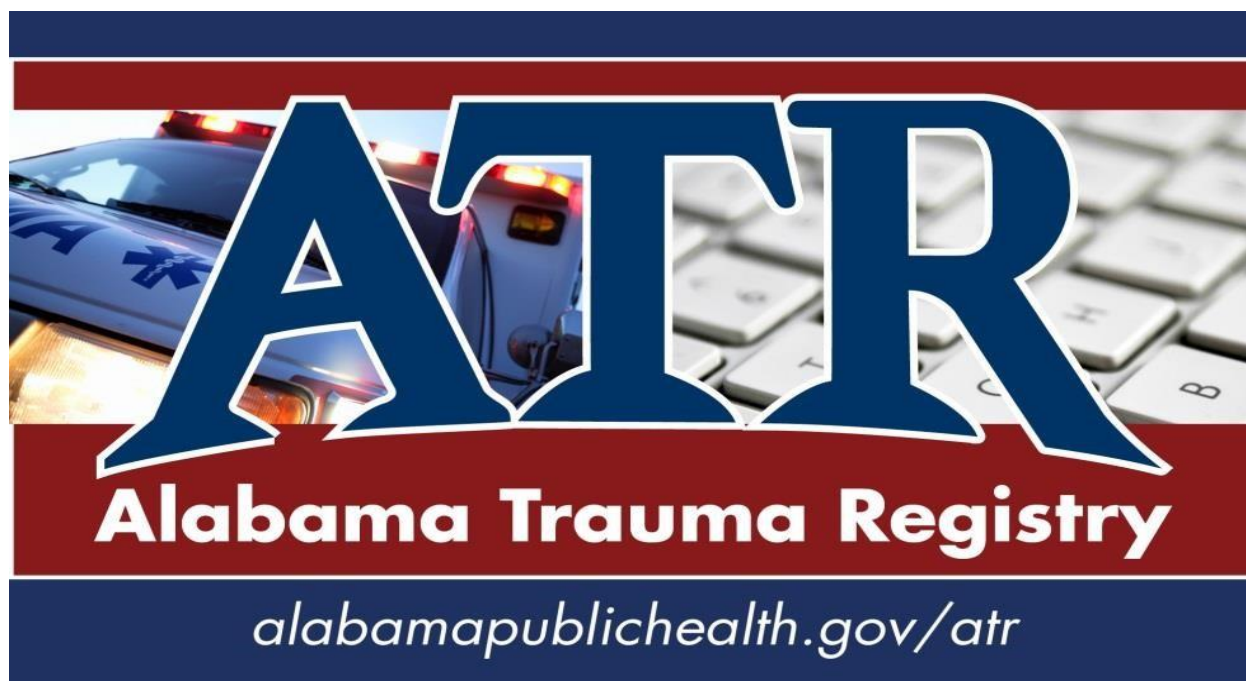


Alabama Head and Spinal Cord Injury Report 2023



**2023 Alabama Head and Spinal Cord
Injury Registry (AHSCIR) Report**

Data Period:

January 1, 2023 – December 31, 2023

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Table of Contents

<i>Acknowledgement and Overview.....</i>	<i>Page 4</i>
<i>ASCHIR and the Role of Rehabilitation Services.....</i>	<i>Page 5</i>
<i>Neurological Injury Resulting in Death in Alabama.....</i>	<i>Page 6</i>
<i>Methods.....</i>	<i>Page 7</i>
<i>Data Use and Comparability.....</i>	<i>Page 9</i>
<i>Results.....</i>	<i>Page 10</i>
<i>Type (Level) of Neurological Injury.....</i>	<i>Page 11</i>
<i>Neurological Trauma Cases by Mechanism of Injury.....</i>	<i>Page 12</i>
<i>Neurological Trauma Cases by Gender.....</i>	<i>Page 13</i>
<i>Neurological Trauma Cases by Race.....</i>	<i>Page 14</i>
<i>Traumatic Brain Injury (TBI).....</i>	<i>Page 15</i>
<i>Spinal Cord Injury (SCI).....</i>	<i>Page 33</i>
<i>Conclusion.....</i>	<i>Page 51</i>

Acknowledgement

The Office of Emergency Medical Services (OEMS) wishes to thank everyone who made this report possible, especially the Trauma Registrars and other personnel throughout the state for their diligent work in reporting trauma data to the repository, as required.

On October 1, 2020, OEMS transitioned from Digital Innovation (DI) Systems to the ESO Gen-6 database following ESO's acquisition of DI. Gen-6 was a new trauma reporting system and required training and familiarization of users. ESO currently serves thousands of customers throughout North America with a broad software portfolio, including EMS, Fire, and hospital software platforms. The OEMS appreciates everyone who participates in consistent trauma data entry and who makes this report possible.

Overview

According to Johns Hopkins University School of Medicine, “the brain is a complex organ that controls thought, memory, emotion, touch, motor skills, vision, breathing, temperature, hunger, and every process that regulates our body. Together, the brain and spinal cord that extends from it, make up the central nervous system, or CNS.” Because of the importance of the CNS to physiology, the organs are encased in bony structures, the skull and spinal column respectively, to protect them. Mechanical forces placed upon the body, either blunt forces (example, kinetic energy from a fall from height) or penetrating forces (examples, a bullet or knife) can result in disruption of the organic structure of the CNS, and therefore the disruption of the function of the CNS. Mechanical disruption of tissue of any type is called “trauma,” from the Greek root τραῦμα (traumatikos) meaning “a wound, hurt, or defeat.” The significance of trauma of the CNS is the debilitation and frequently permanent disabilities imparted upon the patient.

The Mayo Clinic identifies the people most at risk of traumatic brain injury (TBI) as children (especially under 4 years of age), young adults (especially those 15 to 24 years of age), adults aged 60 years and older, and males of any age group. TBI leads to issues involving consciousness (coma, vegetative state, brain death, and reduced consciousness or cognition); physical issues such as seizures, fluid buildup on the brain (hydrocephalus), as well as infections and vascular damage (resulting in swelling or stroke). One of the most frequently occurring mechanisms of TBI are falls (resulting in blunt injury), especially in the elderly.

Spinal cord injury (SCI) risks are found to be greatest in ages mirroring TBI, although a high frequency is observed in adults between 25 and 39 years of age and especially because of motor vehicle accidents. SCI (occurring with or without associated TBI) is responsible for partial or full paralysis of the body, at and below the level of injury. A study conducted by Miller School of Medicine at the University of Miami identified that, since 2015 approximately 38 percent of SCI occurred in motor vehicle accidents, 32 percent in falls, 14 percent due to violence, 8 percent due to sports injuries, and 7 percent due to other causes.

Whereas TBI and SCI most often occur independently of one another, a significant commonality lies in the post traumatic care and rehabilitation required for management of both processes. TBI often results in cognitive deficits where SCI results in some level of paralysis. Both processes often require lengthy hospital stays and even more lengthy rehabilitative phases to return the patient to as close to pre-injury normalcy as possible.

The Alabama Head and Spinal Cord Injury Registry (AHSCIR) and the Role of the Alabama Department of Rehabilitation Services (ADRS)

The ADRS is charged with offering rehabilitation services to patients with moderate to severe traumatic brain and/or spinal cord injuries. At times, patients are unaware of, or have difficulty understanding, state supported rehabilitation services – the result of which leads to inadequate rehabilitation, disability management, and work force re-entry assistance. Patients who have sustained debilitating injuries are identified and linked with ADRS via the AHSCIR, a registry mandated by Alabama Act 98-611. This law, which requires all hospitals in Alabama to submit data related to head and/or spinal cord injury cases to the Alabama Department of Public Health (ADPH), was passed in May 1998. The Alabama Trauma Registry (ATR), established after AHSCIR data collection began in 1999, strives to broaden collection efforts to include data related to all types of trauma. Those requesting services have been provided appropriate need-based referral information. More specifically, development of the ATR component pertains to an expansion of the head and spinal cord injury registry into a larger, more comprehensive program. Trauma registry personnel in the OEMS collect statewide data by working with hospitals at all levels of trauma care (acute and ancillary). Ultimately, registry data analysis and injury pattern evaluations will permit researchers and policymakers to identify better ways of reducing injury mortality and morbidity in Alabama.

It is important to provide the public with mortality and morbidity statistics to accurately illustrate the impact injuries have on individuals, families, and society. Additionally, the information assists with the design of prevention programs to mitigate the long-term effects of injuries in Alabama. As previously described, the ADRS uses the AHSCIR data to locate patients suffering from head and/or spinal cord injuries to make them aware of state supported services and perform follow-up treatment and referrals.

Neurological Injury Resulting in Death in Alabama

The data presented herein includes mortality (death) statistics. For patients entered into the AHSCIR, mortality statistics are in relation to deaths occurring after arrival at the hospital and taking place during interventional and stabilization phases of care. Further, no intention is outlined for the injury mechanisms. Many Alabama residents and visitors succumb to devastating neurological injuries and are found deceased by law enforcement, fire, and emergency medical services (EMS) agencies. The OEMS routinely provides prehospital electronic patient care report (e-PCR) data, working closely with the ADPH Center for Health Statistics, the Alabama Violent Death Reporting System (AVDRS), Maternal Mortality Review (MMRP), Child Death Review System (CDR), Fetal and Infant Mortality Review (FIMR), Sudden Unexplained Drug Overdose Review System (SUDORS) and also participates in the ADPH Fatality Committee. Data presented in this report only involves those patients entered into the AHSCIR; therefore, surviving to hospital arrival and listed mortality or fatality rates are comparative only to those hospitalized patients and not to the general population of Alabama.

A report was published in the Centers for Disease Control and Prevention (CDC) Morbidity and Mortality Weekly Report (MMWR) on October 15, 2021, by Daugherty, et. al, outlining the fact that some disparity exists between regions of the United States in the mortality of Traumatic Brain Injury. Particularly, between the years of 2016 to 2018 TBI-related deaths were lowest in the Northeast United States (U.S.) (12.8 per 100,000) and highest in the Southern U.S. and Midwest U.S. (19.2 per 100,000 and 18.1 per 100,000, respectively). This report highlights the fact that approximately one million U.S. deaths over the past two decades have involved TBI and that TBI rates vary by state; recognizing that states with higher rates tend to have greater proportions of TBI patients in rural areas. The three highest rates were found in Alaska (34.8), Wyoming (32.6), and Montana (29.5). All three states are well known for isolated wilderness.

Daugherty J, Zhou H, Sarmiento K, Waltzman D. *Differences in State Traumatic Brain Injury Related Deaths, by Principal Mechanisms of Injury, Intent, and Percentage of Population Living in Rural Areas – United States, 2016 – 2018*. MMWR Morb Mortal Wkly Rep 2021;70:1447-1452

Methods

The ATR entered 15,945 patients in the Year 2023. Of those 15,945 patients, 659 (4 percent) were recorded as dying during either the initial emergency department phase of care, or during subsequent medical interventional phases.

The AHSCIR is a subset of the ATR. AHSCIR report inclusion criteria used in previous years, prior to the Gen-6 implementation, was evaluated and adjusted to the present criteria listed below. The present criteria were developed to specifically include more relevant diagnosis standards and to avoid pulls based upon general descriptions such as “shaken baby syndrome.”

Precise medical charting is accomplished using the International Statistical Classification of Diseases and Related Health Problems (ICD), a globally used diagnostic tool for epidemiology, health management, and clinical purposes such as charting for insurance repayment for services. ICD is maintained by the World Health Organization (WHO), the primary healthcare influencer within the United Nations system. ICD is currently in its tenth version (ICD-10) first published in 1994. The most pertinent strength of the ICD-10 system is the precision of the diagnosis codes by body system. A very narrow set of injury codes for central neurological injuries were identified to choose patients of interest experiencing TBI and SCI. Use of inclusive criteria such as “head injury” or “back injury” would increase the spectrum of patients under study, which would convolute the meaning of representation in the target group.

The ICD-10 coding rules also improve the usefulness of mortality statistics by giving preference to certain categories, by consolidating conditions, and by systematically selecting a single cause of death from a reported sequence of conditions. The single selected cause for tabulation is called the “underlying cause of death,” and the other reported causes are the “no underlying causes of death.” The combination of underlying and no underlying causes is the “multiple causes of death.” Herein, we predominately consider the primary area of anatomical and physiological injury to be the cause of death even if other comorbidities could contribute to the process of dying, such as diabetes or underlying cardiac disease.

2020 - 2023 REPORT CRITERIA

Brain	Spinal Cord
<p><i>S04 Injury of Cranial Nerves</i> Injury of optic nerve, oculomotor, trochlear, trigeminal, abducent, facial, acoustic, accessory, olfactory, other, unspecified</p>	<p><i>S14 Injury of Nerves and Spinal Cord at Neck Level</i> C1, C2, C3, C4, C5, C6, C7, C8* central cord syndrome, lesion, anterior cord syndrome, Brown-Sequard syndrome, other</p>
<p><i>S06 Intracranial Injury</i> Traumatic cerebral edema, Diffuse TBI, Focal TBI, Epidural Hemorrhage, Traumatic Subdural Hemorrhage, Traumatic Subarachnoid Hemorrhage, other specified intracranial injuries, unspecified intracranial injury, Traumatic Brain Compression and Herniation</p>	<p><i>S24 Injury of Nerves and Spinal Cord at Thorax Level</i> T1, T2-T6, T7-T10, T11-T12 unspecified, complete lesion, incomplete lesion, Brown-Sequard syndrome, anterior versus posterior, other</p>
<p><i>S07 Crushing Injuries of the Head</i> Skull, Other Parts of Head, Unspecified <i>NOTE: Crush injuries of the head are highly likely synonymous with TBI.</i></p>	<p><i>S34 Injury of Lumbar/Sacral Spinal Cord and Nerves</i> L1, L2, L3, L4, L5 Concussion, edema, unspecified, complete lesion, incomplete lesion, unspecified, other</p>

