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Disparities in traumatic brain injury-related deaths—United States, 2020

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Abstract

Introduction: Traumatic brain injury (TBI) affects how the brain functions and remains a prominent cause of death in the United States. Although preventable, anyone can experience a TBI and epidemiological research suggests some groups have worse health outcomes following the injury.

Methods: We analyzed 2020 multiple-cause-of-death data from the National Vital Statistics System to describe TBI mortality by geography, sociodemographic characteristics, mechanism of injury (MOI), and injury intent. Deaths were included if they listed an injury International Classification of Diseases, Tenth Revision (ICD-10) underlying cause of death code and a TBI-related ICD-10 code in one of the multiple-cause-of-death fields.

Results: During 2020, 64,362 TBI-related deaths occurred and age-adjusted rates, per 100,000 population, were highest among persons residing in the South (20.2). Older adults (> 75) displayed the highest number and rate of TBI-related deaths compared with other age groups and unintentional falls and suicide were the leading external causes among this older age group. The age-adjusted rate of TBI-related deaths in males was more than three times the rate of females (28.3 versus 8.4, respectively); further, males displayed higher numbers and age-adjusted rates compared with females for all the principal MOIs that contributed to a TBI-related death. American Indian or Alaska Native, Non-Hispanic (AI/AN) persons had the highest age-adjusted

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Disclaimer

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

IRB Statement

The Centers for Disease Control and Prevention (CDC) reviewed this activity which was deemed not to be research; it was conducted consistent with applicable federal law and CDC policy (i.e., 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.).

Conflict of Interest

None.

The Journal of Safety Research has partnered with the Office of the Associate Director for Science, Division of Injury Prevention, National Center for Injury Prevention and Control at the CDC in Atlanta, Georgia, USA, to briefly report on some of the latest findings in the research community. This report is the 72nd in a series of “Special Report from the CDC” articles on injury prevention.

rate (29.0) of TBI-related deaths when compared with other racial and ethnic groups. Suicide was the leading external cause of injury contributing to a TBI-related death among AI/AN persons.

Practical application: Prevention efforts targeting older adult falls and suicide are warranted to reduce disparities in TBI mortality among older adults and AI/AN persons. Effective strategies are described in CDC's Stopping Elderly Accidents, Deaths, & Injuries (STEADI) initiative to reduce older adult falls and CDC's Preventing Suicide: A Technical Package of Policy, Programs, and Practices for the best available evidence in suicide prevention.

Keywords

Traumatic brain injury; Fatal injury; Health disparities; Surveillance; ICD-10

1. Introduction

Although preventable, traumatic brain injury (TBI) has contributed to the deaths of more than one million Americans during the last 20 years (Daugherty, Waltzman, Sarmiento, & Xu, 2019). TBI is caused by a bump, blow, or jolt to the head or penetrating head injury and results in the disruption of normal brain function (Centers for Disease Control and Prevention [CDC], 2022). A TBI can be unintentional, self-inflicted, or result from an assault. Anyone is at risk for sustaining a TBI; however, epidemiological research suggests that not all persons who sustain one are affected equally and that some groups experience worse outcomes, such as death, following the injury (Daugherty et al., 2019; CDC, 2022; CDC, 2021; CDC, 2019). Age and sex differences in TBI-related deaths are well documented in the United States, with older adults aged 75+ years having the highest rates when compared with all other age groups. In addition, males have higher age-adjusted TBI death rates than females (CDC, 2022; CDC, 2019; Daugherty et al., 2019). Differences in fatal outcomes of TBI by U.S. geographic location are also well described, with people residing in rural areas displaying higher rates compared to those living in urban areas (Daugherty, Sarmiento, Waltzman, & Xu, 2022; Daugherty, Zhou, Sarmiento, & Waltzman, 2021). An examination of TBI-related deaths by race and ethnicity revealed higher annual age-adjusted rates among American Indian/Alaska Native (AI/AN), non-Hispanic persons when compared to other racial and ethnic groups over an 18-year study period (2000–2017; Daugherty et al., 2019). In order to reduce disparities in TBI-related deaths among population subgroups (e.g., age, sex, race and ethnicity, geographical location) it is important to examine epidemiological data describing differences in injury intent and mechanisms of injury (MOI) and to incorporate this information into the development of culturally-responsive prevention strategies.

