

SURVEILLANCE REPORT

Traumatic Brain Injury-related Deaths by Age Group, Sex, and Mechanism of Injury

UNITED STATES 2018 AND 2019



ACKNOWLEDGEMENTS

This surveillance report on fatal traumatic brain injury (TBI) was prepared by staff from the Division of Injury Prevention (DIP), National Center for Injury Prevention and Control (NCIPC), Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, Georgia.

Contributors to this report included

Alexis B. Peterson, PhD¹

Karen E. Thomas, MPH²

Hong Zhou, MS, MPH²

Corresponding Author

Alexis B. Peterson

Apeterson4@cdc.gov

This report describes the incidence of TBI-related deaths obtained from the National Vital Statistics System's 2018 and 2019 multiple-cause-of-death files.

All material appearing in this report is in the public domain and may be reproduced or copied without permission; citation as to source, however, is appreciated.

SUGGESTED CITATION: Centers for Disease Control and Prevention (2022). Surveillance Report of Traumatic Brain Injury-related Deaths by Age Group, Sex, and Mechanism of Injury—United States, 2018 and 2019. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services.

DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

¹Applied Science Branch, DIP, NCIPC, CDC

²Data Analytics Branch, DIP, NCIPC, CDC

OVERVIEW

Traumatic brain injury (TBI) is caused by bump, blow, or jolt to the head or a penetrating head injury that results in the disruption of normal brain function.¹ TBI is a preventable injury. It results in death and disability for thousands of people each year and remains a serious public health concern. TBIs were identified in 25% (N=60,134) of all injury-related deaths that occurred during 2017² in the United States.

This surveillance report describes the national numbers and rates of TBI-related deaths by socio-demographic characteristics during 2018 and 2019. To assess TBI-related deaths by age group, sex, principal mechanism of injury (MOI), and injury intent, we report the average annual numbers and rates during 2018 and 2019. TBI-related deaths were obtained from the National Vital Statistics System (NVSS), which captures data for all deaths registered in the 50 U.S. states and the District of Columbia.³

METHODS

TBI-related deaths were obtained from the 2018 and 2019 NVSS multiple-cause-of-death files. NVSS is a partnership between the National Center for Health Statistics and state/local jurisdictions that results in the compilation of records of all deaths in the United States.³ Deaths were included if the record included an injury-related International Classification of Diseases 10th Revision (ICD-10)⁴ underlying cause of death code (V01–Y36, Y85–Y87, Y89, U01–U03) and a TBI-related ICD-10 code in one of the 20 multiple-cause-of-death fields. The following TBI-related ICD-10 codes correspond to the established TBI death surveillance definition:² S01, S02.0, S02.1, S02.3, S02.7–S02.9, S04.0, S06, S07.0, S07.1, S07.8, S07.9, S09.7–S09.9, T90.1, T90.2, T90.4, T90.5, T90.8, T90.9. The mechanism/intent of injury categories of interest were unintentional motor vehicle traffic crashes, unintentional falls, unintentionally struck by or against an object, other or unspecified unintentional injury, suicide, homicide, and other/unknown for this analysis. The underlying cause of death fields were searched for the codes listed in the table below to identify the cause of injury. These codes are consistent with the ICD-10 external cause of injury matrix.⁵ The public-use multiple-cause-of-death files were used for most of the analysis.⁶ Deaths were obtained from the multiple-cause-of-death files available through CDC WONDER for the analysis stratified by region of decedents' residence.⁷

Mechanism/Intent of Injury	ICD-10 Codes
Unintentional motor vehicle crashes	[V02–V04](.1-.9), V09.2, [V12–V14](.3-.9), V19(.4-.6), [V20–V28](.3-.9), [V29–V79](.4-.9), V80(.3-.5), V81.1, V82.1, [V83–V86](.0-.3), V87(.0-.8), V89.2
Unintentional falls	W00–W19
Unintentional struck by/against	W20–W22, W50–W52
Unintentional, other	All the other codes in the V01–X59, Y85–Y86 ranges
Suicide	U03, X60–X84, Y87.0
Homicide	U01–U02, X85–Y09, Y87.1
Other/unknown	Y10–Y34, Y87.2, Y89.9, Y35–Y36, Y89(.0,.1)

Regional analysis of TBI-related deaths focuses on the [U.S. census region](#) of the decedent's residence.