****NOTE: Humans have 7 cervical vertebrae and 8 cervical nerves.***

DATA USE AND COMPARABILITY

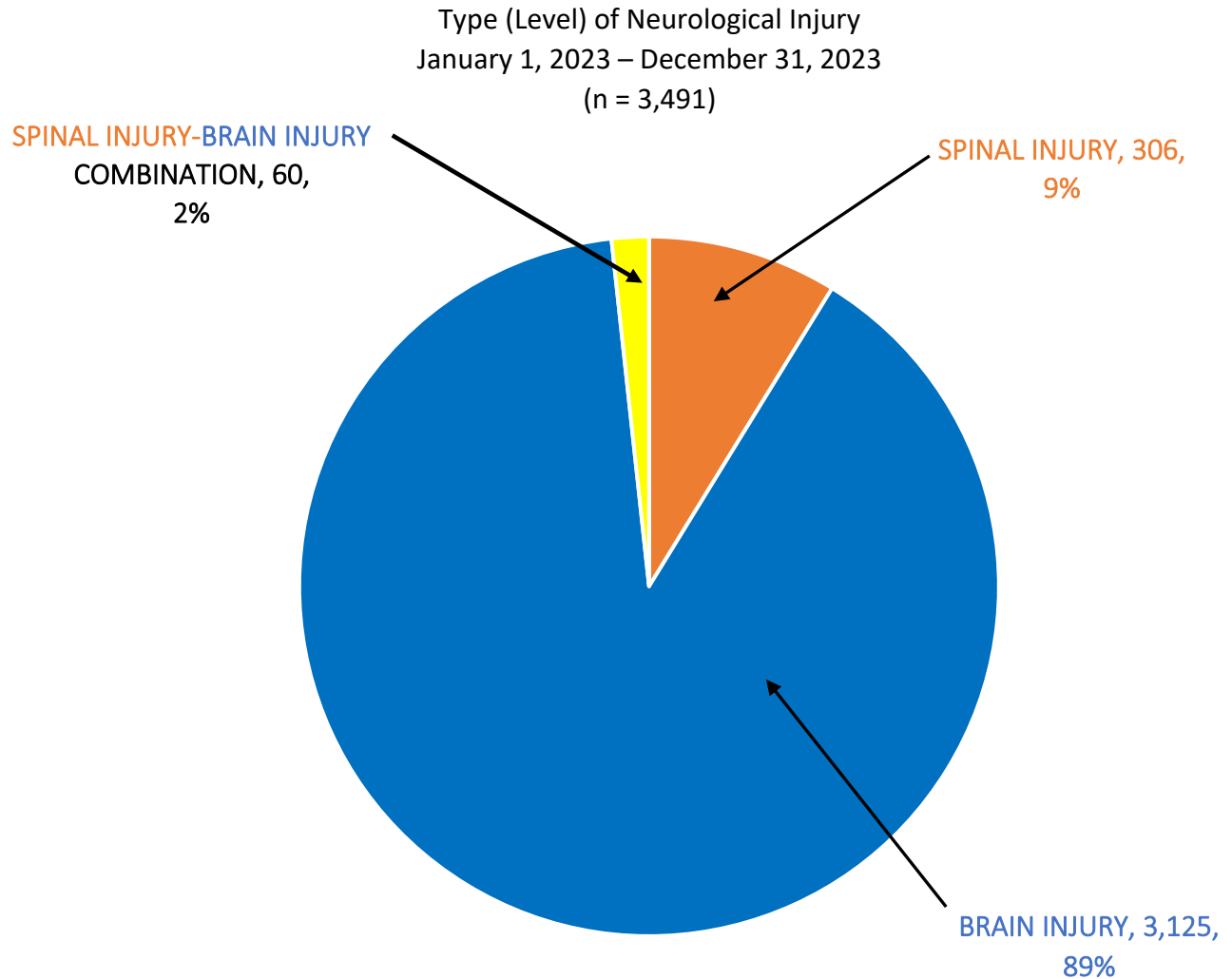
All data contained in this report must be interpreted with careful judgment. It is important to note that the information presented in this report is based on data from the AHSCIR, which was submitted as of October 7, 2023. The data in this report is not comparable to state or federal data from other sources, due to variations in collection and analytical techniques. Less severe head and spinal cord injuries are under-represented in this analysis by design. Consequently, some less severe injuries are not included in the AHSCIR case definition, thereby, permitting registrars to omit reporting them. Additionally, mortality may be underestimated because of cases in which individuals expired at the scene and bypassed hospitals. The statistical significance of the summary data for the SCI and combined TBI/SCI cases is also limited by the small population size regarding some respective data subgroups. Cases admitted to a given hospital and then transferred to another hospital during treatment may erroneously be counted twice if the transfer was not coordinated through the Alabama Trauma Communication Center (ATCC).

RESULTS

The ATR received reports of 3,491 neurological injuries of the head and spinal cord for Year 2023 compared to 3,817 reported head and spinal cord injury cases that were included in this report for Year 2022. The reduction of 9 percent may be attributable to several factors including software issues experienced by Alabama Trauma System reporters in the accumulation period prior to data sampling Year 2023 patient entry period.

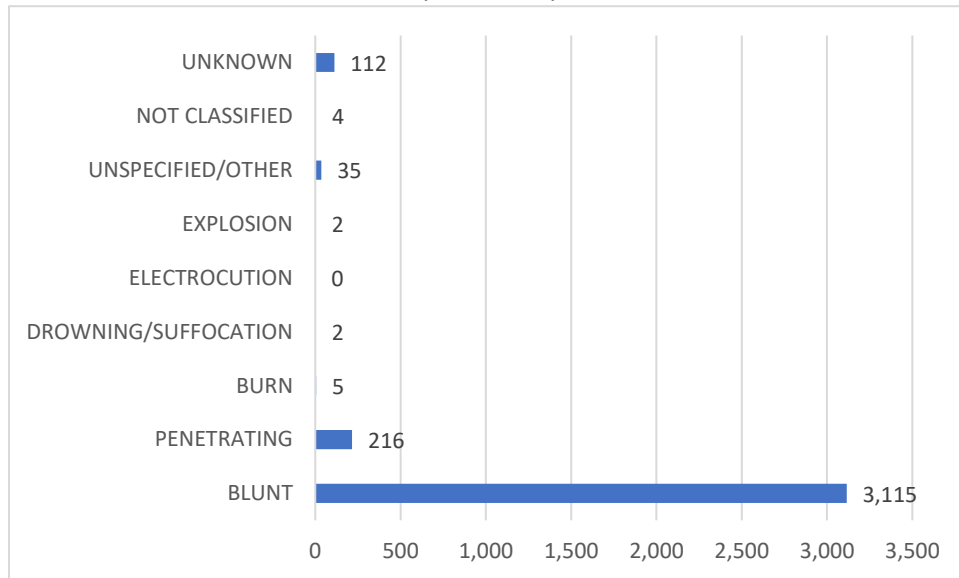
TBI exclusively constituted approximately 89 percent ($n = 3,125$) of the reported cases and SCI exclusively constituted approximately 9 percent ($n = 306$). This document will use the term TBI when referring to blunt or penetrating head injuries resulting in diagnosis of injury of central nervous system neurons above the level of the spinal cord. SCI will be used in referring to blunt or penetrating injury of the spine below the level of brain. No separate analyses are presented for combined neurological injury, i.e., traumatic brain injury and concomitant spinal cord injury. Data extraction found that about 60 patients (approximately 2 percent) suffered from combination of TBI and SCI injuries. Of the patients who suffered any type of SCI, approximately 62 percent ($n = 228$) suffered spinal injury at the level of the cervical spine.

Disclaimer: Calculation for this report used Microsoft Excel for Office 365 (2016).



NOTE: This data represents the presence of injury within individual patients. The injury level should be considered the primary area of traumatic neurological insult. Combination injuries are considered to be equally distributed between primary head injuries and primary spinal injuries for the purpose of this comparison.

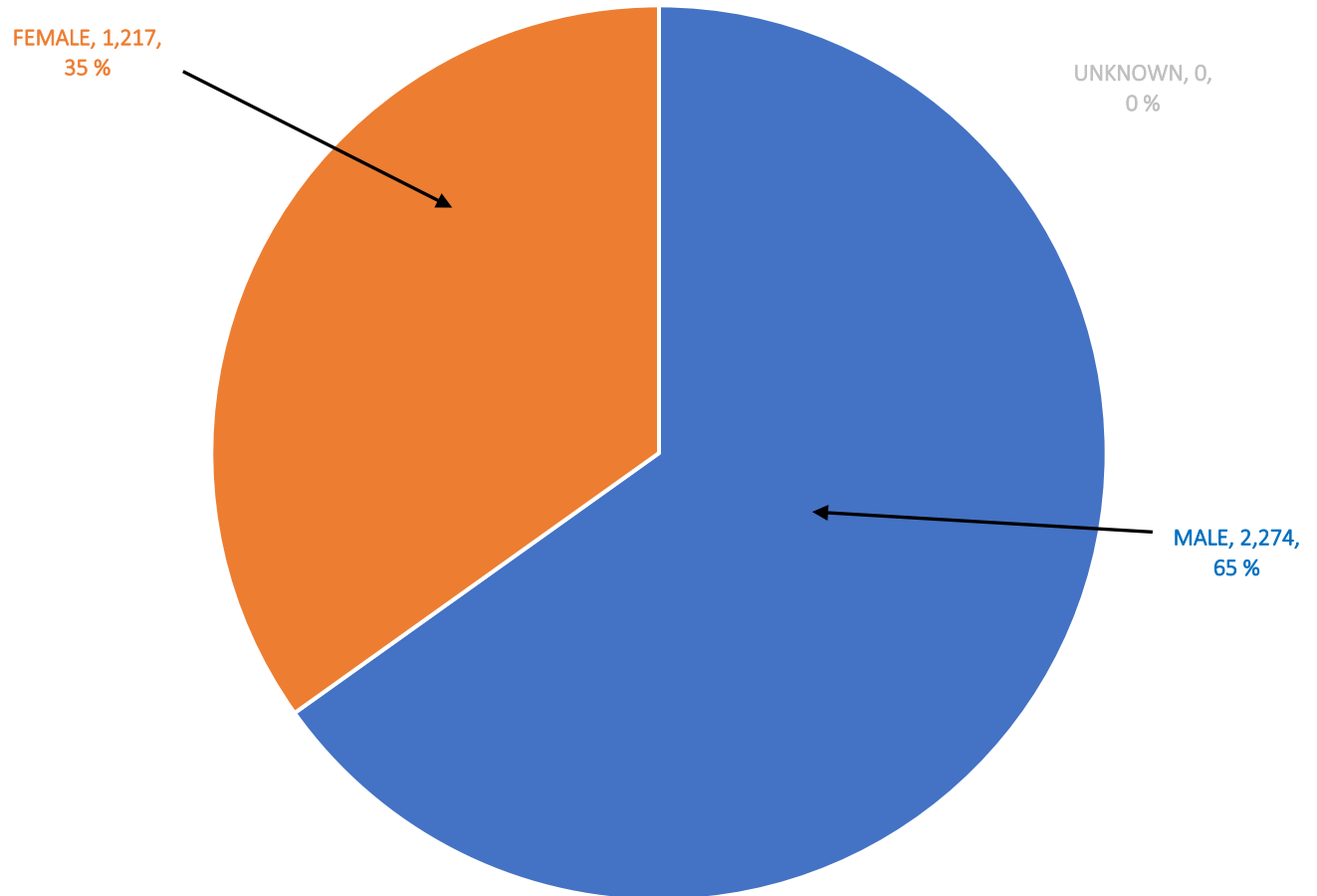
Neurological Trauma Cases by Mechanism of Injury
January 1, 2023 – December 31, 2023
(n = 3,491)



Eighty-nine percent (n = 3,115) of the cases were injuries due to blunt trauma. Penetrating injuries accounted for 6 percent (n = 216) of the traumatic neurological injury cases for 2023.

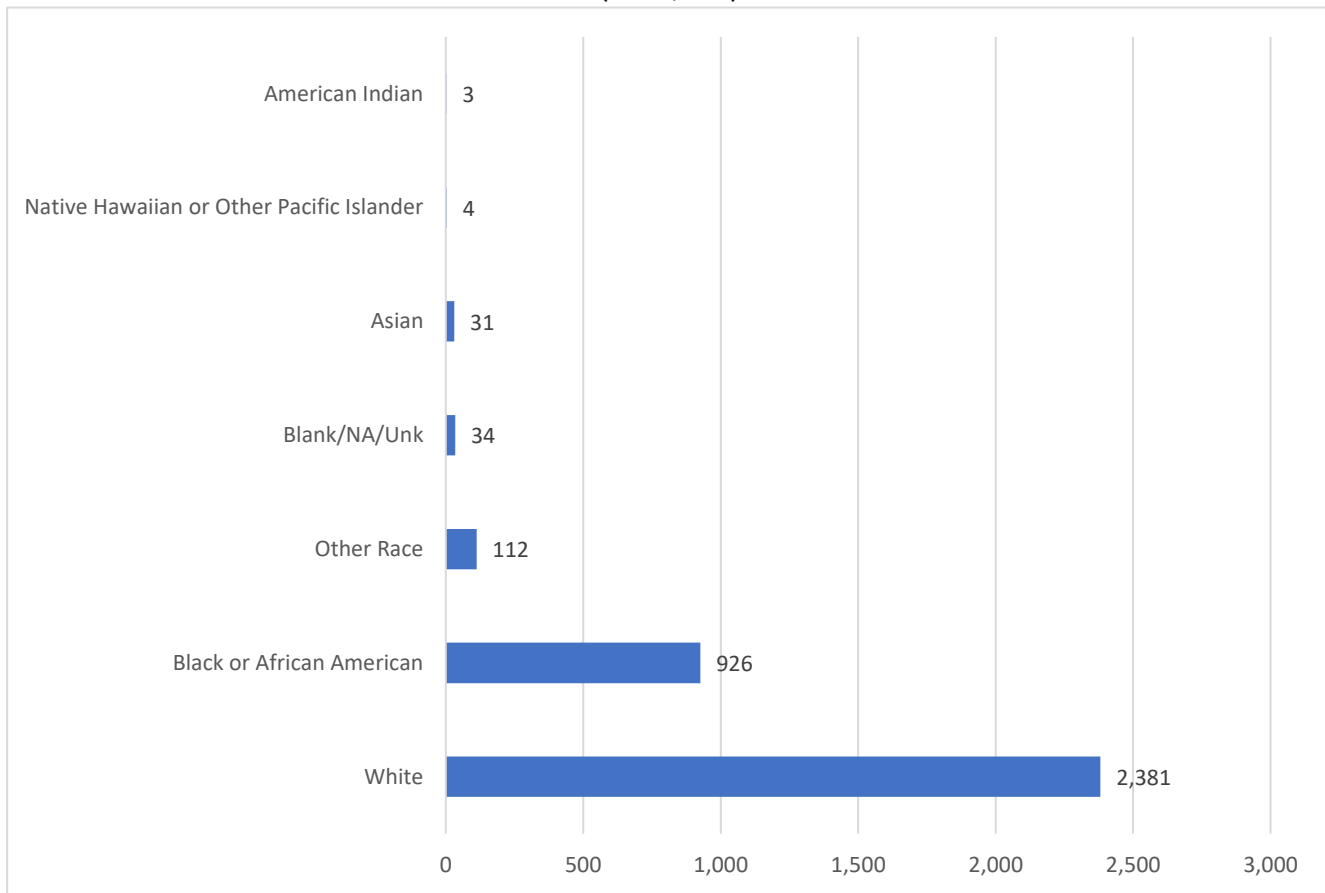
Type	Count	Percentage
Blunt	3,115	89%
Penetrating	216	6%
Burn	5	0%
Electrocution	0	0%
Drowning/Suffocation	2	0%
Explosion	2	0%
Not Valued	151	5%
Total	3,491	100%
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other	

Neurological Trauma Cases by Gender
January 1, 2023 – December 31, 2023
(n = 3,491)



Gender	Count	Percentage
Male	2,274	65%
Female	1,217	35%
Not Valued	0	0%
Total	3,491	100%
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other	

Neurological Trauma Cases by Race
January 1, 2023 – December 31, 2023
(n = 3,491)



