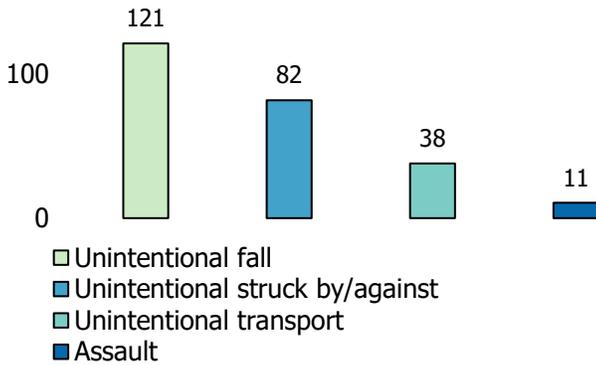
### Top causes of TBI ED visits

- **Unintentional falls** were the most common cause of TBI-related ED visits among children overall, followed by being unintentionally struck.
- **Children ages 15 to 17** had significantly higher rates of TBI ED visits caused by being accidentally struck, transport accidents, and assault than all other age groups. This age group also had a significantly higher rate of falls than all other groups except children 10 to 14.
- **Males** had significantly higher rates of TBI ED visits due to unintentional falls, being accidentally struck, transport accidents, and assault than females.
- **Children in rural counties** had significantly higher rates of TBI ED visits due to accidental falls, being accidentally struck, and transport accidents than children in urban counties. However, the TBI ED visit rate due to assault was higher among children residing in an urban county.

Please note: Causes are not mutually-exclusive and only the most common causes are included.

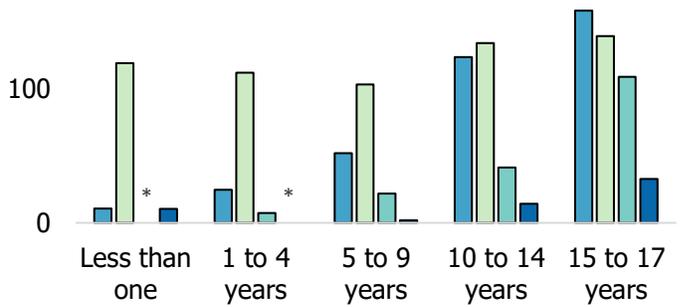
**Top TBI ED visit causes, 2019–2023**

Age-adjusted rate per 100,000 people



**Top TBI ED visits causes by age, 2019–2023**

Rate per 100,000 people



\*Count < 20. No rate calculated.

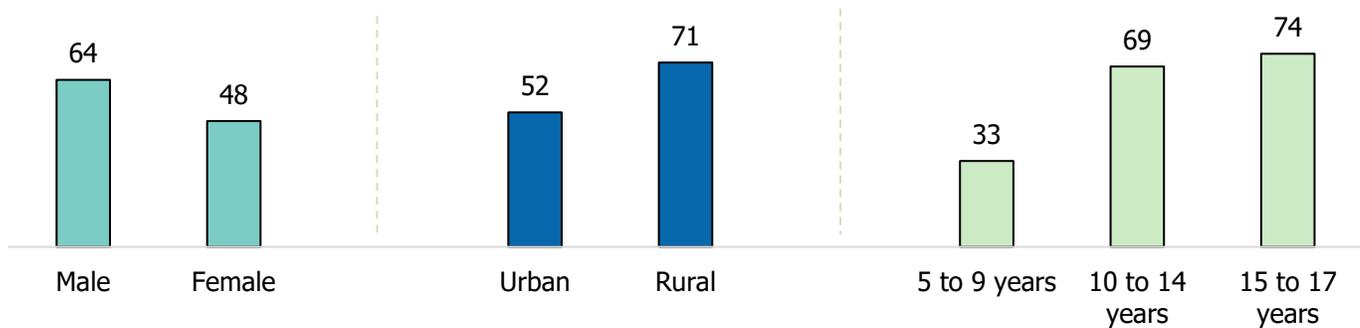
**Sports and recreational (SPAR) head injury**

Sports and recreational activities, such as team sports, biking, and enjoying playgrounds, are an important part of childhood. However, TBIs—specifically concussions—are a concern for student athletes. Concussions are a mild type of TBI that occur when the brain moves in the skull due to a blow to the head or body and are a risk of sports and recreational activities.<sup>15</sup> For athletes, there is also risk of multiple concussions. Multiple TBIs or concussions can increase the amount of time it takes to recover and cause issues with memory and concentration.<sup>15</sup>

SPAR activities contributed to **22%** of **TBI ED visits** (including concussions and other types of TBI) and **29%** of **TBI hospitalizations** (including concussions and other types of TBI) among school-aged children (5 to 17) in Wisconsin from 2019 to 2023.