The leading causes of TBI-related deaths vary by population subgroup. In the United States, TBI-related deaths are most frequently caused by suicide (primarily driven by the underlying MOI of firearms), unintentional falls, and motor vehicle crashes (CDC, 2022; CDC, 2021; Daugherty et al., 2019). However, the leading MOIs of TBI-related deaths differ when epidemiological studies are stratified by age or race and ethnicity. During 2018 and 2019, the leading MOI of TBI-related deaths was unintentional falls among older U.S. adults aged 75+ while motor vehicle crashes and homicide contributed to most TBI-related deaths among children aged birth to 17 years (CDC, 2022). A recent CDC analysis

of death data from the National Vital Statistics System (NVSS) revealed that intentional injuries (i.e., suicide and homicide) contributed to higher rates of TBI-related deaths among White, non-Hispanic persons and Black, non-Hispanic persons, while unintentional injuries (e.g., motor vehicle crashes, falls) contributed to higher rates of TBI-related deaths among AI/AN, non-Hispanic persons and Hispanic persons during 2015 to 2017 (Daugherty et al., 2019). Understanding differences in the leading MOIs contributing to TBI-related deaths is paramount for developing prevention activities that target those at greatest risk of sustaining this injury. This epidemiological report describes health disparities in TBI-related deaths by geography, sociodemographic characteristics, MOI, and injury intent utilizing the most recent NVSS data available. We analyzed 2020 multiple-cause-of-death data from the NVSS. Public health officials may use the findings from this analysis to identify priority areas, such as suicide and unintentional falls, for TBI prevention programs aimed at populations disproportionately affected.

2. Methods

We examined TBI-related deaths using the 2020 NVSS multiple-cause-of-death files. NVSS is a partnership between the National Center for Health Statistics (NCHS) and state and local jurisdictions that results in the compilation of records of all deaths in the United States (NCHS, 2016a). Deaths were included if they had an underlying cause of death code of an injury (ICD-10 codes: V01–Y36, Y85–Y87, Y89, U01–U03, World Health Organization, 2022), 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 (CDC, 2019): 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. For this analysis, the injury mechanism/intent categories of interest were motor vehicle traffic crashes, unintentional falls, unintentionally struck by or against an object, other or unspecified unintentional injury, all mechanisms of suicide (e.g., firearm, drowning, poisoning), all mechanisms of homicide, and other, which includes TBIs of undetermined intent and those caused by legal intervention or war. To identify the cause of injury, codes listed in Appendix A were searched for in the underlying cause of death field. These codes are consistent with the ICD-10 external cause of injury matrix (NCHS, 2021a). The public use multiple-cause-of-death file was used for most of this study (NCHS, 2022a). For the analysis stratified by region of decedents' residence, deaths were obtained from the multiple-cause-of-death files available through CDC WONDER (NCHS, 2022b). Regions include the Northeast, Midwest, South, and West as defined by the U.S. Census (United States Census Bureau, 2021).

Suicides among children < 10 years were not presented because it is unclear whether children < 10 are able to form suicidal intent (Crepeau-Hobson, 2010). Rates for suicides were age-adjusted to the 10 years and older population. Any suicides in the 0 to 9 years age group were moved to the "other" cause category so that the sum of causes equaled the total number of TBI-related deaths.

Rates were calculated using bridged race population estimates obtained from NCHS as the denominator (NCHS, 2021b). Age-adjusted rates were calculated by the direct method of

age adjusting using the 2000 standard U.S. population (Klein & Schoenborn, 2001). While deaths are a complete census of all occurrences, confidence intervals were presented to account for random variation (Kochanek, Murphy, Xu, & Arias, 2019).

3. Results

During 2020, TBI contributed to 64,362 deaths, equating to approximately 176 TBI-related deaths each day in the United States (Table 1).

Among TBI-related deaths with known age, children from birth to 17 years accounted for 4.3 % (data not shown) of decedents. Older U.S. adults aged 75 years (76.8 per 100,000 population), 65–74 years (23.7), and those aged 55–64 years (19.3) had the highest rates of TBI-related deaths per 100,000 population. Males displayed an age-adjusted rate of TBI-related deaths that was more than three times that of females (28.3 versus 8.4 per 100,000 population, respectively). When compared to other racial and ethnic groups, AI/AN, non-Hispanic persons had the highest age-adjusted rate (29.0 per 100,000 population) while Asian/Pacific Islander, non-Hispanic persons had the lowest rates (7.7) of TBI-related deaths. Age-adjusted rates of TBI-related deaths were highest among persons residing in the South (20.2 per 100,000 population), followed by persons residing in the Midwest (19.2), West (17.0), and Northeast (12.7).