U.S. Census Region	States Included
Northeast	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania
Midwest	Indiana, Illinois, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota
South	Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas
West	Arizona, Colorado, Idaho, New Mexico, Montana, Utah, Nevada, Wyoming, Alaska, California, Hawaii, Oregon, and Washington

For suicide data, deaths among children <10 years were not presented because determining suicidal intent in younger children is difficult and case counts were <20 indicating unstable rates.⁸ Rates for deaths due to suicide were age-adjusted to the population 10 years and older. Suicide deaths in the birth to 9 years age group were moved to the “other/unknown” cause category so that the sum of causes equals the total number of TBI-related deaths.

Rates were calculated using bridged race population estimates obtained from National Center for Health Statistics (NCHS) as the denominator.⁹ Age-adjusted rates were calculated by the direct method of age adjusting using the 2000 U.S. Census population.¹⁰ While deaths are a complete census of all occurrences, confidence intervals were presented to account for random variation.¹¹ Z-tests or nonoverlapping confidence intervals were used to analyze differences of TBI-related death rates between males and females by mechanism of injury when appropriate.



RESULTS

**Traumatic Brain Injury-related
Deaths by Age Group, Sex,
and Mechanism of Injury**

UNITED STATES 2018 AND 2019



LIST OF TABLES

TABLE 1

Annual number and rate per 100,000 of traumatic brain injury-related deaths by selected socio-demographic characteristics – National Vital Statistics System, United States, 2018 and 2019

TABLE 2

Average annual number and rate per 100,000 of traumatic brain injury-related deaths by age group and mechanism of injury – National Vital Statistics System, United States, 2018 and 2019

TABLE 3

Average annual number and rate per 100,000 of traumatic brain injury-related deaths by sex and mechanism of injury – National Vital Statistics System, United States, 2018 and 2019

TABLE 1 – Annual number and rate per 100,000 of traumatic brain injury-related deaths[†] by selected socio-demographic characteristics – National Vital Statistics System, United States, 2018 and 2019