**SPAR ED visits\* for concussion by sex, geography, and age, 2019–2023**

Rate per 100,000 people



\*Rates for both sexes and urban/rural children are age-adjusted

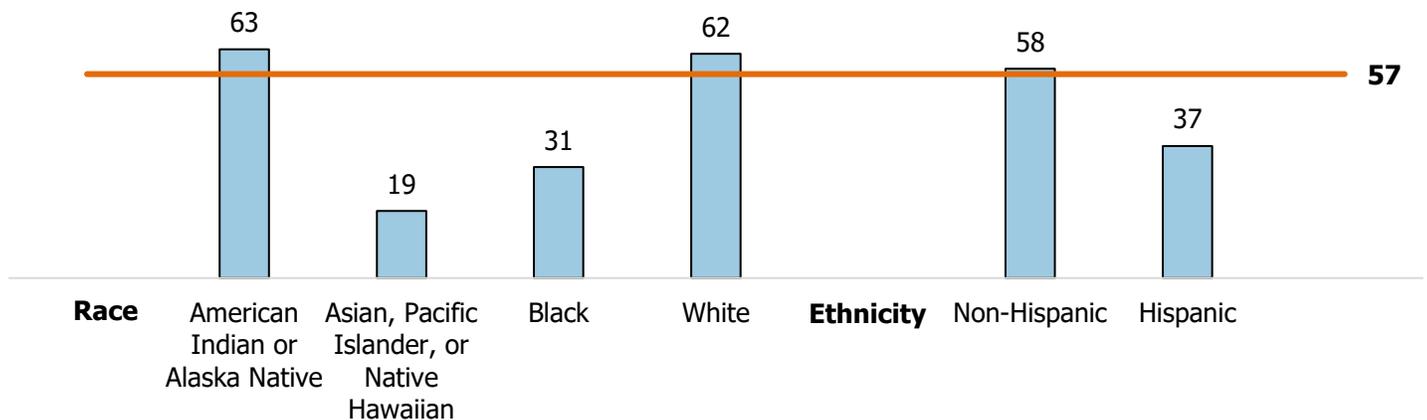
**Who had the highest ED concussion visit rate for SPAR activities?**

- **Males** had a significantly higher concussion ED visit rate for SPAR activities than females.
- **Children ages 10 to 14** and **ages 15 to 17** had the highest rates of concussion ED visits for SPAR activities
- **Children in rural counties** had significantly higher rates of SPAR TBI ED visits for concussions compared to children in urban counties.

### SPAR concussion ED visit rate by race and ethnicity, 2019–2023

Age adjusted rate per 100,000

— Rate among all children



Black children had a significantly lower ED visit rate for concussions related to SPAR activities than the rate among all children. Asian, Pacific Islander, or Native Hawaiian children also had a significantly lower SPAR concussion rate. The rate among American Indian or Alaska Native children was not significantly different than the overall rate. White children had a significantly higher rate than the overall rate. The rate among Hispanic children was significantly lower than the overall rate, while the rate among non-Hispanic children was not significantly different. The rates for SPAR-related ED visits overall (not restricted to concussion) followed the same patterns.

Despite a lower ED visit rate for concussion, a survey of Wisconsin high school students found a significantly greater percentage of non-Hispanic, Black students (24.7%) self-reported a concussion from sports in the past year than non-Hispanic, white students (10.6%).<sup>16</sup> This discrepancy suggests that despite higher levels of concussions due to sports, student athletes from communities of color may not go to the ED for care after SPAR-related head injuries as often as white children, possibly based on lack of awareness of symptoms.<sup>17</sup> It is also possible that underdiagnosis among Black children may contribute to the lower rates of SPAR concussion in the ED compared to white children.<sup>17</sup>

The higher rate of SPAR concussions among males may be because males participate more often in contact sports, like football and lacrosse, that result in more TBIs.<sup>18</sup> However, females are at greater risk for concussion than males when playing sports with the same rules.<sup>19</sup> Survey data shows no significant difference between the percentage of Wisconsin female (11.6%) and male (12.5%) students reporting a sports-related concussion in the previous year.<sup>16</sup>

Student athletes do not always report symptoms of concussion because they don't recognize the symptoms or don't want to stop playing.<sup>20</sup> Athletes can only report a concussion if they are aware of the symptoms, but not everyone receives the same education. Children from low-income families do not have the same awareness of concussion symptoms as high-income families.<sup>17,20</sup> This difference could be related to limited access to high quality sports education and athletic trainers. Student athletes and their parents need access to information about the symptoms of a head injury or concussion, so they know when to see a medical provider.