During 2020, more than half of TBI-related deaths (54 %, N = 34,715) were categorized as unintentional injuries (i.e., motor vehicle crashes, falls, struck by or against an object, other unintentional injury with mechanism unspecified), while 45 % (N = 28,649) were categorized as intentional injuries (i.e., all mechanisms of homicide and suicide). Suicide, unintentional falls, and motor vehicle crashes contributed to the highest age-adjusted rates of TBI-related deaths (7.3 per 100,000 population, 4.8 and 3.2, respectively) (Table 2).

The data show variation by age group when stratifying TBI-related deaths by injury intent and MOI. Motor vehicle crashes and homicides contributed to the highest rates of TBI-related deaths among children (analyzed separately) aged birth to 17 years (1.1 and 1.1 per 100,000 population, respectively; data not shown). Among older adults aged 75 years, unintentional TBIs, combined across MOI, contributed to rates of TBI-related deaths that were more than four times higher than those due to intentional injuries (63.3 and 13.3, respectively). This difference is particularly driven by the rate of unintentional falls (55.1) among older adults. Rates of TBI-related deaths attributable to motor vehicle crashes were the greatest cause of TBI among those aged 15–24 years (4.8) and 25–34 years (4.7).

Intentional injuries contributed to a higher age-adjusted rate of TBI-related deaths among males than unintentional injuries (14.5 per 100,000 compared with 13.4) (Table 3). This difference is particularly driven by males' rate of suicide (13.1). In contrast, among females, unintentional TBIs contributed to a higher age-adjusted rate of TBI-related deaths than intentional injuries (5.6 per 100,000 compared with 2.7). This difference is particularly driven by the rate of unintentional falls (3.4) among females. Males had higher total numbers and age-adjusted rates of all the examined causes that contributed to TBI-related

deaths (e.g., motor vehicle crashes, falls, being struck by or against an object, suicide, homicide) compared with females (Table 3).

The leading cause of TBI-related death, with respect to intent and MOI, varied by race and ethnicity (Table 4). Among Black, non-Hispanic persons, intentional injuries contributed to a higher age-adjusted rate of TBI-related deaths than unintentional injuries, (11.4 compared with 8.4 per 100,000 population); this difference was driven by the age-adjusted rate of homicide (7.6). In contrast, unintentional injuries contributed to a higher age-adjusted rate of TBI-related deaths than intentional injuries among White, non-Hispanic (9.8 compared with 9.1 per 100,000 population), Hispanic all races (7.4 compared with 4.5), and Asian/Pacific Islander, non-Hispanic (5.3 compared with 2.2) persons. However, suicide was the leading cause of TBI-related deaths among White, non-Hispanic persons. Unintentional falls were the leading MOI of TBI-related deaths among Hispanic (3.7 per 100,000 population, age-adjusted rate) and Asian/Pacific Islander, non-Hispanic (3.7) persons. AI/AN, non-Hispanic persons had age-adjusted rates with overlapping confidence intervals for unintentional TBIs and intentional TBIs (14.4 and 13.1, respectively). Suicide was the leading cause of TBI-related deaths among this group.

4. Discussion

More than 64,000 TBI-related deaths occurred in the U.S. population in 2020, with rates varying by age group, sex, and race and ethnicity. The age-adjusted rate of TBI-related deaths per 100,000 population in 2020 (18.0 per 100,000, age-adjusted) represents a 6.5% increase from 2019 (16.9 age-adjusted rate; CDC, 2022). The highest rates occurred among older adults aged 75 years, males, and among AI/AN, non-Hispanic persons which is consistent with previous CDC surveillance reports (CDC, 2022; CDC, 2021) and epidemiological research (Daugherty et al., 2019). Children aged birth to 17 years accounted for less than 5% of all TBI-related deaths with known age, a finding consistent with previous CDC surveillance reports (CDC, 2022; CDC, 2021). Suicide and unintentional falls were the most common causes of TBI-related death in 2020. Further examination of TBI-related deaths by injury intent and within each MOI also revealed differences by age group, sex, and race and ethnicity.