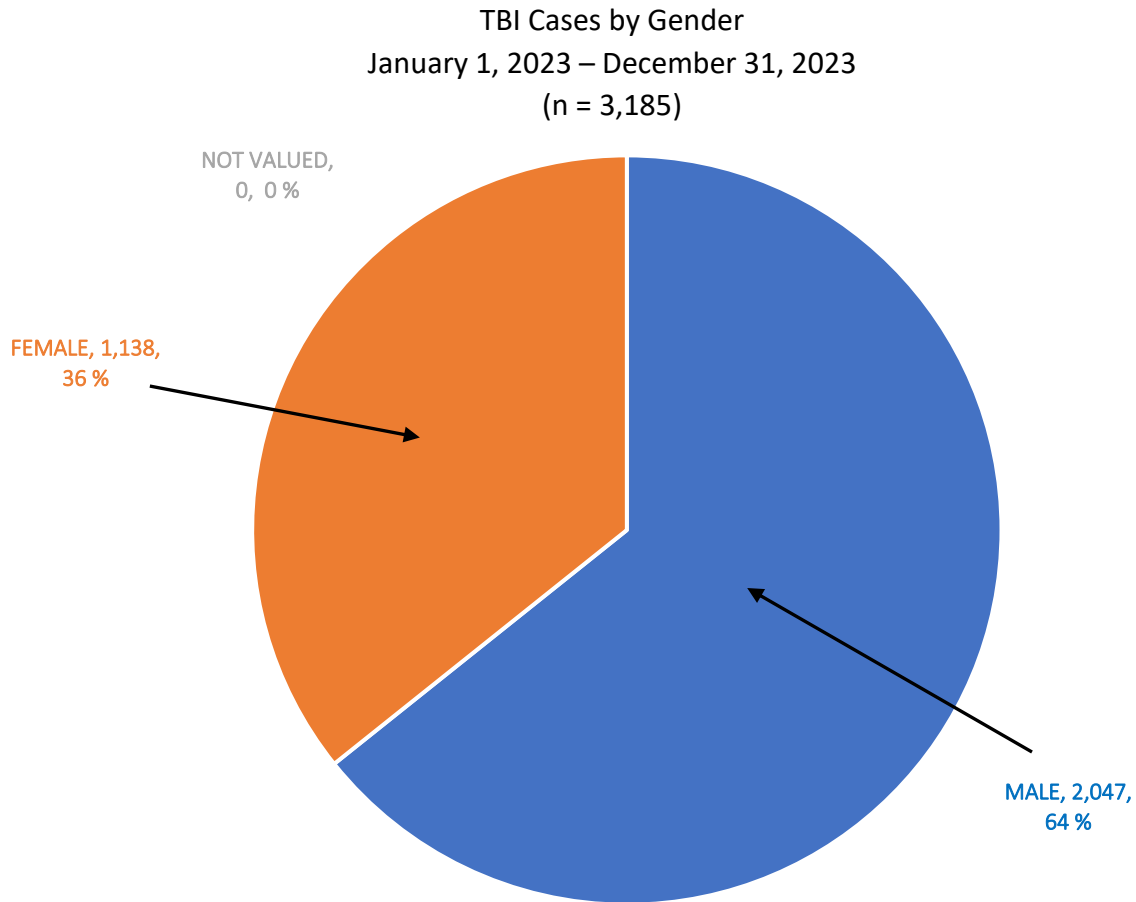
Race	Count	Percentage
Other Race	112	3%
Black/African American	926	27%
White	2,381	68%
Hawaiian/Pacific Islander	4	0%
Asian	31	1%
American Indian	3	0%
Not Valued	34	1%
Total	3,491	100%
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other	

Traumatic Brain Injury (TBI)

TBI occurs when an external mechanical force (either blunt or penetrating) causes a physical or physiological disruption and dysfunction of the brain. Blunt mechanical forces can be caused by a violent blow or jolt to the head particularly (being hit in the head by a baseball, for example) or applied to the body in general resulting in movement of the brain within the skull (such as in shaken baby syndrome). The inner structure of the skull cranium (brain vault) contains many jagged features that may injure the brain or cranial nerves. The base, or floor, of the cranium contains most of the jagged structures and the bottom of the brain is the location of the 12 pairs of cranial nerves. The origin of the cranial nerves lies within the brain and brain stem (the brain's interface with the spinal cord). They are contained within the skull above the level of the cervical spinal cord, and their injury was included into the ICD-10 criteria for brain injury for this report. Any force or mechanism that does not result in significant penetration, in this case of the head, is said to be "blunt force trauma." Blunt force trauma resulting in TBI is often associated with motor vehicle crashes, falls, and impacts to the head in sports, objects dropped upon the head, other impacts of the head, and the head impacting upon other objects. Perusal of the data (highlighted below) reveals that 91 percent (3,185) of the 3,491 neurological injuries registered in 2023 in Alabama were diagnosed with TBI. Of the 3,185 TBI cases identified, 82 percent (2,858) were documented as occurring with blunt force trauma.

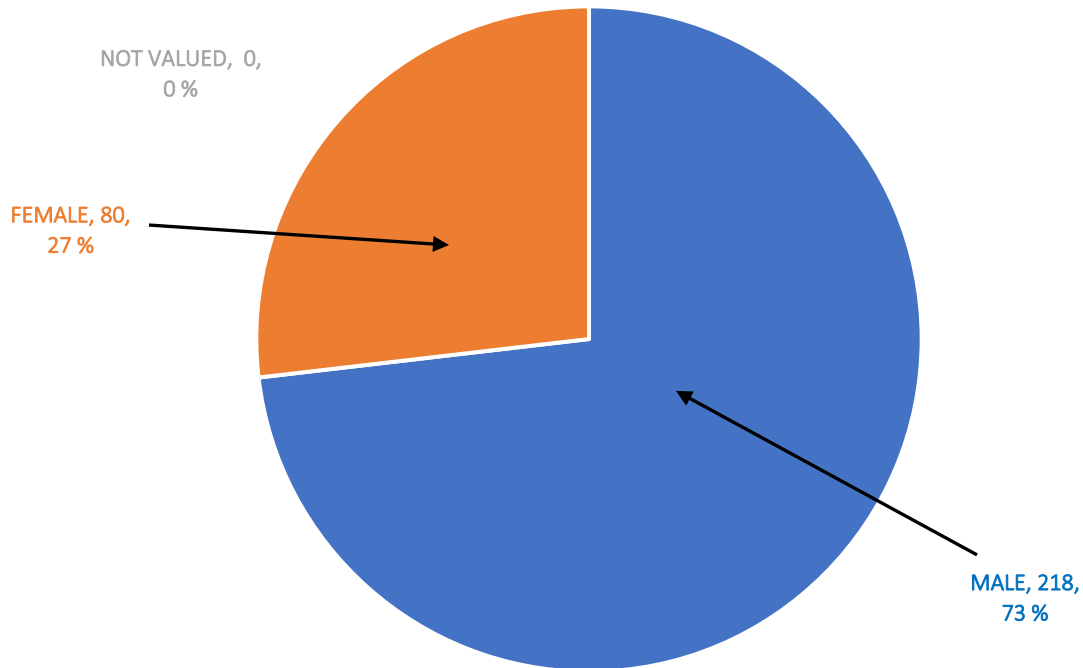
Of the remaining 18 percent (327) of TBI patients, 176 (6 percent of all TBI) suffered from penetrating trauma of the head. Penetrating trauma typically involves foreign objects (knives, arrows, projectiles such as bullets and shrapnel or wreckage) forcibly penetrating the skull. Of the 176 penetrating trauma TBI patients, 160 (91 percent) were firearms injuries and 15 (9 percent) were documented as otherwise "cut or pierced." Of firearms related penetrating trauma, 73 patients died during treatment (46 percent fatality rate among firearms related injury) where 1 patient from the "cut or pierced" penetrating trauma group died (7 percent among cut or pierce related injury).

Neurological Injuries	TBI	Blunt	Penetrating	Firearms
3,491	3,185	2,858	176	160
% of Total Neurological Injury	% of TBI			% of Firearms
TBI = 91.23%	Blunt = 89.73%			Survived = 87
Blunt TBI = 81.87%	Penetrating = 5.53%			Died = 73
Penetrating TBI = 5.04%	Firearms Penetrating = 5.02%			Survival = 54.37%
Firearms TBI = 4.58%	Firearms Penetrating Fatality = 2.29%			Mortality = 45.63%
Firearms TBI Fatality = 2.09%				



A cursory review reveals that males predominate the injury population for neurological injuries in general and for TBI in particular. U.S. Census estimates for 2023 outline that Alabama had a population of approximately 5,108,468 citizens. Of those, approximately 48 percent are male, and 52 percent are female. Elementary calculation of odds ratio (relative risk) finds that the risk of males experiencing TBI versus female, compared to the general population, are 75 percent greater, or approaching twice the risk.

TBI Case Fatalities by Gender
January 1, 2023 – December 31, 2023
(n = 298)

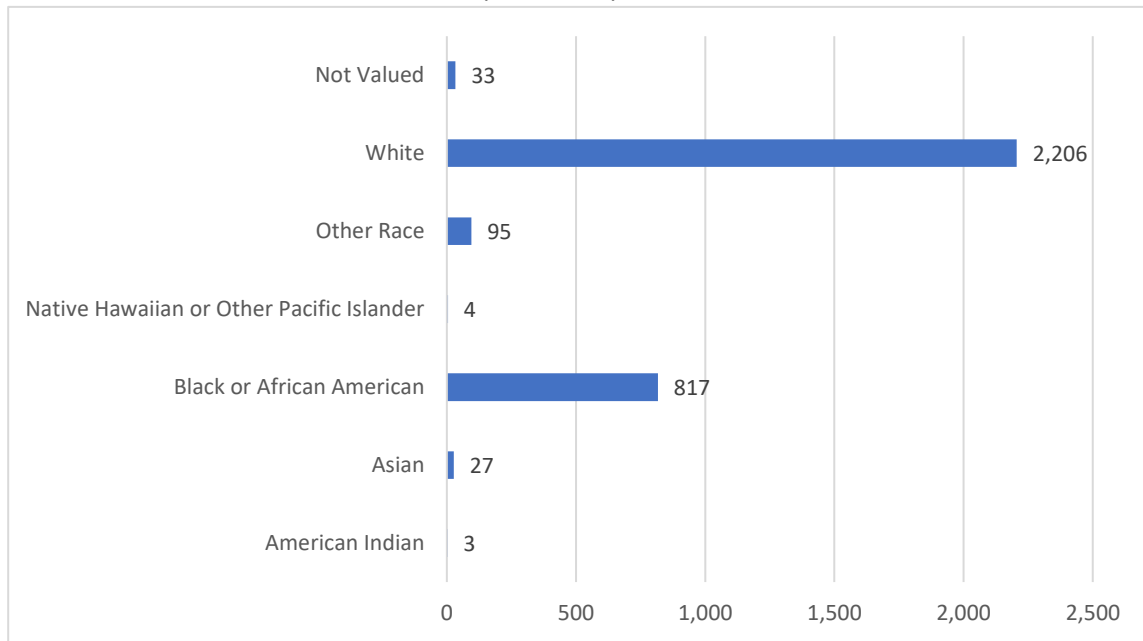


Gender	Count	Percentage	Fatalities	Population Percentage	Fatality Proportion
Male	2,047	64%	218	11%	73%
Female	1,138	36%	80	7%	27%
Not Valued	0	0%	0	0%	0%
Total	3,185	100%	298	9%	100%
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other				

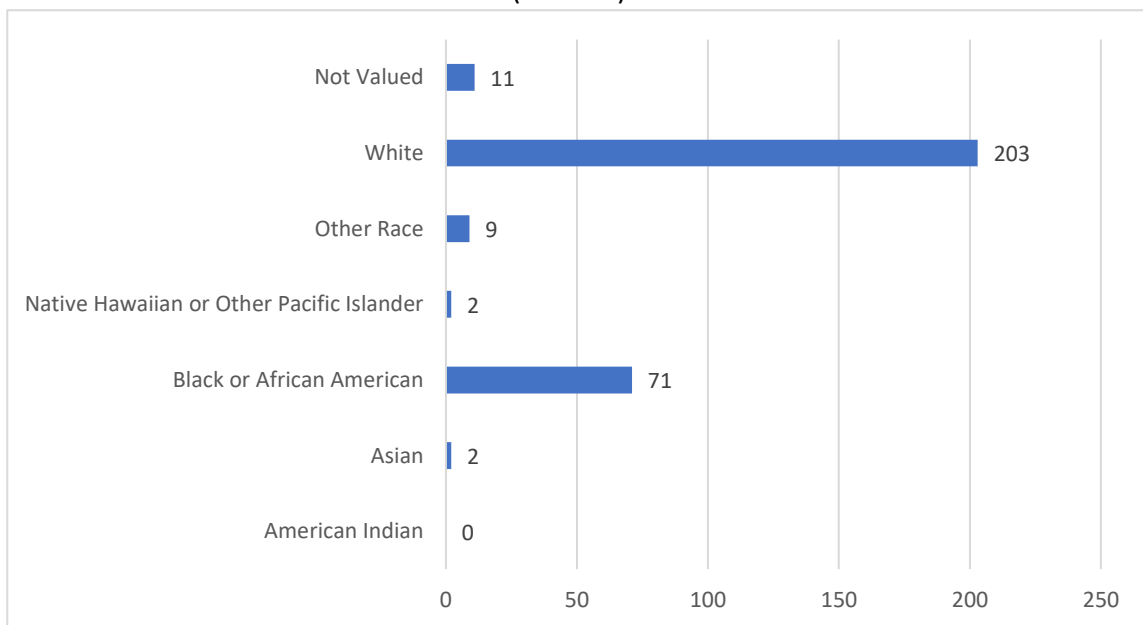
While males predominate the injury population in general, they also significantly predominate the TBI fatality proportion. Odds ratio calculation regarding gender and fatality finds that the odds of male TBI patients dying during the treatment phase is 58 percent higher than female TBI patients. It is noteworthy to point out that slightly less than 10 percent of TBI patients died because of their injuries, where slightly more than 90 percent of the injured survived to experience the recovery and rehabilitation process. Likely, the high survivability rate is due to emergency services available in Alabama in reasonably close proximity. Survivability, however, translates into the necessity of rehabilitation.

TBI Cases and Fatality by Race
January 1, 2023 – December 31, 2023

TBI Incidence by Race
(n = 3,185)



TBI Mortality by Race
(n = 298)



TBI Race and Mortality Statistics
(n = 3,185)

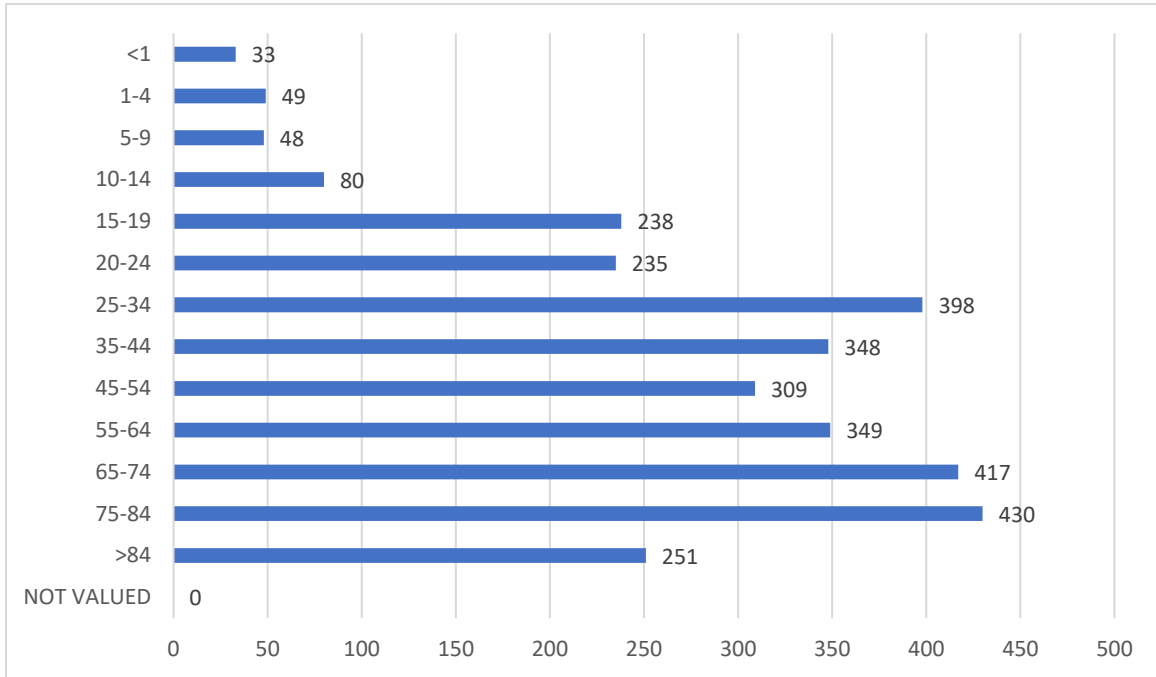
Race	Count	Population Percentage	Fatalities	Fatality Proportion
American Indian	3	0%	0	0%
Asian	27	1%	2	1%
Black/African American	817	26%	71	24%
Native Hawaiian/Pacific Islander	4	0%	2	0%
Other Race	95	3%	9	3%
White	2,206	69%	203	68%
Not Valued	32	1%	11	4%
Omitted from Calculation	1	---	---	---
Total	3,185	100%	298	100%

As established earlier, 3,185 observations of TBI were recorded from the 2023 patient group of 3,491 neurological trauma patients entered into the Registry database. One observation was omitted from calculation due to identification of race. Normally such observations are identified as “not valued” as no definitive race was selected. Further, it is noteworthy that Hispanic ethnicity is not an isolated race value. Hispanic identity is considered an ethnicity and is considered a subset, generally of black or white race status in data evaluation. This is unique in TBI evaluation as often the patient cannot express his or her declared Hispanic heritage or identification.