## Hospitalizations

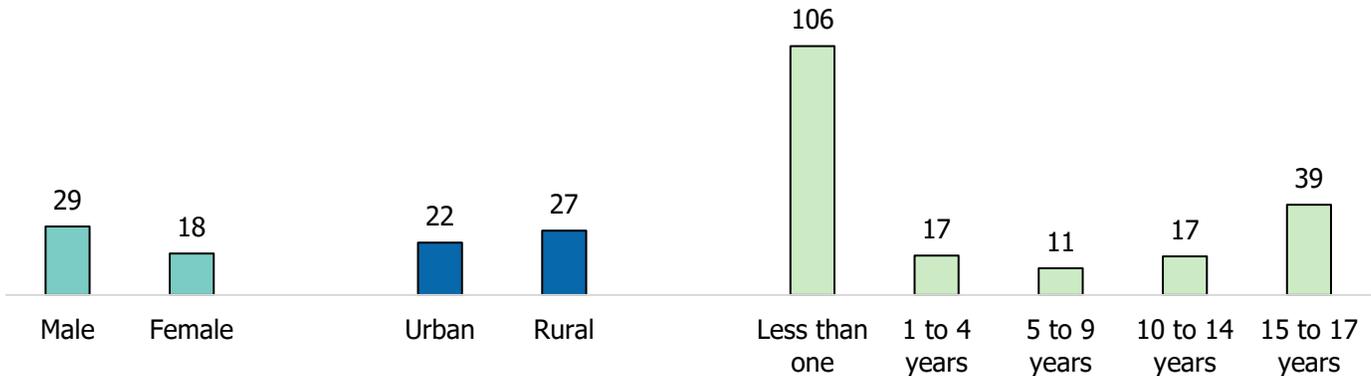
There were 1,483 pediatric TBI-related ED visits from 2019 to 2023, at a crude rate of 23.6 hospitalizations per 100,000 children.

- **The hospitalization rate did not change significantly** between 2019 and 2023.
- **Male** children experienced a significantly higher rate of TBI-hospitalizations than females.
- **Children from rural counties** had a significantly higher TBI-related hospitalization rate than those from urban counties.
- **Children less than one year old** had the highest hospitalization rate, significantly higher than all other age groups.
- **Black children** had a hospitalization rate significantly higher than the overall pediatric rate.

Seventy-six percent of TBI hospitalizations involved a moderate brain injury and 15% involved a mild brain injury. Penetrating brain injuries (where an object enters the brain) accounted for 5.3% of TBI hospitalizations. Severe brain injuries accounted for less than 1% of TBI hospitalizations. Ninety-two percent of TBI hospitalizations involved an intracranial injury. Forty-five percent involved a skull fracture. These two types of injuries are not mutually exclusive and can be diagnosed at the same time.