Older age is a known risk factor for TBI (Thompson, McCormick, & Kagan, 2006) and U.S. trauma centers are seeing a greater proportion of elderly patients with more comorbid diseases as the population ages (Dutton et al., 2010). Pre-existing comorbidities (e.g., diabetes mellitus, hypertension, coronary heart disease) at the time of the TBI are associated with reduced functional independence 2 to 4 years post-injury (Lecours, Sirois, Ouellet, Boivin, & Simard, 2012) and increased 1-year mortality (Selassie, McCarthy, Ferguson, Tian, & Langlois, 2005) among this older age group (Gardner, Dams-O'Connor, Morrissey, & Manley, 2018). Further, anticoagulant therapies (e.g., non-vitamin K oral anticoagulants, warfarin [Coumadin]) and aspirin are often routinely used to manage chronic conditions among older adults. In this older population, anticoagulant use can result in an increased likelihood of intracranial hemorrhage (Maegele et al., 2017) and further complications from TBIs. Unintentional falls were the most common MOI for TBI-related deaths among those aged 75 years. This MOI is most common among older adults due to functional

declines including vision, muscle strength, and balance. This is consistent with older age being a known major risk factor for falls (Moreland, Kakara, and Henry, 2020; Jin, 2018; Ambrose, Cruz, & Paul, 2015). CDC's Stopping Elderly Accidents, Deaths, & Injuries (STEADI) can help health care providers incorporate fall prevention for older patients into their routine clinical practice. The STEADI initiative has three core components of screening older patients for fall risk, assessing modifiable risk factors, and intervening to reduce risk using effective clinical and community strategies (National Center for Injury Prevention and Control (NCIPC), 2019). Effective clinical and community strategies include reviewing and managing patient medications, physical therapy, and exercises that improve gait, balance, and strength (e.g., tai chi) (Stevens & Lee, 2018). The public can actively prevent falls by screening themselves or their loved ones for fall risk using the Falls Free Checkup¹; talking to their health care provider about their, or their loved one's, fall risk; having an annual eye exam; performing balance and strength exercises; and working with an occupational therapist to modify the home to increase safety (e.g., remove tripping hazards).

Our study is congruent with previous epidemiological data that has consistently found higher counts and age-adjusted rates of TBI-related deaths among males compared with females for overall incidence and across all intentional and unintentional MOI. TBI research suggests males are more likely than females in the general adult population to sustain (Faul & Coronado, 2015) and die from a TBI (Hong et al., 2022). Systematic reviews of epidemiological research report an increased propensity to sustain more severe TBIs among males when compared with females (Chang, Guerriero, & Colantonio, 2015; Toccalino, Colantonio, & Chan, 2021), which may contribute to the higher age-adjusted rates of TBI-related deaths across all intentional and unintentional MOI examined in this study. For example, the higher age-adjusted rate of TBI-related deaths due to unintentional falls among males might be related to circumstances of the fall, such as a larger proportion of males falling from heights (e.g., ladders) (Timsina et al., 2017), which increases the likelihood of moderate to severe injuries, including TBI.

In the United States, racial and ethnic differences persist with respect to injury intent and MOI of TBI-related deaths, and our findings corroborate a recent epidemiological analysis of TBI-related deaths over an 18-year (2000 to 2017) study period (Daugherty et al., 2019). Intentional TBIs attributed to homicide disproportionately affected Black, non-Hispanic persons compared with all other racial/ethnic groups. The underlying reasons for this disparity are complex and likely include the person's opportunities for education and their economic and household stability, as well as physical characteristics of their built environment (Schleimer et al., 2022). Further, structural racism and longstanding systemic inequities among various and racial and ethnic groups, have resulted in limited economic, educational, and housing opportunities associated with inequities in risk for violence (Bailey, Krieger, Agenor, Graves, Linos, & Basset, 2017). Implementing evidence-based strategies for preventing violence before it begins can help decrease rates of TBI-related homicides. CDC's NCIPC has created resources² that outline the best available evidence-

¹Available here: Falls Free CheckUp (<https://www.ncoa.org>).

²Technical packages for violence prevention are available from: Technical Packages for Violence Prevention [Violence Prevention] Injury Center|CDC.

based strategies to be used in combination with a multilevel, multisector effort to prevent multiple types of violence (i.e., adverse childhood experiences, child abuse and neglect, youth violence, intimate partner violence and sexual violence).