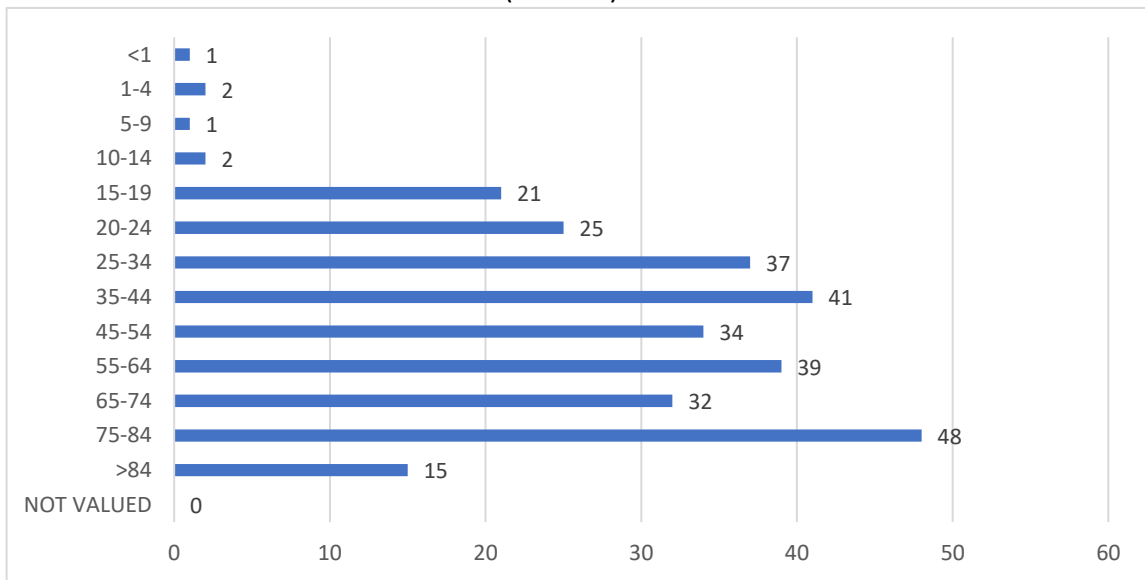
Odds ratio analysis of race and outcome of mortality was performed in comparison of black/African American (n = 817) versus white race (n = 2,206) combined with all non-black/African American race (n = 161) as control and no statistical evidence was found for influence of race in outcome of mortality. Further, U.S. Census 2023 population estimates were compared to the racial components of represented TBI patients and very similar patterns of population proportion were observed. White alone was estimated to constitute 69 percent of Alabama’s population, and white alone, not Hispanic or Latino, constitute 65 percent compared to an unknown proportion of the observed patients as race is observed not reported for severely injured patients. Black/African American alone were estimated to constitute 27 percent of Alabama’s population compared to 24 percent of the patient population. It was also observed that the Other Race categories were similarly comparable to the U.S. Census population estimates for their groupings.

TBI Cases and Fatality by Age
January 1, 2023 – December 31, 2023

TBI Incidence by Age
(n = 3,185)



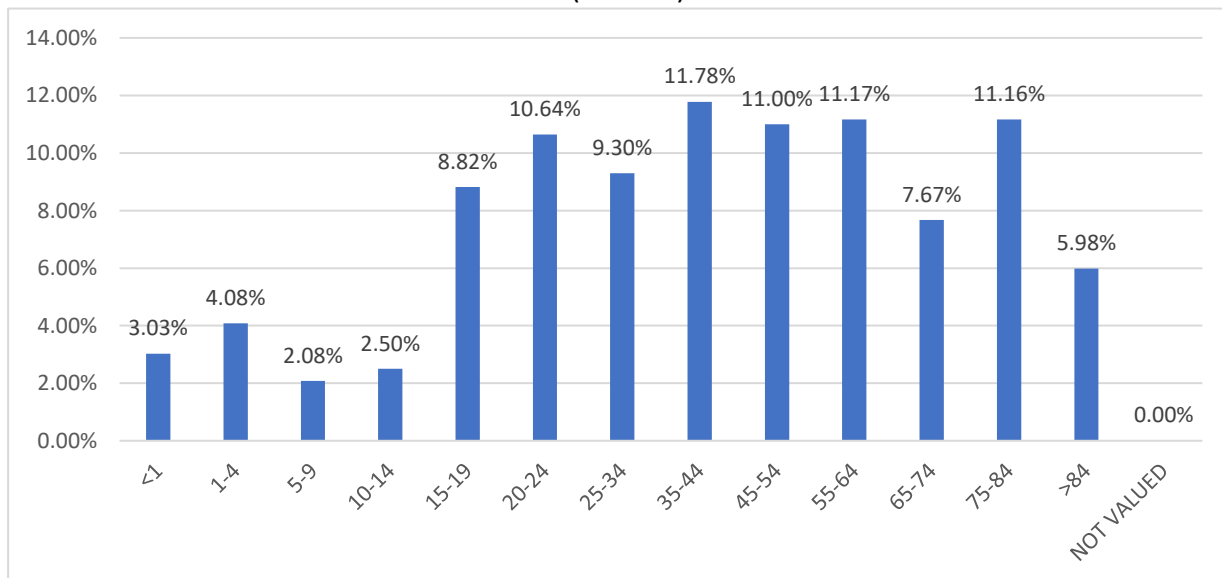
TBI Mortality by Age
(n = 298)



TBI Age and Mortality Statistics
(n = 3,185)

AGE GROUP YEARS	COUNT	PERCENT	DEATHS	FATALITY RATE
< 1	33	1.04%	1	3.03%
1 – 4	49	1.54%	2	4.08%
5 – 9	48	1.51%	1	2.08%
10 – 14	80	2.51%	2	2.50%
15 – 19	238	7.47%	21	8.82%
20 – 24	235	7.38%	25	10.64%
25 – 34	398	12.50%	37	9.30%
35 – 44	348	10.93%	41	11.78%
45 – 54	309	9.70%	34	11.00%
55 – 64	349	10.96%	39	11.17%
65 – 74	417	13.09%	32	7.67%
75 – 84	430	13.50%	48	11.16%
> 84	251	7.88%	15	5.89%
NOT VALUED	0	0.00%	0	0.00
TOTALS	3,185	100.00%	298	OVERALL %

TBI Fatality Rate by Age Comparison
(n = 298)



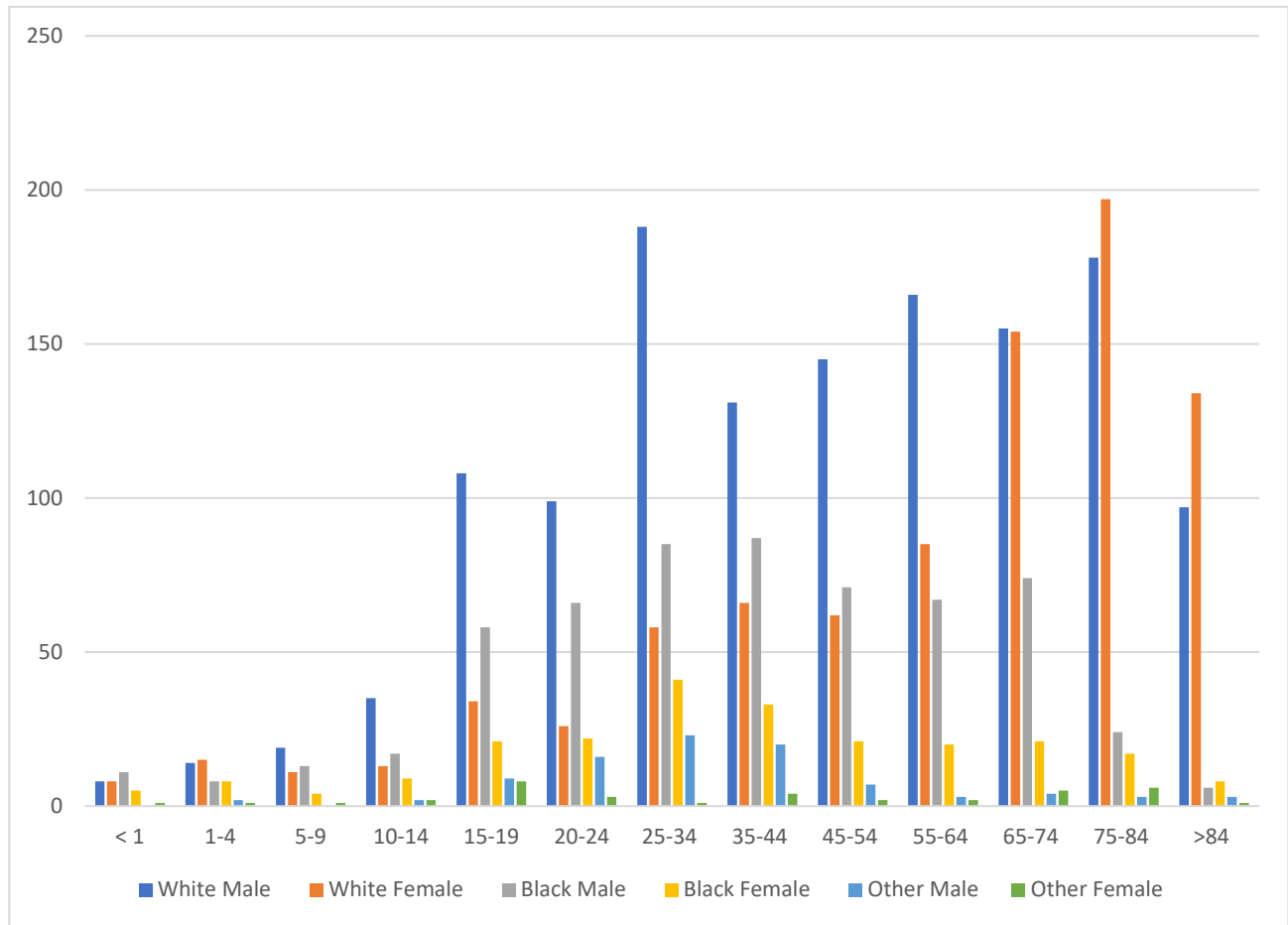
Incidence of TBI below 15 years of age is far lower than other categories and with fatality being sparse with relative equivalence across the age categories. Injury and death totals peak in the 35 to 64 and 75 to 84 year categories, while fatality rate progressively increases with age.

TBI Cases by Age, Gender, and Race: Comparison Table
January 1, 2023 – December 31, 2023
(n = 3,185)

Upon query for observations regarding combination factors (gender, race, and age), it was determined that 33 individuals were not valued regarding race, but that all were placed into an age category. Proportional analysis was conducted upon the remaining 3,152 observations and are compared below.

Age	White Male	White Female	Black Male	Black Female	Other Male	Other Female	Total	% Total
< 1	8	8	11	5	0	1	33	1%
1-4	14	15	8	8	2	1	48	2%
5-9	19	11	13	4	0	1	48	2%
10-14	35	13	17	9	2	2	78	2%
15-19	108	34	58	21	9	8	238	7%
20-24	99	26	66	22	16	3	232	7%
25-34	188	58	85	41	23	1	396	12%
35-44	131	66	87	33	20	4	341	11%
45-54	145	62	71	21	7	2	308	10%
55-64	166	85	67	20	3	2	343	11%
65-74	155	154	74	21	4	5	413	13%
75-84	178	197	24	17	3	6	425	13%
>84	97	134	6	8	3	1	249	8%
NOT VALUED	0	0	0	0	0	0	33	1%
Total	1,343	863	587	230	92	37	3,185	100%
Approximate % Total	42%	27%	18%	7%	3%	1%	100%	

TBI Age Distribution by Gender and Race



It is noted that white males lead every age category until age 75. White females predominate at ages 75-84 years and surpass white males after age 75 years. Although with fewer contributing occurrences, males of black/African American race and the composite “Other Races” categories predominate with similar patterns. Races other than white and black/African American were grouped to demonstrate the male gender predomination more clearly.

Discharge Disposition (From Emergency Department Phase of Care) Following TBI
January 1, 2023 – December 31, 2023
(n = 3,185)

Emergency Department Discharge Disposition	Facility Count	Facility Percentage
Acute Care Facility	147	4.62%
Another Type of Inpatient Facility Not Defined Elsewhere	8	0.25%
Burn Center	0	0.00%
Burn Unit	0	0.00%
Child Protective Agency	0	0.00%
Correctional Facility/Court/Law Enforcement	6	0.19%
Floor	538	16.89%
Home or Self-Care (Routine Discharge)	603	18.93%
Home with Services	2	0.06%
Hospice	1	0.03%
Intensive Care Unit	1,393	43.74%
Intermediate Care Facility	0	0.00%
Interventional Radiology	6	0.19%
Labor and Delivery	0	0.00%
Left Against Medical Advice (AMA)	19	0.60%
Long-Term Care	0	0.00%
Mental Health/Psychiatric Hospital (Inpatient)	1	0.03%
Morgue	44	1.38%
Neonatal/Pediatric Care Unit	0	0.00%
Nursing Home	2	0.06%
Observation Unit	18	0.57%
Operating Room	246	7.72%
Rehab (Inpatient)	0	0.00%
Skilled Nursing Facility	2	0.06%
Step-Down Unit	141	4.43%
Telemetry Unit	2	0.06%
Blank/NA/Unk	6	0.19%
TOTALS	3,185	100.00%

Of the 3,185 patients observed to have suffered TBI, 2,501 (79 percent) were known to have been transferred into another medical interventional environment following discharge from the ED. The proportion of patients who were ultimately transferred into inpatient or provided outpatient rehabilitation services is unknown. Being that 79 percent of all patients remained under medical care following the ED phase of intervention and with a combined proportion of 56 percent (approximately 1,794 patients) being transferred into acute or intermediate care, intensive care, surgery, or step-down evaluation, it is likely that rehabilitation services were required for approximately 1,500 to 2,000 patients. These estimates are in keeping with proportions outlined by the CDC “Traumatic Brain Injury in the United States: A Report to Congress” in 1999. The report is available online at: (https://www.cdc.gov/traumaticbraininjury/pubs/tbi_report_to_congress.html).