### TBI hospitalization rate\* by sex, geography, and age, 2019–2023

Rate per 100,000 people

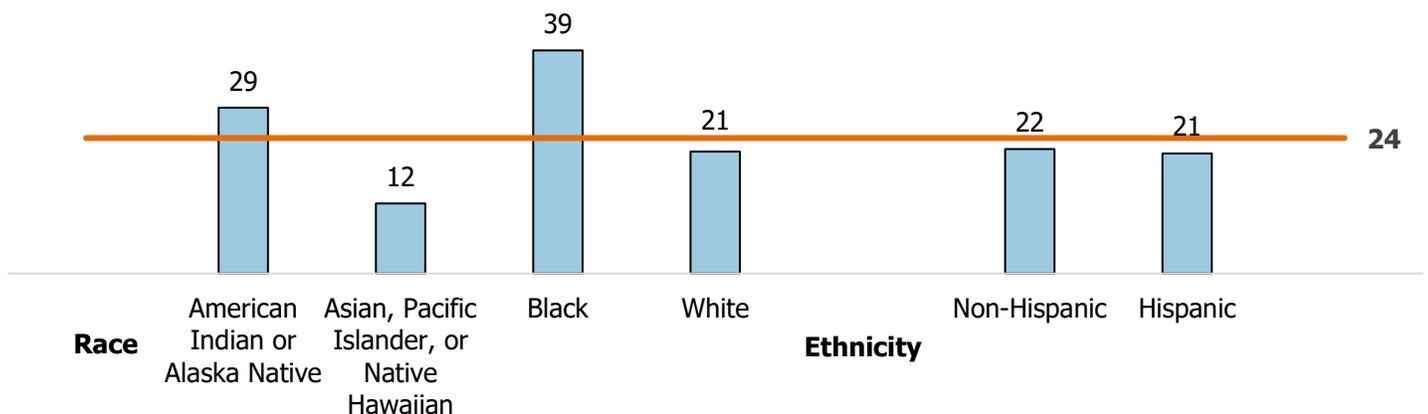


\*Rates for both sexes and urban/rural children are age-adjusted

### TBI hospitalization rate by race and ethnicity, 2019–2023

Age adjusted rate per 100,000

— Rate among all children



Black children experienced a significantly higher rate of TBI hospitalization than the age-adjusted rate for Wisconsin children overall. White and Asian, Pacific Islander, or Native Hawaiian children had TBI hospitalization rates significantly lower than the overall pediatric rate. The rate among American Indian or Alaska Native children was not significantly different than the overall rate. Non-Hispanic children experienced rates of TBI hospitalization significantly lower than the overall pediatric rate, and the rate among Hispanic children was not significantly different than the overall rate.

Conditions like neighborhood safety, parental education level and income, and culture affect a child’s risk for the causes of TBI.<sup>21</sup> Discriminatory practices and policies have significantly affected communities of color. These communities often face reduced road and neighborhood safety as well as lower levels of seat belt use.<sup>22,23</sup> In turn, children in these communities are at greater risk of traffic injury or violence.<sup>22</sup> In addition, limited access to resources after a TBI and on-going stress due to racism or poverty can result in poor TBI outcomes.<sup>21</sup> Working with communities to understand the roots of injury as well as leveraging community strengths is key to preventing the causes of TBI and support children living with a TBI.

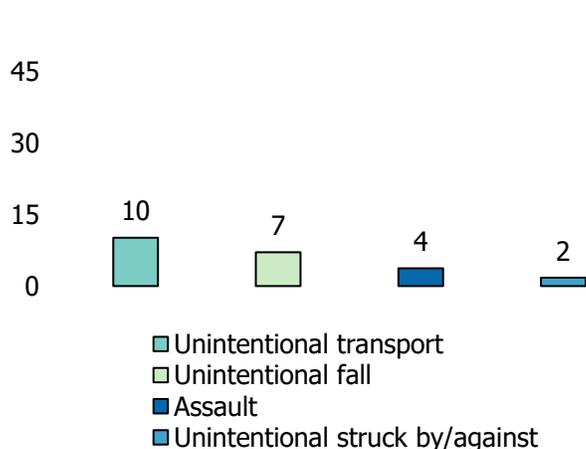
### Top causes of TBI hospitalizations

- **Unintentional transport injuries** were the most common cause of hospitalization among children overall, with increasing rates as age increased.
- **Causes varied significantly among age groups.** Among children less than 1, rates of falls and assault were significantly higher than other age groups.
- **Males** had significantly higher rates of all top causes.
- **Children in rural counties** had significantly higher rates of accidental falls and transport injury than those in urban counties.

Please note: Causes are not mutually-exclusive and only the most common causes are included.

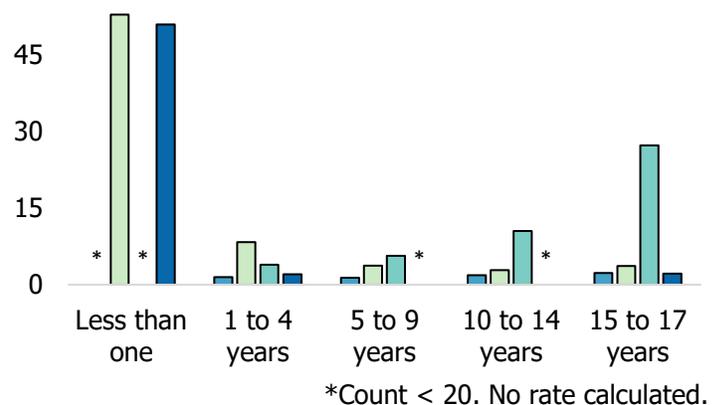
**Top TBI hospitalization causes, 2019–2023**