Among White, non-Hispanic and AI/AN, non-Hispanic persons, suicide contributed to the highest age-adjusted rates of TBI-related death and is consistent with previous data documenting its increasing prevalence among these populations when compared with other racial/ethnic groups (Ivey-Stephenson, Crosby, Jack, Haileyesus, Kresnow-Sedacca, 2017). The underlying reasons for this disparity are complex and can include alcohol and/or substance use dependence, mental and physical health problems, poverty, and taboos around seeking mental health support (systematic review by Odafe, Talavera, Soumia, Hong, & Walker, 2016). CDC encourages using the best available evidence-based strategies, such as identifying and supporting persons at risk of suicide, creating protective environments (e.g., reducing access to lethal means), teaching coping and problem-solving skills, and strengthening access and delivery of suicide care (Stone et al., 2017). CDC is currently working with funded partners, Southern Plains Tribal Health Board and Wabanaki Public Health and Wellness, to increase capacity to adapt, implement, and evaluate ongoing suicide prevention programs with the best available evidence (Stone et al., 2017). Understanding racial and ethnic differences in injury intent and MOI in TBI mortality is a first step in developing targeted prevention strategies for groups at high risk for this injury. Further, health care workers should recognize that racial and ethnic disparities persist within the full spectrum of the TBI experience starting with social and environmental factors and conditions leading to the injury, acute diagnosis and care, and rehabilitation through long-term health outcomes (Saadi, Bannon, Watson, & Vranceanu, 2022) and across health care more generally (NCHS, 2016b).

This study is subject to several limitations. First, in cases of multiple injuries, non-TBI diagnoses might have contributed to the deaths included in this analysis. Second, incomplete reporting or misclassification of the cause of death field on the death certificate could lead to underestimation or overestimation of TBI-related deaths. Third, the specificity of conclusions drawn regarding the leading contributors of TBI-related deaths is limited due to the broad categorization of the principal MOI. Fourth, race and Hispanic origin on death certificates can be misclassified, particularly for AI/AN, Asian/PI, and Hispanic populations (Arias, Heron, & Hakes, 2016; Arias, Xu, Curtin, Bastian, & Tejada, 2021). This can lead to an underestimation of TBI-related deaths among these groups.

Understanding the leading intentional and unintentional MOI of TBI-related deaths and identifying groups at increased risk is important in targeted prevention of this injury. Health care providers can play a critical role by assessing patients at increased risk (e.g., persons at risk for suicide or unintentional falls) and by providing evidence-based and culturally-responsive interventions or referrals when warranted.

Biography

Alexis Peterson, PhD, is a health scientist on the Traumatic Brain Injury (TBI) Team in the Division of Injury Prevention (DIP) at CDC's Injury Center. As a health scientist, her

role on the TBI team is to promote the accurate reporting of TBI incidence and burden to inform the general public and stakeholders. She is also responsible for the development of projects and scientific manuscripts addressing multiple aspects of TBI, including sports- and recreation-related TBI.

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APPENDIX

Appendix

Appendix A

Category of ICD-10 codes for mechanism of injury and/or injury intent.

Mechanism and/or intent	ICD-10 codes
Unintentional motor vehicle crashes	[V02-V04](0.1,0.9), V09.2, [V12-V14](0.3–0.9), V19 (0.4–0.6), [V20-V28](0.3–0.9), [V29-V79](0.4–0.9), V80 (0.3–0.5), V81.1, V82.1, [V83-V86](0.0–0.3), V87 (0.0–0.8), V89.2
Unintentional falls	W00-W19
Unintentionally struck by/against	W20-W22, W50-W52
Unintentional, other	All other codes in the V01-X59, Y85-Y86 ranges
Suicide	U03, X60-X84, Y87.0
Homicide	U01-U02, X85-Y09, Y87.1
Other (undetermined intent or due to legal intervention or war)	Y10-Y34, Y87.2, Y89.9, Y35-Y36, Y89(0.0,0.1)

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Number and rate* of traumatic brain injury-related deaths[†] by selected sociodemographic characteristics — National Vital Statistics System, United States, 2020.

Table 1

Socio-demographic characteristics	Number	Rate* (95% CI)
Age (years)		
Birth-17	2,774	3.8 (3.7–4.0)
Birth-4	612	3.2 (2.9–3.4)
5–9	282	1.4 (1.2–1.6)
10–14	621	3.0 (2.8–3.2)
15–24	7,389	17.4 (17.0–17.8)
25–34	8,301	18.0 (17.6–18.4)
35–44	6,761	16.0 (15.7–16.4)
45–54	6,716	16.6 (16.2–17.0)
55–64	8,199	19.3 (18.9–19.8)
65–74	7,725	23.7 (23.2–24.3)
75+	17,755	76.8 (75.7–78.0)
Sex		
Male	47,668	29.4 (29.1–29.6)
	Crude §	
	Adjusted ¶	28.3 (28.0–28.6)
Female	16,694	10.0 (9.8–10.1)
	Crude §	
	Adjusted ¶	8.4 (8.3–8.6)
Race/ethnicity**		
White, non-Hispanic persons	46,281	23.1 (22.9–23.3)
	Crude §	
	Adjusted ¶	19.2 (19.0–19.4)
Black, non-Hispanic persons	8,852	20.3 (19.9–20.7)
	Crude §	
	Adjusted ¶	20.2 (19.8–20.7)
Hispanic persons	6,683	10.9 (10.6–11.2)
	Crude §	