Whereas the incidence of TBI has been reducing from peaks observed in the early 1980s, likely due to mandated and improved safety ergonomics in general, the physically devastating nature of TBI remains. The large proportion of post-ED hospitalized patients within Alabama’s 2023 TBI population attests to that fact. Not considered here are the true fatality rates of TBI patients who were declared deceased in the field, and unknown are the proportion of patients who perished due to their injuries after leaving the ED. Data collection mechanisms in Alabama, as with any data collection system, are susceptible to incomplete data entry which sometimes limits information. Whereas mortality numbers of patients beyond the hospital phase of care cannot be fully accounted, information regarding patients entering the ADRS is available from that agency.

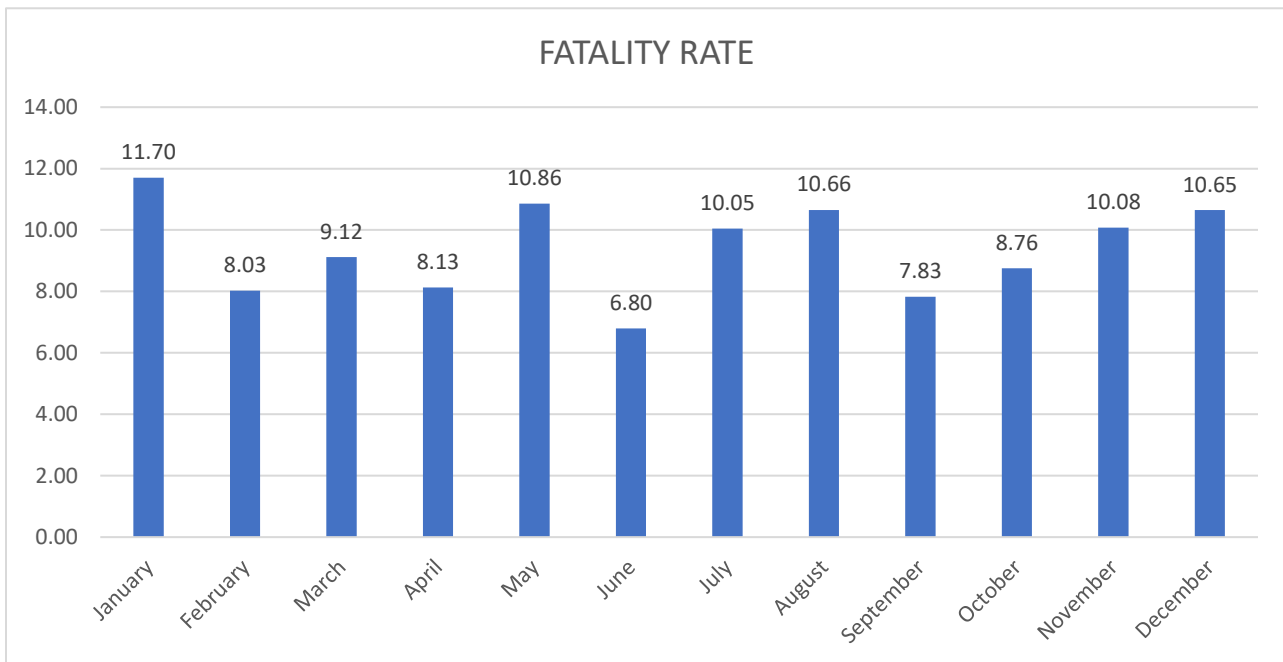
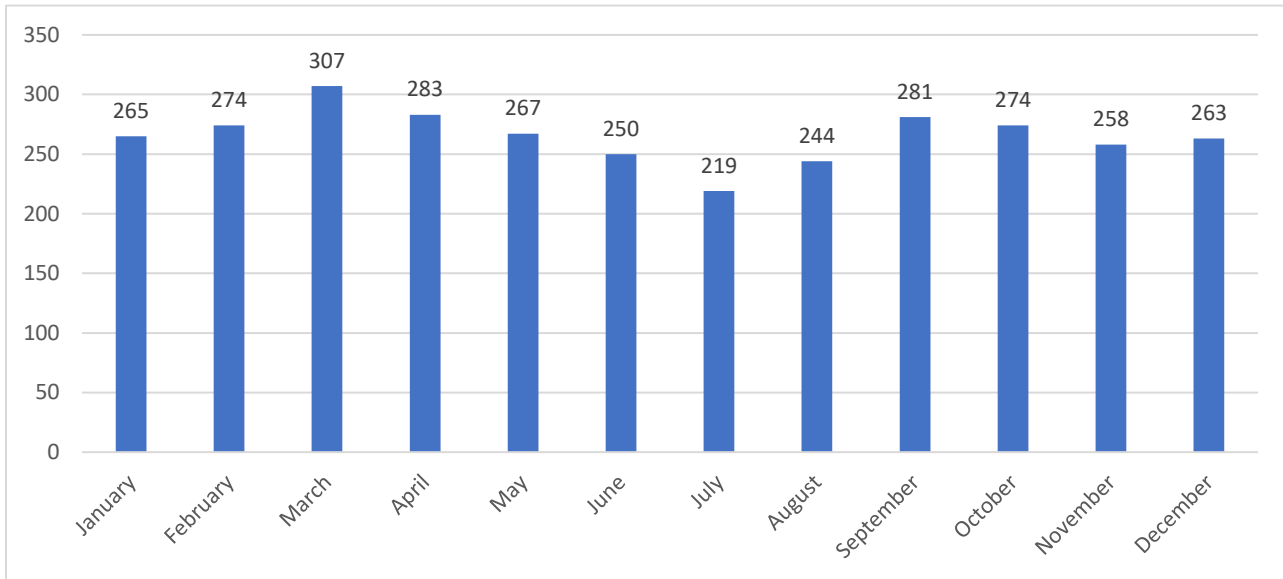
Mechanism of Injury Occurrence in TBI Cases
and Fatality as Outcome by Gender
January 1, 2023 – December 31, 2023
(n = 3,185)

Mechanism Of Injury	Percent of Females	Percent of Males	Fatality Rate Female	Fatality Rate Male
Cut or Pierce	0.35%	0.54%	0.00%	9.09%
Drowning/Submersion	0.00%	0.05%	0.00%	0.00%
Fall	51.41%	31.95%	4.62%	7.95%
Fire or Flame	0.26%	0.05%	66.67%	100.00%
Hot Object or Substance	0.00%	0.05%	0.00%	0.00%
Firearm	2.72%	6.30%	45.16%	45.74%
Machinery	0.00%	0.10%	0.00%	0.00%
*MVT-Occupant	24.34%	23.84%	7.58%	8.40%
MVT-Motorcyclist	0.44%	2.05%	0.00%	11.90%
MVT-Pedal Cyclist	0.18%	0.73%	0.00%	20.00%
MVT-Pedestrian	1.67%	2.78%	10.53%	31.58%
MVT-Other	0.00%	0.00%	0.00%	0.00%
MVT-Unspecified	2.90%	2.83%	12.12%	12.07%
Pedal Cyclist, Other	0.62%	0.98%	0.00%	0.00%
Pedestrian, Other	0.70%	0.78%	12.50%	12.50%
Other Land Transport	8.35%	11.09%	3.16%	3.96%
Other Transport	0.00%	0.24%	0.00%	0.00%
Natural or Environmental	0.53%	0.39%	16.67%	0.00%
Overexertion	0.00%	0.00%	0.00%	0.00%
Poisoning	0.00%	0.00%	0.00%	0.00%
Struck by or Against	2.81%	8.84%	3.13%	3.87%
Suffocation/Asphyxiation	0.00%	0.00%	0.00%	0.00%
Other Specified, Classifiable	0.26%	0.10%	0.00%	0.00%
Other Specified, Not Elsewhere Classified	0.18%	0.20%	0.00%	0.00%
Pedestrian Conveyance	0.44%	0.15%	0.00%	33.33%
Electrical	0.00%	0.00%	0.00%	0.00%
Mechanical	0.09%	0.20%	0.00%	25.00%
Explosion	0.00%	0.10%	0.00%	0.00%
Abuse	0.18%	0.05%	0.00%	0.00%
Not Classified	0.26%	1.32%	0.00%	14.81%
Blank/NA/Unk	1.32%	4.30%	26.67%	7.95%

**NOTE: "MVT" is an acronym for "Motor Vehicle Transportation" which is subset with a qualifier such as "occupant" (which indicates either driver or passenger).*

A cursory review reveals that falls are a predominant mechanism of injury; 51 percent of females and 32 percent of males incur TBI by falling. As a result of a fall, 5 percent of the females who fall and 8 percent of the males who fall end up dying in the ED during care. The second most prevalent mechanism of injury is MVT-Occupant (or being involved in a motor vehicle crash) as either the driver or a passenger. Of females, 24 percent incurred TBI via a motor vehicle crash, while 24 percent of males likewise incurred TBI. Of females incurring TBI via a motor vehicle crash, 8 percent died as a result, while 8 percent of males died. The mortality rate for motorcycle accidents was 12 percent for males and 0 percent for females and bicycle accidents were 20 percent fatal for males and 0 percent fatal for females. The rate for pedestrian accidents is 2 percent in females and 3 percent in males and the resulting death rates are 11 percent in females and 32 percent in males. TBI is devastating in patients whose impacts were sufficient to cause injury despite the use of a helmet, and other injuries incurred could have also contributed to death. The high death rates in the injuries incurred outside of a vehicle's protection mechanisms also speak to the effectiveness of modern vehicular safety devices. The highest death rates of classifiable mechanisms are those of firearm injury. Although the population percentage of both males and females who incur TBI secondary to firearm injury are minimal with 3 percent of females and 6 percent of males, the resulting death rates are 45 percent and 46 percent respectively.

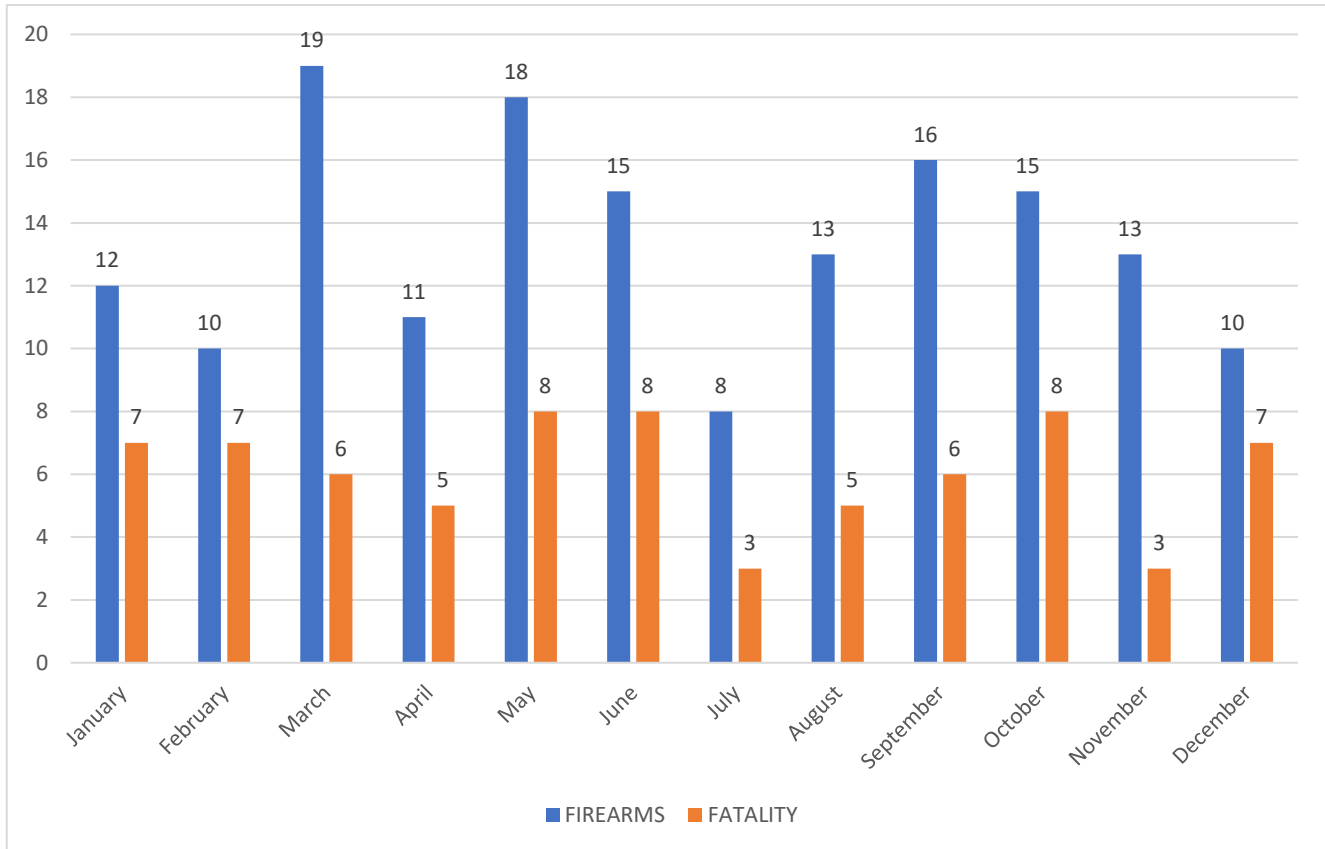
TBI Occurrence and Fatality by Month
January 1, 2023 – December 31, 2023
(n = 3,185)



Of the 3,185 patients who experienced TBI in this study, only 233 (7 percent) experienced firearms injuries. Firearms injuries averaged 11.67 per month, with a low of 8 incidents in February and July and a high of 15 incidents in June. The highest fatality rate for firearms injuries was 7 out of 12 (58 percent) in April and the lowest was 3 out of 14 injuries (21 percent) in November. In the TBI subgroup, the greatest number of injuries were incurred from falls and motor vehicle accidents.