Age-adjusted rate per 100,000 people



**Top TBI hospitalization causes by age, 2019–2023**

Rate per 100,000 people



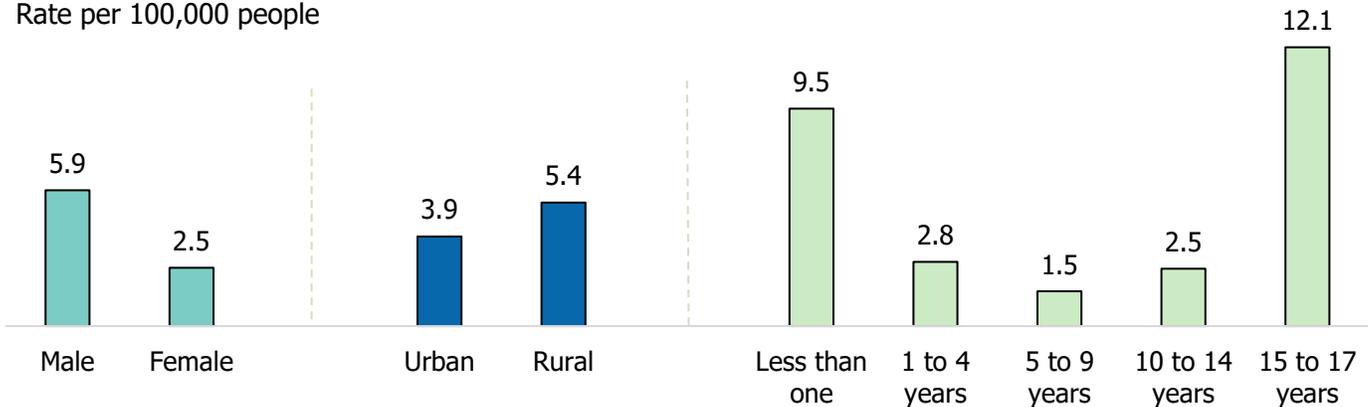
## Deaths

There were 276 pediatric TBI-related deaths among Wisconsin residents from 2019 to 2023 at a crude rate of four deaths per 100,000 children.

- **The rate of TBI-related pediatric deaths did not change significantly** from 2019 to 2023.
- **Children less than one and 15 to 17 years old** had the highest TBI-related death rates, significantly higher than all other age groups.
- **Males** had a higher rate of TBI-related death than females.
- **Black children** had a significantly higher age-adjusted rate of TBI-related death (12.2 per 100,000 people) than the age-adjusted overall pediatric rate (4.3 per 100,000). The rate among white children (3.6 per 100,000) was significantly lower than the overall rate. Rates for other races and ethnicities could not be calculated due to low counts.
- **Children in rural counties** had a significantly higher TBI death rate than urban-residing children.

### TBI death rate\* by sex, geography, and age, 2019–2023

Rate per 100,000 people



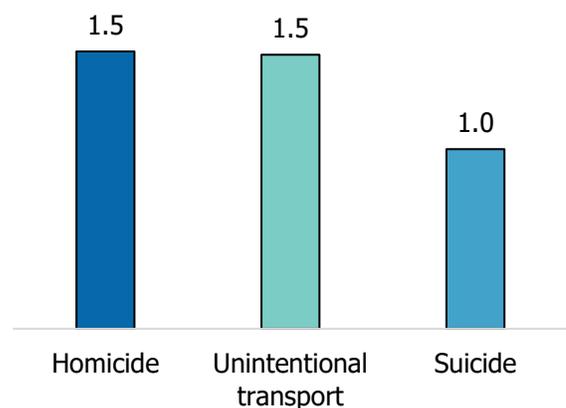
\*Rates for both sexes and urban/rural are age-adjusted

### Top causes of TBI deaths

- **Homicide and unintentional transport injuries** were the most common causes of TBI-related deaths among children.
- Males experienced a significantly higher rate of TBI-related homicide deaths than females during this period. A higher percentage of deaths among males was due to suicide than among females.
- The highest rate of homicide-related deaths was among children less than 1, where rates could be calculated. The majority of deaths due to suicide were among children 15 to 17 years old.
- A greater percentage of deaths among children from urban counties were caused by homicide than rural-residing children.