Socio-Demographic Characteristic		2018 Number	2018 Rate* (95% CI)	2019 Number	2019 Rate* (95% CI)
Age (Years)					
Birth-17		2,493	3.4 (3.3-3.5)	2,476	3.4 (3.3-3.5)
Birth-4		659	3.3 (3.1-3.6)	612	3.1 (2.9-3.4)
5-9		248	1.2 (1.1-1.4)	270	1.3 (1.2-1.5)
10-14		456	2.2 (2.0-2.4)	497	2.4 (2.2-2.6)
15-24		6,688	15.6 (15.2-16.0)	6,417	15.0 (14.7-15.4)
25-34		7,376	16.2 (15.8-16.5)	7,251	15.8 (15.4-16.1)
35-44		6,041	14.7 (14.3-15.0)	6,110	14.7 (14.3-15.0)
45-54		6,780	16.3 (15.9-16.7)	6,536	16.0 (15.6-16.4)
55-64		8,250	19.5 (19.1-20.0)	8,057	19.0 (18.6-19.4)
65-74		7,473	24.5 (24.0-25.1)	7,542	24.0 (23.4-24.5)
75+		16,591	75.7 (74.5-76.8)	17,314	76.7 (75.6-77.8)
Sex					
Male	Crude [§]	44,496	27.7 (27.4-27.9)	44,610	27.6 (27.3-27.9)
	Adjusted [¶]		26.8 (26.6-27.1)		26.6 (26.4-26.9)
Female	Crude [§]	16,069	9.7 (9.5-9.8)	16,001	9.6 (9.5-9.8)
	Adjusted [¶]		8.2 (8.1-8.4)		8.1 (8.0-8.2)
Race/Ethnicity**					
White, Non-Hispanic persons	Crude [§]	45,402	22.6 (22.4-22.8)	45,160	22.5 (22.3-22.7)
	Adjusted [¶]		19.0 (18.8-19.2)		18.7 (18.5-18.9)
Black or African American, Non-Hispanic persons	Crude [§]	6,983	16.3 (15.9-16.7)	7,135	16.5 (16.1-16.9)
	Adjusted [¶]		16.4 (16.0-16.8)		16.6 (16.2-17.0)
Hispanic persons	Crude [§]	5,761	9.7 (9.4-9.9)	5,937	9.8 (9.6-10.1)
	Adjusted [¶]		11.1 (10.8-11.4)		11.3 (11.0-11.6)
American Indian or Alaska Native, Non-Hispanic persons	Crude [§]	656	23.9 (22.0-25.7)	611	22.1 (20.3-23.8)
	Adjusted [¶]		24.5 (22.5-26.4)		23.1 (21.3-25.0)
Asian or Pacific Islander, Non-Hispanic persons	Crude [§]	1,619	8.0 (7.6-8.3)	1,649	7.9 (7.6-8.3)
	Adjusted [¶]		8.2 (7.8-8.6)		8.0 (7.6-8.4)
U.S. Census Region of Decedent's Residence					
Northeast	Crude [§]	8,306	14.8 (14.5-15.1)	8,092	14.5 (14.1-14.8)
	Adjusted [¶]		12.8 (12.5-13.1)		12.3 (12.0-12.6)
Midwest	Crude [§]	13,478	19.8 (19.4-20.1)	13,335	19.5 (19.2-19.8)
	Adjusted [¶]		18.0 (17.7-18.3)		17.7 (17.4-18.0)
South	Crude [§]	25,179	20.2 (20.0-20.5)	25,323	20.2 (19.9-20.4)
	Adjusted [¶]		19.0 (18.8-19.2)		18.9 (18.6-19.1)
West	Crude [§]	13,602	17.5 (17.2-17.8)	13,861	17.7 (17.4-18.0)
	Adjusted [¶]		16.4 (16.2-16.7)		16.5 (16.3-16.8)
Total	Crude [§]	60,565	18.5 (18.4-18.7)	60,611	18.5 (18.3-18.6)
	Adjusted [¶]		17.1 (17.0-17.2)		16.9 (16.8-17.1)

TABLE 1 (cont'd)

Annual number and rate per 100,000 of traumatic brain injury-related deaths[†] by selected socio-demographic characteristics – National Vital Statistics System, United States, 2018 and 2019

Key Findings

- Nationally 60,565 TBI-related deaths occurred during 2018 and 60,611 during 2019.
- Children from birth to 17 years accounted for approximately 4.1% (data not shown) of TBI-related deaths during both 2018 and 2019.
- Rates of TBI-related deaths per 100,000 population were highest among adults aged ≥ 75 years (75.7 in 2018 and 76.7 in 2019), those aged 65-74 years (24.5 in 2018 and 24.0 in 2019), and individuals aged 55-64 years (19.5 in 2018 and 19.0 in 2019).
- The age-adjusted rate of TBI-related deaths per 100,000 population in males (26.8 in 2018 and 26.6 in 2019) was more than three times the rate of females (8.2 in 2018 and 8.1 in 2019).
- During 2018 and 2019, American Indian or Alaska Native, Non-Hispanic persons had the highest average annual age-adjusted rate (24.5 per 100,000 population in 2018 and 23.1 in 2019) of TBI-related deaths when compared to other racial and ethnic groups.
- Age-adjusted rates of TBI-related deaths per 100,000 population were highest among persons residing in the South (19.0 in 2018 and 18.9 in 2019), followed by persons residing in the Midwest (18.0 in 2018 and 17.7 in 2019), West (16.4 in 2018 and 16.5 in 2019), and Northeast (12.8 in 2018 and 12.3 in 2019).

Abbreviations: CI = confidence interval

[§]Deaths with missing age were included.

[†]Deaths with missing age were excluded (3 deaths in 2018 and 5 deaths in 2019). Rates were age-adjusted by the direct method to the 2000 U.S. Census population.