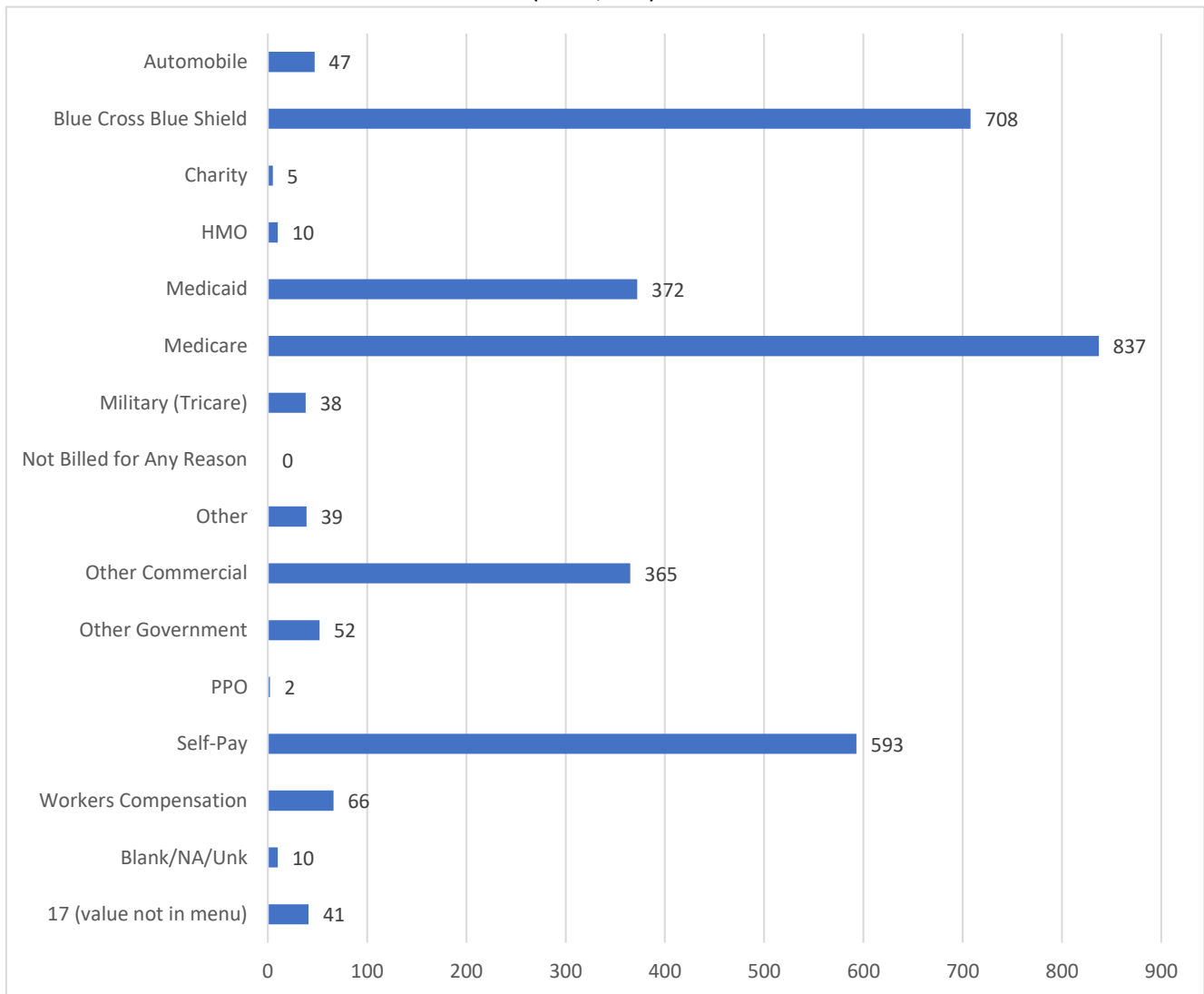
Firearms TBI Injury Per Month
January 1, 2023 – December 31, 2023
(n = 160)

Firearms TBI Fatality Per Month
(n = 73)



Firearms-related TBI averages 13.33 occurrences per month, ranging from 8 incidents in July to 19 incidents in March. Similarly, firearms-related TBI fatalities average 6 occurrences per month, ranging from 3 in July and November, to 8 in May, June, and October. Note that these statistics only involve those patients entered into the AHSCIR and are not reflective of general firearms injury incidence or fatality within the state of Alabama.

TBI Cases by Payer Source
January 1, 2023 – December 31, 2023
(n = 3,185)



Of the 3,185 TBI patients, all patients were billed for services. Source of payment is not known or not clear on 51 patients (2 percent). Five patients were written off as charity (<1 percent). Further, 2,497 patients (78 percent) were billed to some sort of insurance or were otherwise covered for charges. The remaining 593 patients (19 percent) were billed as “self pay” which is typically done when there is no billable insurance. The largest single payer of all categories is Medicare (837 patients or 26 percent of all TBI patients). Medicare is reserved for patients of advanced age or verified disability.

TBI Case Primary Payer Source and Fatality Statistics
(n = 3,185)

Primary Payer	Count	Percent	Deaths	Fatality Rate
Automobile	47	1.48%	7	14.89%
Blue Cross Blue Shield	708	22.23%	45	6.36%
Charity	5	0.16%	1	20.00%
HMO	10	0.31%	2	20.00%
Medicaid	372	11.68%	36	9.68%
Medicare	837	26.28%	69	8.24%
Military (Tricare)	38	1.19%	1	2.63%
Not Billed for Any Reason	0	0.00%	0	0.00%
Other	39	1.22%	6	15.38%
Other Commercial	365	11.46%	42	11.51%
Other Government	52	1.63%	4	7.69%
PPO	2	0.06%	0	0.00%
Self-Pay	593	18.62%	69	11.64%
Workers Compensation	66	2.07%	7	10.61%
Blank/NA/Unk	10	0.31%	1	10.00%
17 (value not in menu)	41	1.29%	8	19.51%
TOTALS	3,185	100.00%	298	

It is noteworthy that 69 (24 percent) of the 298 fatalities were verified as “self-pay”; therefore, may or may not have the ability or resources to pay hospital charges for services rendered. Further, 593 (19 percent) of all TBI patients were also listed at “self-pay” as noted previously.

Spinal Cord Injury (SCI)

The Mayo Clinic (2020) defines a spinal cord injury as damage to any part of the spinal cord or nerves at the end of the spinal canal. Spinal cord injuries in many instances often cause permanent changes in strength, sensation, and other body functions below the site of the injury. Spinal cord injuries result from damage to the vertebrae, ligaments, or disks of the spinal column or to the spinal cord itself.

A traumatic spinal cord injury may stem from a sudden, traumatic blow to the spine that fractures, dislocates, crushes, or compresses one or more of the vertebrae. It also may result from a gunshot or knife wound that penetrates and cuts the spinal cord. Additional damage usually occurs over days or weeks because of bleeding, swelling, inflammation, and fluid accumulation in and around the spinal cord. A non-traumatic spinal cord injury may be caused by arthritis, cancer, inflammation, infections, or disk degeneration of the spine.

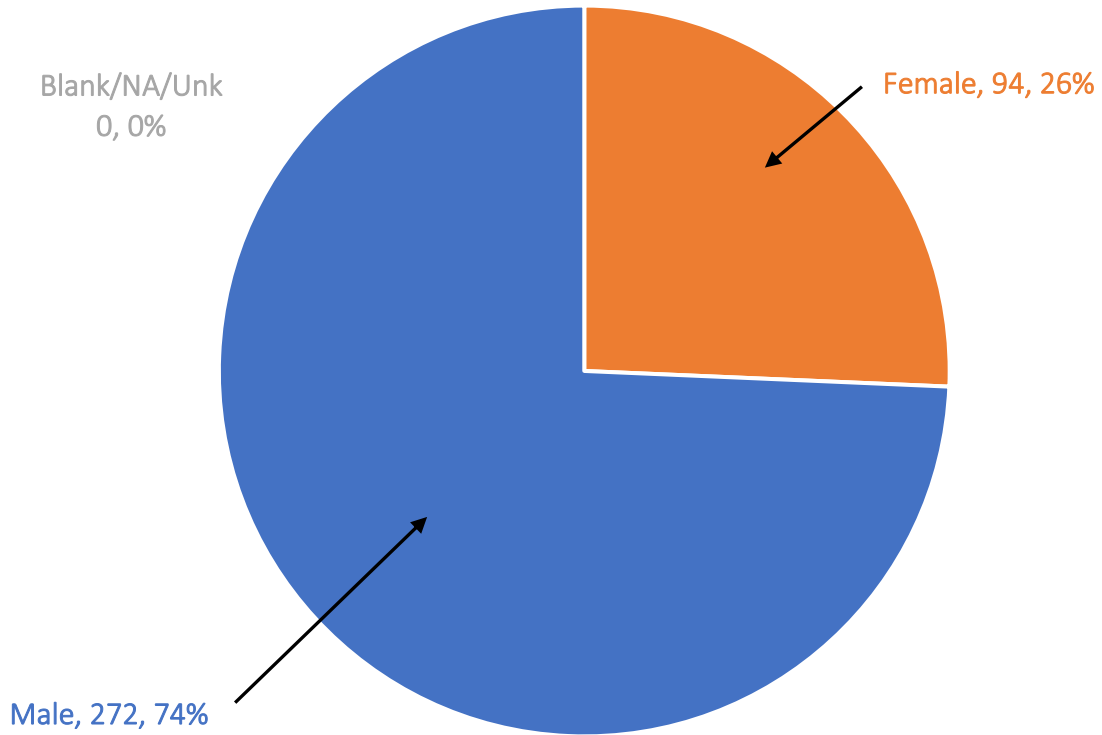
Mechanisms of Injury

According to the National Spinal Cord Injury Statistical Center (NSCISC) 2023 Annual Report, the most common causes of spinal cord injuries are:

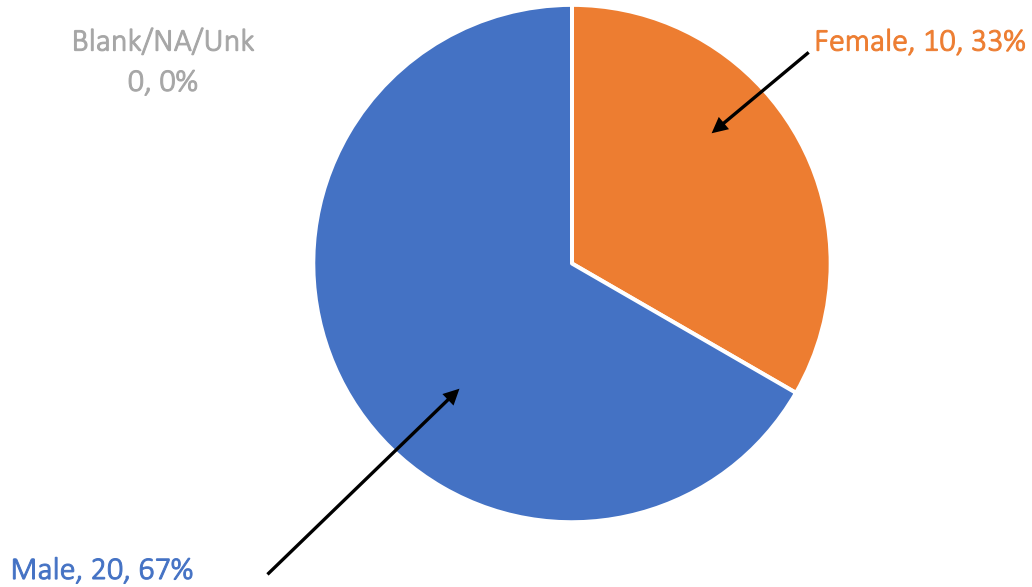
- Motor vehicle accidents. Auto and motorcycle accidents are the leading causes of spinal cord injuries, accounting for more than 40 percent of new spinal cord injuries each year.
- Falls. Spinal cord injury after age 45 is most often caused by a fall. Overall, falls cause approximately one-quarter of spinal cord injuries.
- Acts of violence. Around 17 percent of spinal cord injuries result from violent encounters, often involving gunshot and knife wounds.
- Sports and recreation injuries. Athletic activities, such as impact sports and diving in shallow water, cause about 10 percent of spinal cord injuries.

Non-traumatic etiologies such as cancer, arthritis, osteoporosis, and inflammation of the spinal cord can also cause spinal cord injuries. (Non-traumatic, disease-mediated cases are not counted in this report.)

SCI Cases by Gender
January 1, 2023 – December 31, 2023
(n = 366)



SCI Case Fatalities by Gender
(n = 30)

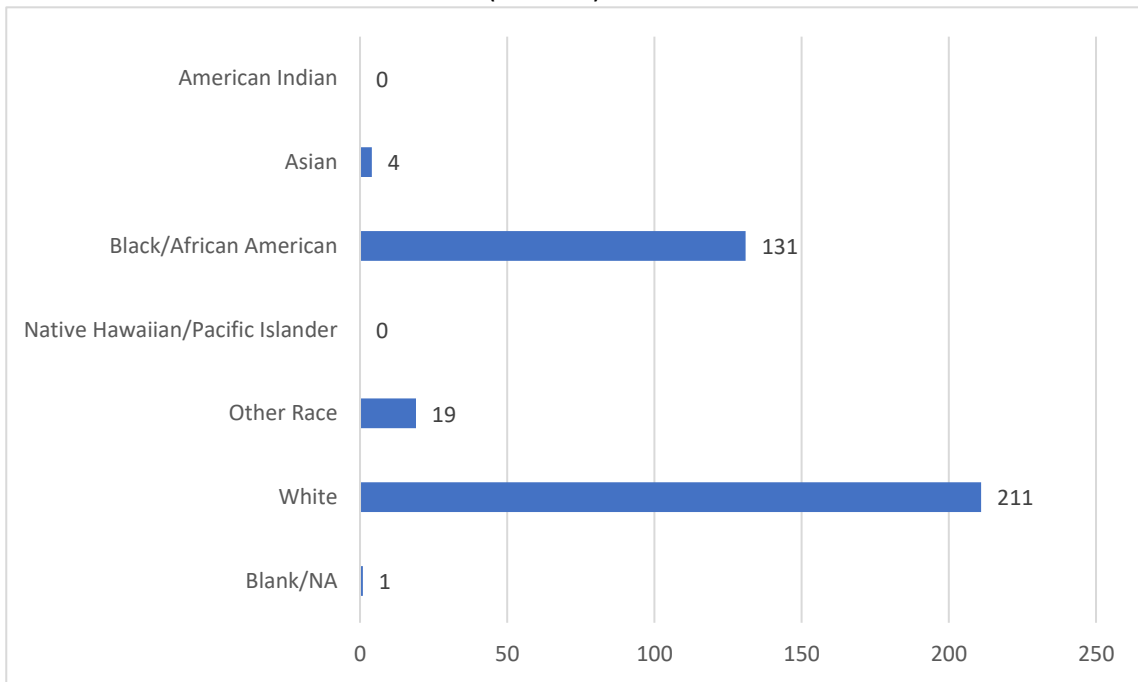


SCI Gender and Mortality Statistics
(n = 366)

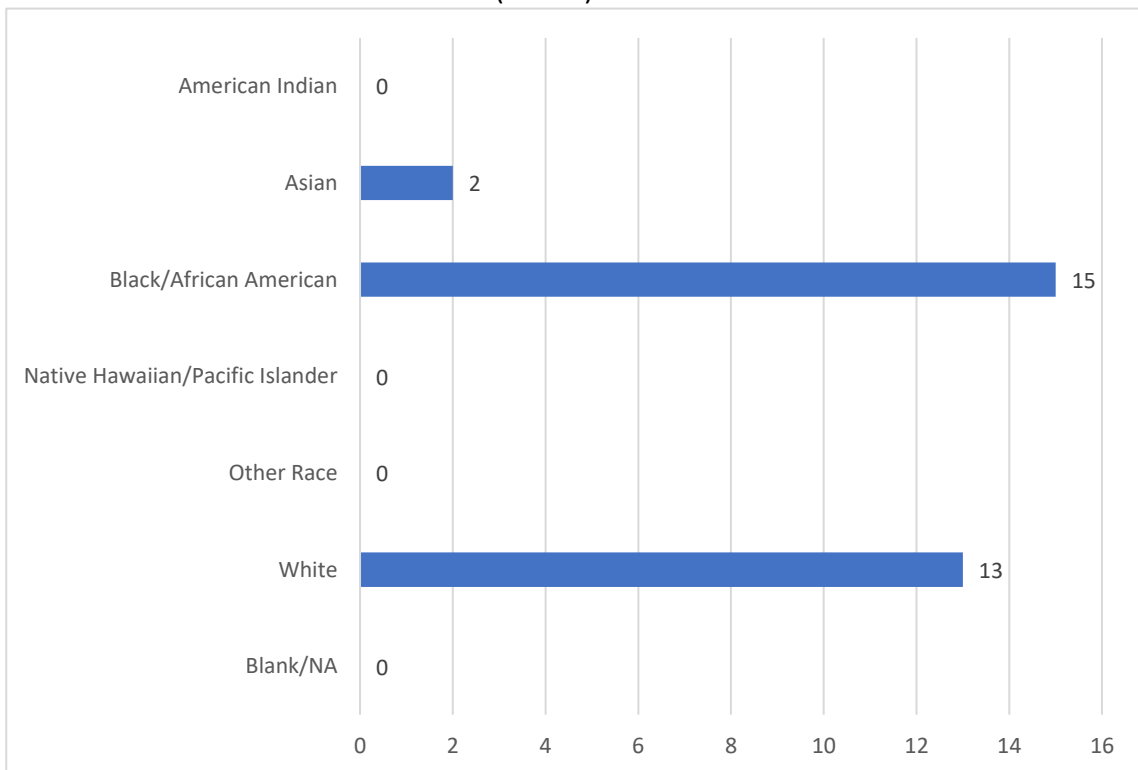
Gender	Count	Percentage	Fatalities	Population Percentage	Fatality Proportion
Male	272	74%	20	11%	67%
Female	94	26%	10	8%	33%
Not Valued	0	0%	0	0%	0%
Total	366	100%	30	16%	100%
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other				

Males predominate neurological injuries in general by a ratio of approximately 2.9:1, males to females, or 48 percent higher male presence. Males predominate over females in the SCI subgroup by approximately three males to every female. No obvious explanation for the disparity is evident.