### TBI death rate\* by top causes, 2019–2023

Rate per 100,000 people



Please note: Percentages were calculated in place of rates where counts were low.

## Funding acknowledgement

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## Appendix

### Methodology

**Population data:** Rates were calculated using data from the Wisconsin Interactive Statistics on Health (WISH) Population module which utilizes U.S. Census data to develop population estimates. Age-adjusted rates only include records where age was known and were calculated using the Standard U.S. Population for Year 2000 for age-adjustment. Groups used for age adjustment were less than one, one to four, five to nine, ten to 14, and 15 to 17 years of age.

External cause was identified based on the underlying cause of death reported on the death record. There is only one underlying cause of death listed in each record. Hospitalization and ED visit records can have multiple external causes indicated (for example, fall and struck by or against). For rate calculations, causes are not mutually exclusive and reflect the total rate of each cause.

**Death data:** Death data for this report came from death records of Wisconsin residents between 2018 and 2022. Values may vary slightly from injury death data on the WISH query system as this system uses provisional data rather than the final data included in this report. TBI-related deaths were identified by searching the multiple cause of death fields for ICD-10 corresponding codes. External cause of death was identified based on the underlying cause of death reported on the death record. There is only one underlying cause of death listed in each record.

**Hospitalization data:** Hospitalization data in this report describes non-fatal injury-related hospitalizations of Wisconsin residents based on the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM). The ICD-10-CM is used by health care organizations to code for injuries and illnesses. These data count inpatient stays and not individual patients. This means that patients transferred between hospitals, readmitted to a hospital for further treatment, or otherwise treated in more than one inpatient stay are counted more than once. TBIs were identified by searching all fields for corresponding codes. Injury hospitalization data is limited to stays with an ICD-10-CM principal diagnosis code related to an injury. This means that if a patient was admitted for multiple reasons, but the primary reason for admission was **not** an injury, the hospitalization stay will not be included in this dataset.

**Emergency department data:** Emergency department (ED) data describes injury-related ED visits of Wisconsin residents based on the ICD-10-CM. TBIs were identified by searching all fields for corresponding codes. This data includes injury-related ED visits where the patient was treated and released. Patients transferred to hospitals for inpatient stays or those who died while in the ED are

not included. The injury ED data subset is limited to visits with an ICD-10-CM diagnosis or external-cause code (e-code) related to injury.

**Race and ethnicity:** Race data are based on population data from the U.S. Census Bureau and include the following racial categories: American Indian and Alaska Native, Asian, Black or African American, Native Hawaiian and Other Pacific Islander, white, and "two or more races." For this report, Asian and Native Hawaiian and Other Pacific Islander were combined. "Two or more races" was not reported.

**Urban and rural:** ED visits and hospitalizations were included in the analysis if the resident zip code on the hospital record was geolocated in a Wisconsin county. For designation in a rural or urban county, residence address was geocoded to identify county of residence. Deaths were included if the resident state was indicated as Wisconsin and county was based on the FIPS code of the decedent's county of residence. Urban and rural counties were based on rurality definitions created by the [Wisconsin Office of Rural Health](#) (accessed 6/17/25).

**External cause:** Causes were categorized using the ICD-10 matrix for deaths and the 2023 ICD-10-CM matrix for ED visits and hospitalizations. Sports and recreation activity codes definitions were adapted from the methodology in a [National Center of Health Statistics Report](#). TBI severity was categorized using the [Association for Armed Forces Health Surveillance Division \(AFHSD\) definitions](#).

**Limitations:** Using an injury subset means that records without codes for injury are not included. As a result, TBI ED visits and hospitalizations may be undercounted. Some records lack external cause of injury codes, meaning they could not be categorized by mechanism and intent. Additionally, some TBI codes lack information about time that consciousness was lost and could not be categorized into a severity level (~4% of pediatric hospitalizations and ~3% of ED visits).