^{**}Deaths in persons with an unknown Hispanic origin were excluded from the distribution by race/ethnicity (144 deaths in 2018 and 119 deaths in 2019).

TABLE 2 – Average annual number and rate per 100,000 of traumatic brain injury-related deaths† by age group and mechanism of injury – United States, 2018 and 2019

AGE GROUP (YRS)	Unintentional Motor Vehicle Traffic Crash		Unintentional Falls [§]		Unintentionally Struck by or Against an Object		Other or Unspecified Unintentional Injury		Suicide [¶]		Homicide		Other ^{**}	
	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)
Birth-17	755	1.0 (1.0-1.1)	37	0.1 (0.0-0.1)	28	0.0 (0.0-0.0)	258	0.4 (0.3-0.4)	¶	¶	662	0.9 (0.9-1.0)	75	0.1 (0.1-0.1)
Birth-4	166	0.8 (0.8-0.9)	17	0.1 (0.1-0.1)	12	0.1 (0.0-0.1)	111	0.6 (0.5-0.6)	¶	¶	292	1.5 (1.4-1.6)	39	0.2 (0.2-0.2)
5-9	135	0.7 (0.6-0.7)	††	††	††	††	37	0.2 (0.1-0.2)	¶	¶	64	0.3 (0.3-0.4)	††	††
10-14	139	0.7 (0.6-0.7)	††	††	††	††	50	0.2 (0.2-0.3)	183	0.9 (0.8-1.0)	85	0.4 (0.3-0.5)	12	0.1 (0.0-0.1)
15-24	1,996	4.7 (4.5-4.8)	88	0.2 (0.2-0.2)	17	0.0 (0.0-0.1)	270	0.6 (0.6-0.7)	2,784	6.5 (6.3-6.7)	1,290	3.0 (2.9-3.1)	108	0.3 (0.2-0.3)
25-34	1,978	4.3 (4.2-4.5)	185	0.4 (0.4-0.4)	39	0.1 (0.1-0.1)	346	0.8 (0.7-0.8)	3,288	7.2 (7.0-7.4)	1,330	2.9 (2.8-3.0)	149	0.3 (0.3-0.4)
35-44	1,390	3.4 (3.2-3.5)	329	0.8 (0.7-0.9)	38	0.1 (0.1-0.1)	334	0.8 (0.7-0.9)	2,933	7.1 (6.9-7.3)	925	2.2 (2.1-2.3)	128	0.3 (0.3-0.3)
45-54	1,396	3.4 (3.3-3.5)	741	1.8 (1.7-1.9)	49	0.1 (0.1-0.1)	482	1.2 (1.1-1.2)	3,219	7.8 (7.6-8.0)	635	1.5 (1.5-1.6)	136	0.3 (0.3-0.4)
55-64	1,370	3.2 (3.1-3.4)	1,706	4.0 (3.9-4.2)	59	0.1 (0.1-0.2)	667	1.6 (1.5-1.7)	3,687	8.7 (8.5-8.9)	529	1.2 (1.2-1.3)	137	0.3 (0.3-0.4)
65-74	884	2.9 (2.7-3.0)	2,945	9.5 (9.3-9.8)	51	0.2 (0.1-0.2)	583	1.9 (1.8-2.0)	2,688	8.7 (8.4-8.9)	283	0.9 (0.8-1.0)	76	0.2 (0.2-0.3)
75+	838	3.8 (3.6-3.9)	12,076	54.3 (53.6-55.0)	50	0.2 (0.2-0.3)	1,043	4.7 (4.5-4.9)	2,705	12.2 (11.8-12.5)	171	0.8 (0.7-0.9)	71	0.3 (0.3-0.4)
Total^{§§}	10,291	3.1 (3.1-3.2)	18,098	5.5 (5.5-5.6)	329	0.1 (0.1-0.1)	3,920	1.2 (1.2-1.2)	21,486	7.5 (7.4 - 7.5)	5,603	1.7 (1.7-1.7)	863	0.3 (0.3-0.3)
Age Adjusted Rate^{¶¶}		3.1 (3.0-3.1)		4.6 (4.5-4.6)		0.1 (0.1-0.1)		1.1 (1.1-1.1)		7.2 (7.2-7.3)		1.7 (1.7-1.8)		0.3 (0.2-0.3)

Abbreviation: CI = confidence interval

¶Age <10 years were excluded, because determining intent in younger children can be difficult. Rates for TBI-related deaths due to suicide were age-adjusted to the population 10 years and older.