SCI Cases by Race
January 1, 2023 – December 31, 2023
(n = 366)



SCI Mortality by Race
(n = 30)

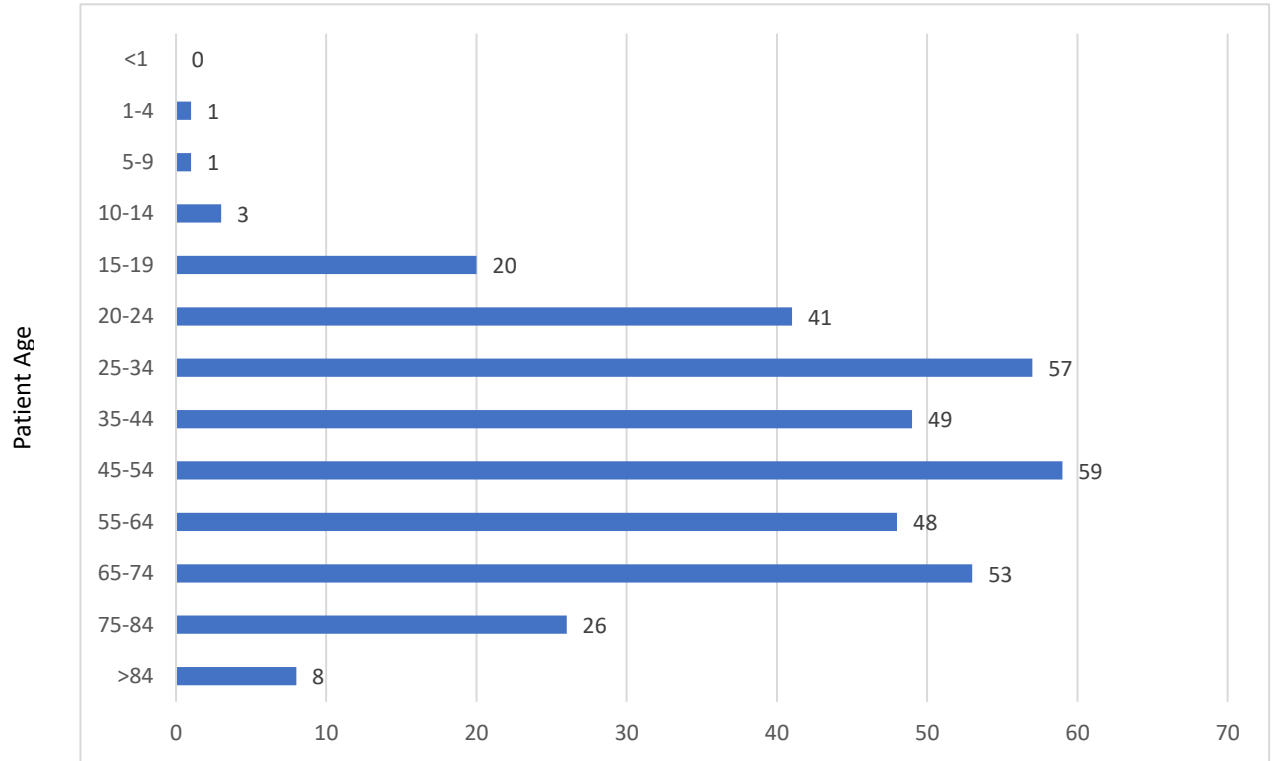


SCI Race and Mortality Statistics
(n = 366)

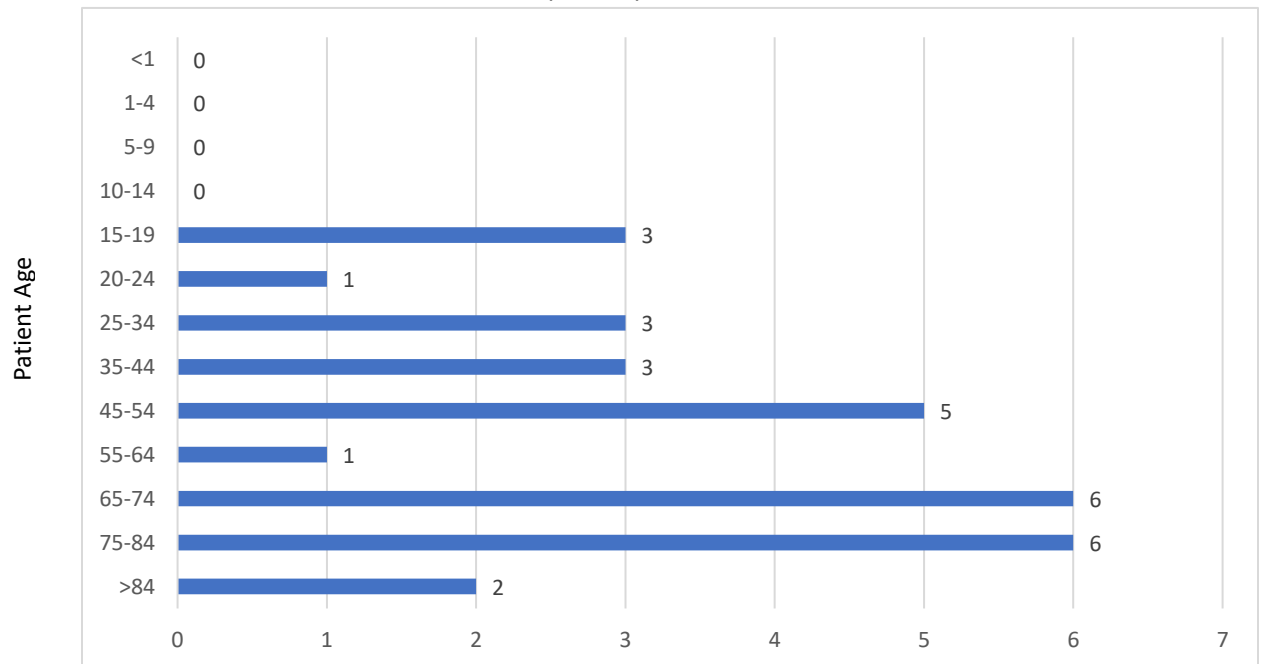
Race	Count	Population Percentage	Fatalities	Fatality Proportion
American Indian	0	0%	0	0%
Asian	4	1%	2	7%
Black/African American	131	36%	15	50%
Native Hawaiian /Pacific Islander	0	0%	0	0%
Other Race	19	5%	0	0%
White	211	58%	13	43%
Not Valued	1	0%	0	0%
Total	366	100%	30	100%
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other			

SCI race and outcome of mortality was compared to that of TBI listed previously and found to parallel with some minor random variation of proportions. It appears that patient race proportions coincide with population race proportions and that no evidence exists for outcome differences among races. Proportional comparisons for SCI cases are also complicated by the relatively small number of cases.

SCI Cases and Fatality by Age
January 1, 2023 – December 31, 2023
SCI Incidence by Age
(n = 366)



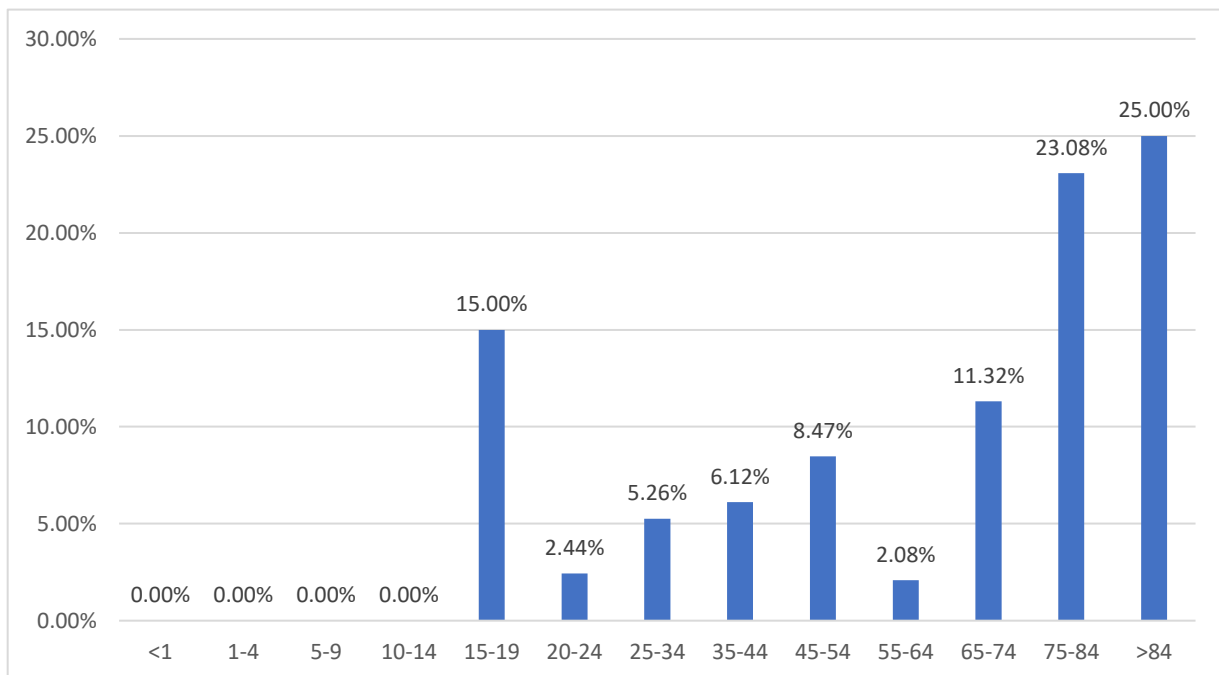
SCI Mortality by Age
(n = 30)



SCI Age and Mortality Statistics
(n = 366)

AGE GROUP YEARS	COUNT	PERCENT	DEATHS	FATALITY RATE
< 1	0	0.00%	0	0.00%
1 – 4	1	0.27%	0	0.00%
5 – 9	1	1.27%	0	0.00%
10 – 14	3	0.82%	0	0.00%
15 – 19	20	5.46%	3	15.00%
20 – 24	41	11.20%	1	2.44%
25 – 34	57	15.57%	3	5.26%
35 – 44	49	13.39%	3	6.12%
45 – 54	59	16.12%	5	8.47%
55 – 64	48	13.11%	1	2.08%
65 – 74	53	14.48%	6	11.32%
75 – 84	26	7.10%	6	23.08%
> 84	8	2.19%	2	25.00%
TOTALS	366	100.00%	30	OVERALL 8.20%

SCI Fatality by Age Comparison
(n = 30)



Fatalities are observed starting at age 15-19 years and initially peaks at 3 fatalities for the age category, then experiences an equivalent bimodal peak at 65-84. It is noteworthy that the first category includes only 5 years while the second category includes 10 years. The initial peak is correlated with a fatality rate of approximately 15 percent, while the second peak correlated to a fatality rate of 23 and 25 percent respectively. Factors driving the much higher death rate at the younger age are unclear.

Discharge Disposition (From Emergency Department Phase of Care) Following SCI
January 1, 2023 – December 31, 2023
(n = 366)

Emergency Department Discharge Disposition	Facility Count	Facility Percentage
Acute Care Facility	6	1.64%
Another Type of Inpatient Facility	1	0.27%
Burn Center	0	0.00%
Burn Unit	0	0.00%
Child Protective Agency	0	0.00%
Correctional Facility/Court/Law Enforcement	0	0.00%
Floor	74	20.22%
Home or Self-Care (Routine Discharge)	9	2.46%
Home with Services	0	0.00%
Hospice	0	0.00%
Intensive Care Unit	184	50.27%
Intermediate Care Facility	0	0.00%
Interventional Radiology	0	0.00%
Labor and Delivery	0	0.00%
Left AMA	0	0.00%
Long-Term Care	0	0.00%
Mental Health/Psychiatric Hospital (Inpatient)	0	0.00%
Morgue	0	0.00%
Musculoskeletal Rehabilitation	0	0.00%
Neonatal/Pediatric Care Unit	0	0.00%
Nursing Home	0	0.00%
Observation Unit	4	1.09%
Operating Room	80	21.86%
Rehab (Inpatient)	0	0.00%
Skilled Nursing Facility	0	0.00%
Step-Down Unit	7	1.91%
Telemetry Unit	1	0.27%
Blank/NA/Unk	0	0.00%
TOTALS	366	100.00%

Of the 366 SCI patients observed, 357 (96 percent) were known to have been transferred from the ED phase of care to another medical interventional environment; 184 (50 percent) went into intensive care unit (ICU) and 80 (22 percent) went to surgery. As large groups were transferred to interventional hospitalization, it stands to reason that a significant proportion of the SCI population would require state provided rehabilitation services either for limited or indefinite periods of time.

Whereas, neither the post ED phase dispositions of TBI and SCI groups, nor post hospitalization dispositions for TBI or SCI have been discussed; in the following section, the post hospitalization outcomes for both injury groups will be described and contrasted.