Socio-demographic characteristics	Number	Rate* (95% CI)
American Indian/Alaskan Native non-Hispanic persons	Adjusted ¶ 6,683	12.2 (11.9–12.5)
	Crude § 785	28.4 (26.4–30.4)
Asian/Pacific Islander, non-Hispanic persons	Adjusted ¶ 785	29.0 (26.9–31.0)
	Crude § 1,626	7.6 (7.3–8.0)
	Adjusted ¶ 1,626	7.7 (7.3–8.0)
U.S census region of decedent's residence		
Northeast	Crude § 8,264	14.8 (14.5–15.1)
	Adjusted ¶ 8,264	12.7 (12.5–13.0)
Midwest	Crude § 14,413	21.1 (20.8–21.4)
	Adjusted ¶ 14,413	19.2 (18.9–19.5)
South	Crude § 27,317	21.6 (21.3–21.8)
	Adjusted ¶ 27,316	20.2 (20.0–20.5)
West	Crude § 14,368	18.3 (18.0–18.6)
	Adjusted ¶ 14,368	17.0 (16.7–17.3)
Total	Crude § 64,362	19.5 (19.4–19.7)
	Adjusted ¶ 64,361	18.0 (17.8–18.1)

Abbreviations: CI = confidence interval.

* Per 100,000 population.

¶ Record-Axis Condition codes were used (usually includes conditions listed in both Part I and Part II of the death certificate).

§ Deaths with missing age were included.

¶ Deaths with missing age were excluded. Rates were age-adjusted to the 2000 U.S. Census population using 12 age groups: 0–4, 5–9, 10–14, 15–19, 20–24, 25–34, 35–44, 45–54, 55–64, 65–74, 74–84, and 85 years.

** Deaths with unknown Hispanic ethnicity were excluded (135 deaths).

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Table 2

Number and rate* of traumatic brain injury-related deaths[†] by intent, mechanism of injury, and age group—National Vital Statistics System, United States, 2020.

Intent and Mechanism of Injury	Age group (years)										Total (all ages)	
	0–4	5–9	10–14	15–24	25–34	35–44	45–54	55–64	65–74	75+		
Total unintentional TBI-related deaths	292	181	250	2,449	2,746	2,473	2,801	4,176	4,720	14,627	34,715	9.2 (9.1–9.3)
Rate (95% CI)	1.5 (1.3–1.7)	0.9 (0.8–1.0)	1.2 (1.1–1.4)	6.0 (5.7–6.2)	5.8 (5.5–6.0)	6.0 (5.7–6.2)	5.9 (5.6–6.1)	6.9 (6.7–7.2)	9.8 (9.5–10.1)	14.5 (14.1–14.9)	63.3 (62.3–64.3)	63.3 (62.3–64.3)
Count	292	181	250	2,449	2,746	2,473	2,801	4,176	4,720	14,627	34,715	34,715
Rate (95% CI)	0.8 (0.7–1.0)	0.6 (0.5–0.7)	0.8 (0.7–0.9)	4.8 (4.6–5.0)	4.8 (4.6–5.0)	4.7 (4.5–4.9)	3.8 (3.6–4.0)	3.5 (3.3–3.7)	3.3 (3.2–3.5)	2.7 (2.5–2.9)	3.1 (2.9–3.3)	3.1 (2.9–3.3)
Count	162	120	170	2,053	2,158	1,614	1,408	1,415	874	713	10,687	10,687
Rate (95% CI)	-	-	-	0.2 (0.1–0.2)	0.2 (0.1–0.2)	0.5 (0.4–0.5)	1.0 (0.9–1.1)	2.1 (2.0–2.2)	4.6 (4.4–4.8)	9.8 (9.5–10.2)	55.1 (54.1–56.0)	55.1 (54.1–56.0)
Count	-	-	-	20	41	43	57	69	56	58	365	365
Rate (95% CI)	-	-	-	0.0 (0.0–0.1)	0.1 (0.1–0.1)	0.1 (0.1–0.1)	0.1 (0.1–0.1)	0.1 (0.1–0.2)	0.2 (0.1–0.2)	0.2 (0.1–0.2)	0.3 (0.2–0.3)	0.3 (0.2–0.3)
Count	106	49	65	305	338	395	491	736	596	1,128	4,209	4,209
Rate (95% CI)	0.5 (0.4–0.7)	0.2 (0.2–0.3)	0.3 (0.2–0.4)	0.7 (0.6–0.8)	0.7 (0.6–0.8)	0.7 (0.7–0.8)	0.9 (0.8–1.0)	1.2 (1.1–1.3)	1.7 (1.6–1.9)	1.8 (1.7–2.0)	4.9 (4.6–5.2)	4.9 (4.6–5.2)
Count	277	88	351	4,814	5,397	4,105	3,765	3,871	2,918	3,063	28,649	28,649
Rate (95% CI)	1.4 (1.3–1.6)	0.4 (0.3–0.5)	1.7 (1.5–1.9)	11.3 (11.0–11.6)	11.7 (11.4–12.0)	9.7 (9.4–10.0)	9.7 (9.4–10.0)	9.3 (9.0–9.6)	9.1 (8.8–9.4)	9.0 (8.6–9.3)	13.3 (12.8–13.7)	13.3 (12.8–13.7)
Count	**	**	212	3,046	3,682	2,990	3,033	3,307	2,614	2,855	21,739	21,739
Rate (95% CI)	-	-	1.0 (0.9–1.2)	7.2 (6.9–7.4)	8.0 (7.7–8.3)	7.1 (6.8–7.4)	7.1 (6.8–7.4)	7.5 (7.2–7.8)	7.8 (7.5–8.1)	8.0 (7.7–8.3)	12.4 (11.9–12.8)	12.4 (11.9–12.8)
Count	277	88	139	1,768	1,715	1,115	732	564	304	208	6,910	6,910
Rate (95% CI)	1.4 (1.3–1.6)	0.4 (0.3–0.5)	0.7 (0.6–0.8)	4.2 (4.0–4.3)	3.7 (3.5–3.9)	2.6 (2.5–2.8)	2.6 (2.5–2.8)	1.8 (1.7–1.9)	1.3 (1.2–1.4)	0.9 (0.8–1.0)	0.9 (0.8–1.0)	0.9 (0.8–1.0)