**Includes undetermined intent, legal intervention, war, and suicide for age <10 years.

††Suppressed for counts <10.

§§Deaths with missing age were included.

¶¶Deaths with missing age were excluded. Rates were age-adjusted to the 2000 U.S. Census population.

TABLE 2 (cont'd) – Average annual number and rate per 100,000 of traumatic brain injury-related deaths[†] by age group and mechanism of injury – United States, 2018 and 2019

Key Findings:

- Among children from birth to 17 years (analyzed separately) the most common mechanisms of injury for TBI-related deaths were motor vehicle crashes (average annual rate of 1.0 per 100,000) and homicide (average annual rate of 0.9 per 100,000).
- Suicide accounted for 35.5% (data not shown) of TBI related deaths and an average annual age-adjusted rate of 7.2 per 100,000 population.
 - » The average annual rates attributable to suicide were highest among older adults aged ≥ 75 years (12.2 per 100,000 population).
 - » Outside of the 10-14 years age group, average annual rates attributable to suicide increased by age group and ranged from 6.5 to 8.7 per 100,000 population.
- Unintentional falls accounted for 29.9% (data not shown) of all TBI-related deaths, with an average annual age-adjusted rate of 4.6 per 100,000 population.
 - » Older adults aged ≥ 75 years had the highest average annual rate (54.3 per 100,000 population) of TBI-related deaths attributable to unintentional falls. This rate was over five times higher than that among those aged 65-74 years (average annual rate of 9.5 per 100,000 population).
- Unintentional motor vehicle crashes accounted for approximately 17% (data not shown) of all TBI-related deaths with an average annual age-adjusted rate of 3.1 per 100,000 population.
 - » Average annual rates of TBI-related deaths attributable to unintentional motor vehicle crashes were highest among individuals aged 15–24 years (average annual rate of 4.7 per 100,000 population) and 25–34 years (average annual rate of 4.3 per 100,000).

TABLE 3 – Average annual number and rate per 100,000* of traumatic brain injury-related deaths† by sex and mechanism of injury – United States, 2018 and 2019

SEX		Unintentional Motor Vehicle Traffic Crashes		Unintentional Falls§		Unintentionally Struck by or Against an Object		Other or Unspecified Unintentional Injury		Suicide¶		Homicide		Other**	
		NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)	NO.	RATE (95% CI)
MALE	Crude§§	7,497	4.6 (4.6-4.7)	10,546	6.5 (6.5-6.6)	275	0.2 (0.2-0.2)	2,850	1.8 (1.7-1.8)	18,684	13.3 (13.1 - 13.4)	4,042	2.5 (2.5-2.6)	660	0.4 (0.4-0.4)
	Age Adjusted Rate¶¶		4.6 (4.5-4.6)		6.3 (6.2-6.4)		0.2 (0.1-0.2)		1.7 (1.6-1.7)		13.0 (12.8-13.1)		2.5 (2.5-2.6)		0.4 (0.4-0.4)
FEMALE	Crude§§	2,794	1.7 (1.6-1.7)	7,552	4.5 (4.5-4.6)	54	0.0 (0.0-0.0)	1,070	0.6 (0.6-0.7)	2,802	1.9 (1.9 - 2.0)	1,561	0.9 (0.9-1.0)	203	0.1 (0.1-0.1)
	Age Adjusted Rate¶¶		1.7 (1.6-1.7)		3.2 (3.2-3.3)		0.0 (0.0-0.0)		0.5 (0.5-0.6)		1.9 (1.8-1.9)		1.0 (0.9-1.0)		0.1 (0.1-0.1)

Key Findings:

- Among principal mechanisms of injury (MOIs) examined that contributed to TBI-related deaths, males had higher average annual age-adjusted rates for all MOIs when compared with females:
 - » Unintentional motor vehicle crashes (an average rate of 4.6 per 100,000 population compared to 1.7 per 100,000 population)
 - » Unintentional falls (an average rate of 6.3 compared to 3.2 per 100,000 population)
 - » Suicide (an average rate of 13.0 compared to 1.9 per 100,000 population); and
 - » Homicide (an average rate of 2.5 compared to 1.0 per 100,000 population).