**Definitions:** All cases identified with 7th character of the code is A or missing unless noted

<b>Traumatic brain injury</b>	<b>ICD-10-CM Codes</b>	<b>ICD-10 Codes</b>
Fracture of skull, other specified skull and facial bones, unspecified fracture (only for ED visits or hospitalizations)	S02.0, S02.1, S02.80, S02.81, S02.82, S02.91	S02.0, S02.1, S02.3, S02.7–S02.9
Optical injury	S04.02, S04.03, S04.04	S04.0
Intracranial injury	S06	S06.0–S06.9
Crushing injury of the skull or head	S07.1	S07.0, S07.1, S07.8, S07.9
Shaken infant syndrome	T74.4	N/A
Open wound of head	N/A	S01.0–S01.9
Other and unspecified injuries of head	N/A	S09.7-S09.9
Sequelae of injuries of head	N/A	T90.1, T90.2, T90.4, T90.5, T90.8, T90.9
<b>Sport or recreational activity</b>	<b>ICD-10-CM Codes</b>	
Nontraffic accident involving motor-driven snow vehicle	V86 (.52, .62, .92)	

Nontraffic accident involving other off-road motor vehicle	V86 (.53,.55,.56,.59,.63,.65,.66,.69,.93,.95,.96,.99)
Animal rider and animal-drawn vehicle accident	V80 (.01,.11,.31,.41,.51,.61,.71,.81), V80.2, V80.81, V80.918, V80.919
Accident to watercraft (fishing boat, other powered watercraft, sailboat, canoe or kayak, inflatable craft, unpowered watercraft, unspecified watercraft)	V90-V92 (.0,.1,.2,.3,.8) (0.02-0.09), V93.0-V93.8(0.02,0.03,0.04,0.09), V94 (.0-.4,0.8)
Accident from diving or jumping into water	W16 (.0,.3,.4,.5,.6,.7,.8,.9), W22.04
Accidental fall from playground equipment	W09
Fall from (nonmotorized) scooter, roller skates or inline skates, skateboard, skis, or snowboard	V00.14, V00 (.1,.2), V01-V06(.01,.02,.11,.12,.91,.92), V00.31, V00.32
Accident due to changes in air pressure due to diving	W94.21
Accidental drowning and submersion while water-skiing	Y93.17
Accidental drowning and submersion in a swimming pool	W67
Pedal cycling	V10–V19
Accident caused by air gun	W34.010, W34.110
Accident caused by paintball gun (unintentional)	W34.011, W34.111
Striking against or struck by sports equipment	W21
<b>TBI severity</b>	
<b>Mild:</b> "Confused or disoriented state which lasts less than 24 hours; or loss of consciousness for up to 30 minutes; or memory loss lasting less than 24 hours. Excludes penetrating TBI. A CT scan is not indicated for most patients with a Mild TBI. If obtained, it is normal" – AFHSD definition	F07.81, S06.0, S02.110, S02.11(1,2, A, BE, F) S02.113, S02.80-82 (7 <sup>th</sup> character=A or missing)
<b>Moderate:</b> "Confused or disoriented state which lasts more than 24 hours; or loss of consciousness for more than 30 minutes, but less than 24 hours; or memory loss lasting greater than 24 hours but less than seven days; or meets criteria for Mild TBI except an abnormal CT scan is present. Excludes penetrating TBI. A structural brain imaging study may be normal or abnormal." - AFHSD definition	S06.1,.2,.4,.5,.6,.9 (0,1,2,3,4,9), S06.30-.38(0,1,2,3,4,9), S06.89 (0,1,2,3,4,9), S02.0, S02.10 (1,2,9), S02.11 (1,8,9,G,H,C,D), S02.19, S02.91, S07.1 (7 <sup>th</sup> character=A or missing)
<b>Severe:</b> "Confused or disoriented state which lasts more than 24 hours; or loss of consciousness for more than 24 hours; or memory loss for more than seven days. Excludes penetrating TBI. A structural brain imaging study may be normal but usually is abnormal." - AFHSD definition	S04.02, S04.03-.04 (1,2,9), S06.1,.2,.4,.5,.6,.9 (5,6,7,8). S06.31-.38 (5,6,7,8), S06 (.895,.896,.897,.898) (7 <sup>th</sup> character=A or missing)
<b>Penetrating:</b> "A head injury in which the scalp, skull and dura mater (the outer layer of the meninges) are penetrated. Penetrating injuries can be caused by high-velocity projectiles or objects of lower velocity such as knives, or bone fragments from a skull fracture that are driven into the brain."- AFHSD definition	S02.80, S02.81, S02.89, S02.11(1,2, A, BE, F), S02.11 (1,8,9,G,H,C,D), S02.19, S02.91 (7 <sup>th</sup> character=B)
<b>Type of TBI</b>	

Intracranial	S06
Skull fracture	S02.0, S02.1, S02.80, S02.81, S02.82, S02.91

## References

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