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Age group (years)	0-4		5-9		10-14		15-24		25-34		35-44		45-54		55-64		65-74		75+		Total (all ages)		
	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Count	Rate (95% CI)	Age-Adjusted Rate (95% CI) §§
Other ^{††}	43	0.2 (0.2-0.3)	13	0.1 (0.0-0.1)	20	0.1 (0.1-0.1)	126	0.3 (0.2-0.3)	158	0.3 (0.2-0.3)	183	0.3 (0.3-0.4)	150	0.4 (0.4-0.5)	152	0.4 (0.3-0.4)	87	0.3 (0.2-0.3)	65	0.3 (0.2-0.4)	997	0.3 (0.3-0.3)	

Abbreviations: CI = confidence interval.

* Per 100,000 population.

[†] Record-Axis Condition codes were used (usually includes conditions listed in both Part I and Part II of the death certificate).

[§] Falls of undetermined intent were not included.

[~] Suppressed for deaths <=10 and rates based on < 20 deaths.

[¶] External cause of injury codes specify that the injury was unintentional but do not specify the actual mechanism 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 TBIs of undetermined intent and those caused by legal intervention or war.

^{§§§} Deaths with missing age were excluded. Rates were age-adjusted to the 2000 U.S. Census population using 12 age groups: 0-4, 5-9, 10-14, 15-19, 20-24, 25-34, 35-44, 45-54, 55-64, 65-74, 74-84, and 85 years.

Table 3

Number and age-adjusted rate* of traumatic brain injury-related deaths[†] by intent, mechanism of injury, and sex—National Vital Statistics System, United States, 2020.

Intent and Mechanism of Injury	Sex		Rate (95% CI)
	Male	Female	
	Number	Number	Rate (95% CI)
Total unintentional TBI-related deaths	22,764	11,951	5.6 (5.5–5.7)
Unintentional motor vehicle crashes	7,957	2,730	1.6 (1.6–1.7)
Unintentional falls [§]	11,463	7,991	3.4 (3.3–3.4)
Unintentionally struck by or against an object	311	54	0.0 (0.0–0.0)
Other unintentional injury, mechanism unspecified [¶]	3,033	1,176	0.6 (0.6–0.6)
Total intentional TBI-related deaths	24,144	4,505	2.7 (2.6–2.8)
Suicide ^{**} (includes all mechanisms)	19,058	2,681	1.8 (1.7–1.9)
Homicide (includes all mechanisms)	5,086	1,824	1.1 (1.1–1.2)
Other^{††}	759	238	0.1 (0.1–0.2)
Total	47,667	16,694	8.4 (8.3–8.6)

Abbreviation: CI = confidence interval.