Abbreviations: CI = confidence interval

*P-value <0.05 for the statistical comparison between male and female for all mechanisms of injury.

†Age <10 years were excluded, because determining intent in younger children can be difficult. Rates for TBI-related deaths due to suicide were age-adjusted to the population 10 years and older.

**Includes undetermined intent, legal intervention, war, and suicide for age <10 years.

§§Deaths with missing age were included.

¶¶Deaths with missing age were excluded. Rates were age-adjusted to the 2000 U.S. Census population.

Limitations:

- In cases of multiple injuries, non-TBI diagnoses might have contributed to the deaths included in this analysis.
- Misclassification of race and ethnicity on death certificates occurs, particularly for American Indian/Alaska Native, Asian/Pacific Islander, and Hispanic populations. This could lead to an underestimation of deaths among these groups.^{12,13}
- Misclassification or incomplete reporting of the cause of death on death certificates could lead to overestimation or underestimation of TBI-related deaths.
- The specificity of conclusions that can be drawn regarding primary causes of TBI-related deaths is limited due to the broad categorization of the principal mechanisms of injury.

Conclusions

- During 2018 and 2019, 60,565 and 60,611 TBI-related deaths occurred in the United States, respectively. This is fewer than the estimated 61,131 TBI-related deaths that occurred in the United States in 2017.²
- Suicide was a leading cause of TBI-related deaths and accounted for 35.5% of TBI-related deaths.
 - » In 2019, suicide was the 10th leading cause of death in the United States.¹⁴ TBI-related death rates attributable to suicide were highest among people ≥ 75 years (12.2 per 100,000). Among persons 15 to 74 years of age, TBI-related suicide death rates ranged from 6.5 to 8.7 per 100,000. These findings suggest suicide-related TBIs are observed across a wide age range and support the tailored need for a comprehensive public health approach to suicide prevention. [CDC's Preventing Suicide: A Technical Package of Policy, Programs, and Practices](#) provides the best available evidence for preventing suicide. The strategies represented in the package include a focus on preventing the risk of suicide, as well as approaches to lessen the immediate and long-term harms of suicidal behavior for individuals, families, communities, and society.
 - » Although this analysis focuses on both open and closed head injuries, epidemiological research has shown that firearm suicide accounted for nearly half (48.3%) of the increase in the absolute incidence of TBI-related death when combining all injury categories showing absolute increases during a 10-year study period (2008 to 2017).¹⁵ Furthermore, rates of TBI-related firearm suicide increased among both males and females in the study.
- Unintentional falls accounted for approximately 30% of TBI-related deaths. The oldest age group (≥ 75 years) had the highest average annual rate (54.3 per 100,000) and accounted for two-thirds of TBI-related deaths attributable to unintentional falls.

- » Health care providers can play an important role in educating patients about falls and TBIs and when appropriate, create/update personalized fall prevention plans during annual wellness visits. CDC's [Stopping Elderly Accidents, Deaths, & Injuries \(STEADI\)](#) initiative can aid health care providers in screening older patients for fall risk, assessing modifiable risk factors, and encouraging participation in evidence-based fall prevention strategies.
- Males and American Indian or Alaska Native (AI/AN) Non-Hispanic persons displayed high rates of TBI-related death.
 - » This finding corroborated a 2000-2017 epidemiological study examining TBI-related death rates by sex and race/ethnicity that revealed motor vehicle crashes accounted for the highest rate of death among males and persons who were AI/AN Non-Hispanic than among all other groups across all years.¹⁶ Expanded use of evidence-based strategies¹⁷ for reducing the likelihood of motor vehicle crashes and related injury if a crash occurs — such as primary seat belt laws covering occupants in all seats, child restraint laws with booster seat provisions for children until at least age 9, car seat distribution plus education program, and universal motorcycle helmet laws — can reduce injuries.
 - » Motor vehicle crashes remain a significant contributor to TBI-related deaths among males and AI/AN Non-Hispanic persons. Impairment caused by alcohol and/or narcotics are known risk factors for motor vehicle crashes. In 2019, when compared to all drivers in fatal crashes, there were 4 male alcohol-impaired drivers for every female alcohol-impaired driver.¹⁸ Rates of alcohol-impaired driving deaths are 2 to 17 times higher among AI/AN Non-Hispanic persons when compared to all racial and ethnic groups.¹⁹ Effective measures for preventing deaths and injuries from impaired driving include— actively enforcing existing 0.08% blood alcohol content laws, minimum legal drinking age laws, zero tolerance laws for drivers younger than 21 years, using sobriety checkpoints, and requiring ignition interlocks for all offenders convicted of alcohol-impaired driving.¹⁷ For tribal communities, The CDC [Tribal Motor Vehicle Injury Prevention, Best Practices Guide](#) outlines effective evidence-based strategies to reduce alcohol-impaired driving (e.g., enforcing legal drinking limits and use of ignition interlocks for offenders).
- Persons residing in the South had the highest annual rates of TBI-related death compared to residents of other U.S. Census regions.
 - » This finding corroborated a 2016-2018 regional analysis of TBI-related deaths that found rates were highest in the South and the level of rurality might contribute to the incidence of this health event in states with higher rates.²⁰ Previous epidemiological research shows residents in rural areas experience higher TBI incidence²¹ and might encounter barriers to accessing life-saving emergency medical care (e.g., Level 1 trauma centers)²² and specialized TBI care.²³
 - » A recent 2016 to 2018 epidemiological study identified suicide as the leading cause of TBI-related death in most states (including states in the South). However, some southern jurisdictions (e.g., the District of Columbia, Louisiana, and South Carolina) experienced rates of TBI-related deaths due to homicide that were nearly double those in many states in the Northeast.¹⁹

REFERENCES

1. <https://www.cdc.gov/traumaticbraininjury/index.html>. Accessed July 15, 2021.
2. Centers for Disease Control and Prevention (CDC). (2021). Surveillance Report of Traumatic Brain Injury-related Hospitalizations and Deaths by Age Group, Sex, and Mechanism of Injury—United States, 2016 and 2017. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. Available from: <https://www.cdc.gov/traumaticbraininjury/pdf/TBI-surveillance-report-2016-2017-508.pdf>
3. Centers for Disease Control and Prevention (CDC). (2021). National Center for Health Statistics. About the National Vital Statistics System. Available from: https://www.cdc.gov/nchs/nvss/about_nvss.htm.
4. Centers for Medicare & Medicaid Services. ICD–10. Baltimore, MD. Available from: <https://www.cms.gov/Medicare/Coding/ICD10>
5. Centers for Disease Control and Prevention (CDC). National Center for Health Statistics. ICD–10: External cause-of-injury mortality matrix [online]. Available from: https://www.cdc.gov/nchs/injury/injury_tools.htm.
6. Centers for Disease Control and Prevention (CDC). National Center for Health Statistics. National Vital Statistics System. Mortality Multiple Cause-of-Death Public Use Data File Documentation. Available from: https://www.cdc.gov/nchs/nvss/mortality_public_use_data.htm
7. Centers for Disease Control and Prevention (CDC) WONDER. Multiple Cause of Death Data. Available from: <https://wonder.cdc.gov/mcd.html>
8. Hawton K, Saunders EAK, O'Connor C. (2012). Self-harm and suicide in adolescents. *The Lancet*, 379 (9834), 2373-2382. [https://doi.org/10.1016/S0140-6736\(12\)60322-5](https://doi.org/10.1016/S0140-6736(12)60322-5)
9. Centers for Disease Control and Prevention (CDC). National Center for Health Statistics. (2020). Bridged-race population estimates—data files and documentation. Retrieved from https://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm
10. Klein RJ, Schoenborn CA. (2001). Age adjustment using the 2000 projected U.S. population. *Healthy People Statistical Notes*, no. 20. Hyattsville, Maryland: National Center for Health Statistics. <https://www.cdc.gov/nchs/data/statnt/statnt20.pdf>
11. Kochanek KD, Murphy SL, Xu JQ, Arias E. (2019). Deaths: Final data for 2017. *National Vital Statistics Reports*; vol 68 no 9. Hyattsville, MD: National Center for Health Statistics. https://www.cdc.gov/nchs/data/nvsr/nvsr68/nvsr68_09-508.pdf
12. Arias E, Heron M, Hakes J. (2016). National Center for Health Statistics; US Census Bureau. The validity of race and Hispanic-origin reporting on death certificates in the United States: an update. *Vital Health Stat 2*;2:1–21. Available from: https://www.cdc.gov/nchs/data/series/sr_02/sr02_172.pdf