* Per 100,000 population, age-adjusted to the 2000 U.S. standard population using 12 age groups: 0–4, 5–9, 10–14, 15–19, 20–24, 25–34, 35–44, 45–54, 55–64, 65–74, 74–84, and 85 years.

[†] Record-axis condition codes were used (usually includes conditions listed in both Part I and Part II of the death certificate).

[§] Falls of undetermined intent were not included.

[¶] External cause of injury codes specify that the injury was unintentional but do not specify the actual mechanism 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 TBIs of undetermined intent and those caused by legal intervention or war.

Table 4

Number and age-adjusted rate* of traumatic brain injury-related deaths[†] by intent, mechanism of injury, and race/ethnicity[§]—National Vital Statistics System, United States, 2020.

Intent and Mechanism of Injury	Race/ethnicity														
	White, non-Hispanic persons			Black, non-Hispanic persons			Hispanic persons			American Indian/Alaskan Native non-Hispanic persons			Asian/Pacific Islander, non-Hispanic persons		
	Number	Rate (95% CI)	Number	Rate (95% CI)	Number	Rate (95% CI)	Number	Rate (95% CI)	Number	Rate (95% CI)	Number	Rate (95% CI)	Number	Rate (95% CI)	
Total unintentional TBI-related deaths	25,875	9.8 (9.7–9.9)	3,545	8.4 (8.1–8.6)	3,722	7.4 (7.2–7.7)	385	14.4 (12.9–15.9)	1,121	5.3 (5.0–5.7)					
Unintentional motor vehicle crashes	6,640	3.3 (3.2–3.3)	1,914	4.3 (4.1–4.5)	1,694	2.7 (2.6–2.9)	167	6.0 (5.1–7.0)	248	1.1 (1.0–1.3)					
Unintentional falls [‡]	15,893	5.2 (5.1–5.3)	1,121	2.8 (2.6–3.0)	1,501	3.7 (3.5–3.9)	155	6.0 (5.1–7.0)	756	3.7 (3.4–3.9)					
Unintentionally struck by or against an object	284	0.1 (0.1–0.1)	18	-	51	0.1 (0.1–0.1)	-	-	-	-					
Other unintentional injury, mechanism unspecified ^{***}	3,058	1.2 (1.2–1.3)	492	1.2 (1.0–1.3)	476	0.9 (0.8–1.0)	61	2.3 (1.7–2.9)	107	0.5 (0.4–0.6)					
Total intentional TBI-related deaths	19,886	9.1 (9.0–9.3)	5,095	11.4 (11.1–11.7)	2,769	4.5 (4.3–4.6)	361	13.1 (11.7–14.4)	476	2.2 (2.0–2.4)					
Suicide ^{††} (includes all mechanisms)	17,716	9.4 (9.2–9.5)	1,714	4.5 (4.3–4.7)	1,676	3.2 (3.0–3.4)	238	9.9 (8.6–11.2)	350	1.9 (1.7–2.1)					
Homicide (includes all mechanisms)	2,170	1.1 (1.1–1.2)	3,381	7.6 (7.3–7.8)	1,093	1.7 (1.6–1.8)	123	4.5 (3.7–5.4)	126	0.6 (0.5–0.7)					
Other^{§§}	520	0.3 (0.2–0.3)	212	0.5 (0.4–0.5)	192	0.3 (0.3–0.4)	39	1.5 (1.1–2.0)	29	0.1 (0.1–0.2)					
Total	46,281	19.2 (19.0–19.4)	8,852	20.2 (19.8–20.7)	6,683	12.2 (11.9–12.5)	785	29.0 (26.9–31.0)	1,626	7.7 (7.3–8.0)					

Abbreviation: CI = confidence interval.

* Per 100,000 population, age-adjusted to the 2000 U.S. standard population using 12 age groups: 0–4, 5–9, 10–14, 15–19, 20–24, 25–34, 35–44, 45–54, 55–64, 65–74, 74–84, and 85 years.

† Record-axis condition codes were used (usually includes conditions listed in both Part I and Part II of the death certificate).

§ Deaths with unknown Hispanic ethnicity were excluded (135 deaths).

‡ Falls of undetermined intent were not included.

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[†] Suppressed for deaths ≤ 10 and rates based on < 20 deaths.

^{**} External cause of injury codes specify that the injury was unintentional but do not specify the actual mechanism 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 TBIs of undetermined intent and those caused by legal intervention or war.