13. Arias E, Xu JQ, Curtin S, Bastian B, TejadaVera B. Mortality profile of the non-Hispanic American Indian or Alaska Native population, 2019. National Vital Statistics Reports; vol 70 no 12. Hyattsville, MD: National Center for Health Statistics. 2021. DOI: <https://dx.doi.org/10.15620/cdc:110370>
14. Stone DM, Simon TR, Fowler KA, et al. (2018). Vital Signs: Trends in State Suicide Rates — United States, 1999–2016 and Circumstances Contributing to Suicide — 27 States. Morb Mortal Wkly Rep; 67:617–624. DOI: <http://dx.doi.org/10.15585/mmwr.mm6722a1>
15. Miller G, Kegler S, Stone D. (2020). Traumatic Brain Injury-Related Deaths From Firearm Suicide: United States, 2008-2017. Am J Public Health; 110(6):897-899. doi: 10.2105/AJPH.2020.305622. Epub 2020 Apr 16. PMID: 32298184; PMCID: PMC7204476.
16. Daugherty J, Waltzman D, Sarmiento K, Xu L. (2019). Traumatic Brain Injury–Related Deaths by Race/Ethnicity, Sex, Intent, and Mechanism of Injury — United States, 2000–2017. Morb Mortal Wkly Rep;68:1050–1056. DOI: <http://dx.doi.org/10.15585/mmwr.mm6846a2>
17. The Guide to Community Preventive Services (The Community Guide), Motor Vehicle-Related Injury Prevention. <http://www.thecommunityguide.org/mvoi>. Accessed 12/29/2021.
18. National Center for Statistics and Analysis. (2021). Alcohol-impaired driving: 2019 data Traffic Safety Facts. Report No. DOT HS 813 120. National Highway Traffic Safety Administration.
19. Centers for Disease Control and Prevention. National Center for Injury Prevention and Control. Tribal Road Safety: Get the Facts. <https://www.cdc.gov/transportationsafety/native/factsheet.html> Accessed 12/29/2021.
20. Daugherty J, Zhou H, Sarmiento K, Waltzman D. (2021). Differences in State Traumatic Brain Injury–Related Deaths, by Principal Mechanism of Injury, Intent, and Percentage of Population Living in Rural Areas — United States, 2016–2018. Morb Mortal Wkly Rep;70:1447–1452. DOI: <http://dx.doi.org/10.15585/mmwr.mm7041a3>
21. Womack L, Daugherty J, Sarmiento K, et al. (2020). Urban–rural traumatic brain injury mortality disparities by age and mechanism of injury. Injury Prevention Oral Presentations (Rurality and Injury);26:A20-A21.
22. American Trauma Society. Find your local trauma center—courtesy of the 2019 ATS-TIEP. Falls Church, VA: American Trauma Society; 2020. [Find Your Local Trauma Center - American Trauma Society \(amtrauma.org\)](http://amtrauma.org)
23. Yue JK, Upadhyayula PS, Avalos LN, Cage TA. (2020). Pediatric traumatic brain injury in the United States: rural-urban disparities and considerations. Brain Sci;10:135. DOI: <https://doi.org/10.3390/brainsci10030135>