Hospital Discharge Dispositions of TBI and SCI Sub-Groups

January 1, 2023 – December 31, 2023

TBI (n = 3,185)

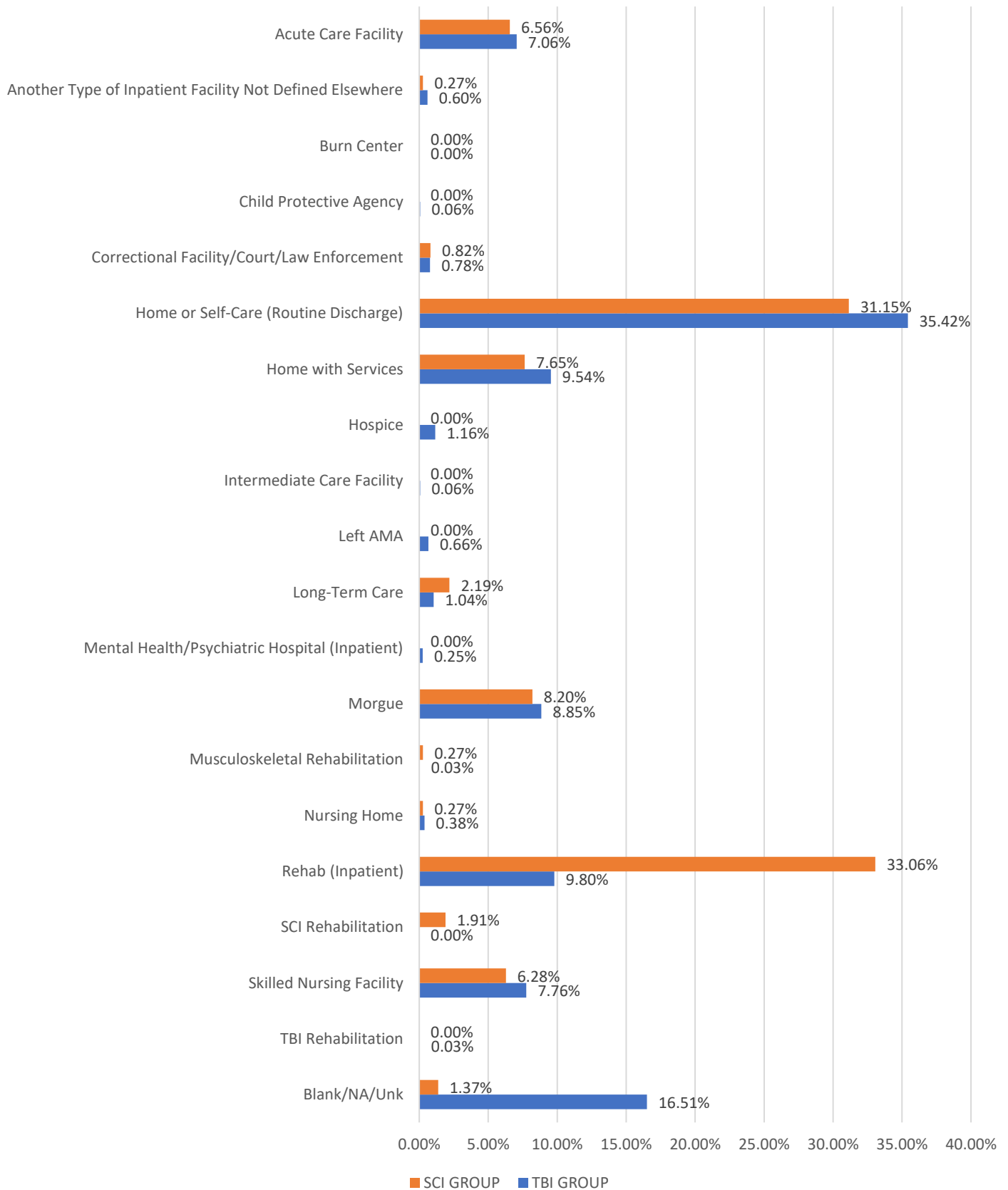
SCI (n = 366)

Hospital Discharge Disposition	TBI Group		SCI Group	
	Count	Percent	Count	Percent
Acute Care Facility	225	7.06%	24	6.56%
Another Type of Inpatient Facility	19	0.60%	1	0.27%
Burn Center	0	0.00%	0	0.00%
Child Protective Agency	2	0.06%	0	0.00%
Correctional Facility/Court/Law Enforcement	25	0.78%	3	0.82%
Home or Self-Care (Routine Discharge)	1128	35.42%	114	31.15%
Home with Services	304	9.54%	28	7.65%
Hospice	37	1.16%	0	0.00%
Intermediate Care Facility	2	0.06%	0	0.00%
Left AMA	21	0.66%	0	0.00%
Long-Term Care	33	1.04%	8	2.19%
Mental Health/Psychiatric Hospital	8	0.25%	0	0.00%
Morgue	282	8.85%	30	8.20%
Musculoskeletal Rehabilitation	1	0.03%	1	0.27%
Nursing Home	12	0.38%	1	0.27%
Rehab (Inpatient)	312	9.80%	121	33.06%
SCI Rehabilitation	0	0.00%	7	1.91%
Skilled Nursing Facility	247	7.76%	23	6.28%
TBI Rehabilitation	1	0.03%	0	0.00%
Blank/NA/Unk	526	16.51%	5	1.37%
TOTALS	3,185	100.00%	366	100.00%

A cursory review finds that 90 percent of outcomes compared between groups are within a few percentage points and most are virtually identical. The exceptions are those patients discharged to home without supportive services being necessary (routine discharge) for which 35 percent of TBI patients and 31 percent of SCI patients are listed, and those patients who were discharged to inpatient rehabilitation facilities for which 10 percent of TBI patients and 33 percent of SCI patients were listed.

A graph chart comparing each hospital discharge disposition proportion is listed on the following page.

Hospital Discharge Disposition Proportions



Mechanism of Injury Occurrence in SCI Cases and Fatality as Outcome

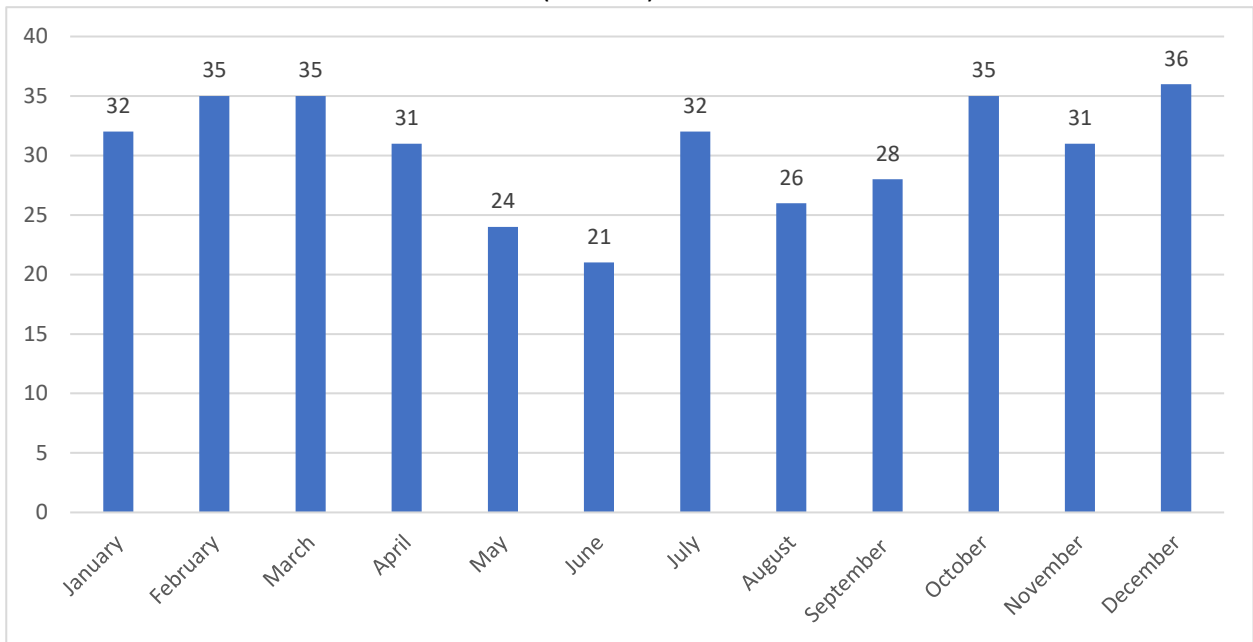
January 1, 2023 – December 31, 2023

(n = 366)

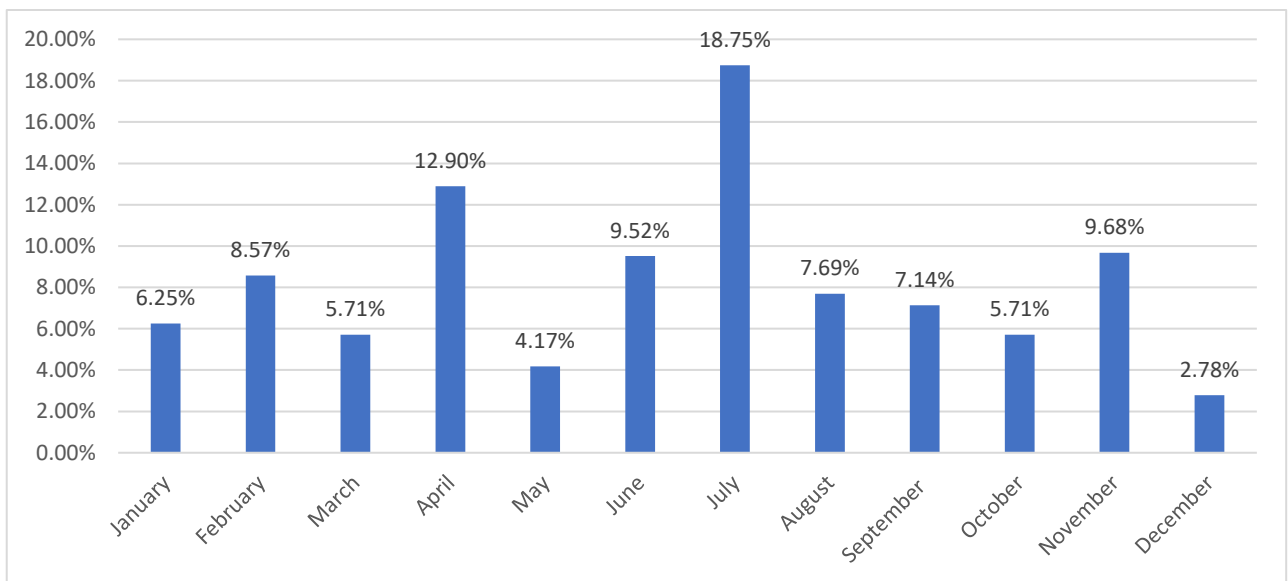
Primary Mechanism of Injury	Count	Percent	Deaths	Fatality Rate
Cut or Pierce	1	0.27%	0	0.00%
Drowning/Submersion	0	0.00%	0	0.00%
Fall	102	27.87%	6	5.88%
Fire or Flame	0	0.00%	0	0.00%
Hot Object or Substance	0	0.00%	0	0.00%
Firearm	48	13.11%	7	14.58%
Machinery	0	0.00%	0	0.00%
MVT-Occupant	134	36.61%	8	5.97%
MVT-Motorcyclist	7	1.91%	1	14.29%
MVT-Pedal Cyclist	2	0.55%	2	100.00%
MVT-Pedestrian	5	1.37%	1	20.00%
MVT-Other	0	0.00%	0	0.00%
MVT-Unspecified	11	3.01%	1	9.09%
Pedal Cyclist, Other	3	0.82%	0	0.00%
Pedestrian, Other	3	0.82%	1	33.33%
Other Land Transport	21	5.74%	1	4.76%
Other Transport	1	0.27%	0	0.00%
Natural or Environmental	0	0.00%	0	0.00%
Overexertion	0	0.00%	0	0.00%
Poisoning	0	0.00%	0	0.00%
Struck by or Against	11	3.01%	0	0.00%
Suffocation/Asphyxiation	0	0.00%	0	0.00%
Other Specified, Classifiable	0	0.00%	0	0.00%
Other Specified, Not Elsewhere Classified	0	0.00%	0	0.00%
Pedestrian Conveyance	1	0.27%	0	0.00%
Electrical	0	0.00%	0	0.00%
Mechanical	4	1.09%	0	0.00%
Explosion	0	0.00%	0	0.00%
Abuse	0	0.00%	0	0.00%
Not Classified	0	0.00%	0	0.00%
Blank/NA/Unk	12	3.28%	2	16.67%
TOTALS	366	100.00%	30	8.20% Overall

Of the 366 SCI patients observed, 134 (37 percent) were injured in motor vehicle accidents as either the driver or occupant. Further, 102 (28 percent) were injured during a fall. Forty-eight patients (13 percent) were injured by firearms, of which 7 (15 percent) died during treatment. Seven patients (2 percent) were injured in motorcycle accidents, of which 1 died (14 percent). Whereas, only 3 patients (1 percent) were injured in pedestrian accidents other than MVT related and 5 patients (1 percent) in MVT related pedestrian accidents. A pedestrian fatality was recorded within the MVT related category as well as the Other-related category, with fatality rates of 20 percent and 33 percent respectively. A total of 159 (43 percent) injuries were related to motor vehicles in some way.

SCI Occurrence and Fatality by Month
January 1, 2023 – December 31, 2023
(n = 366)

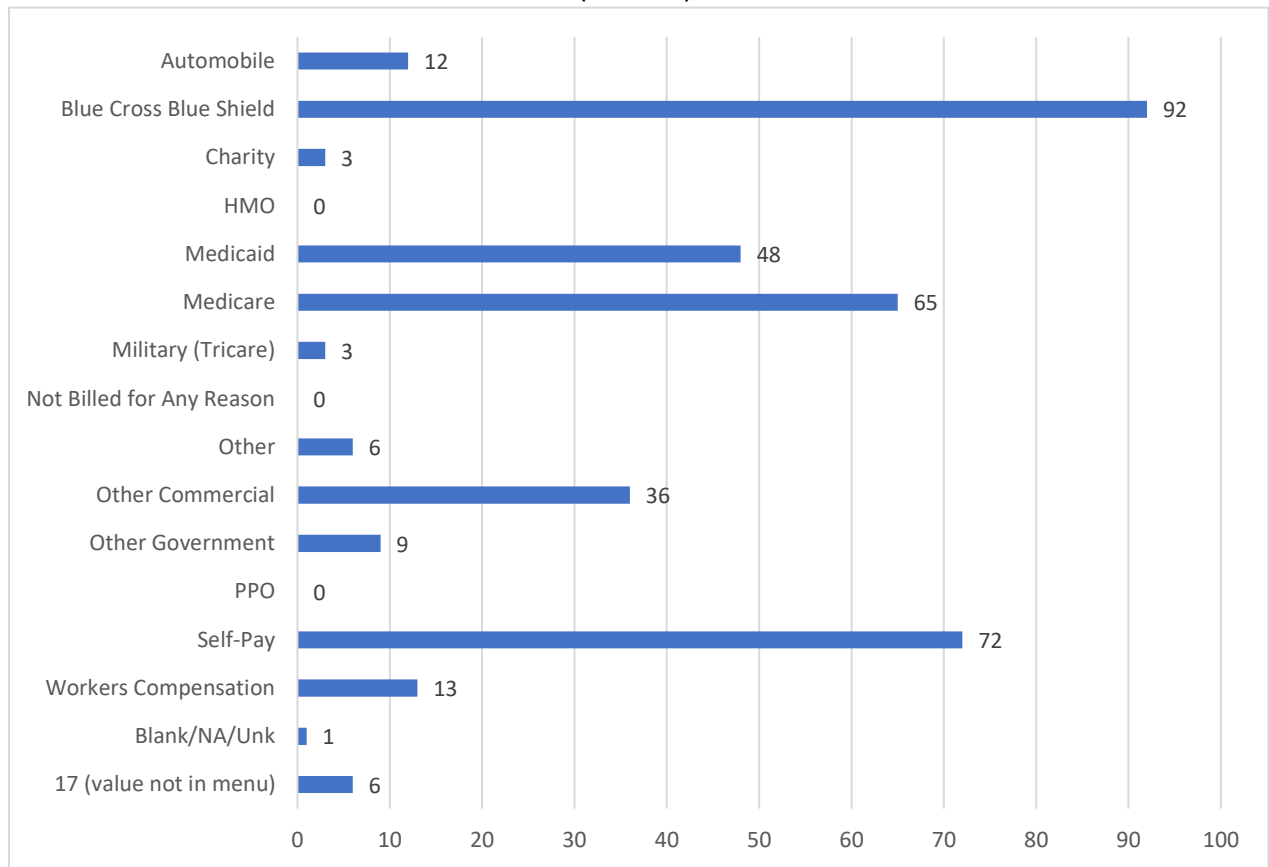


FATALITY RATE



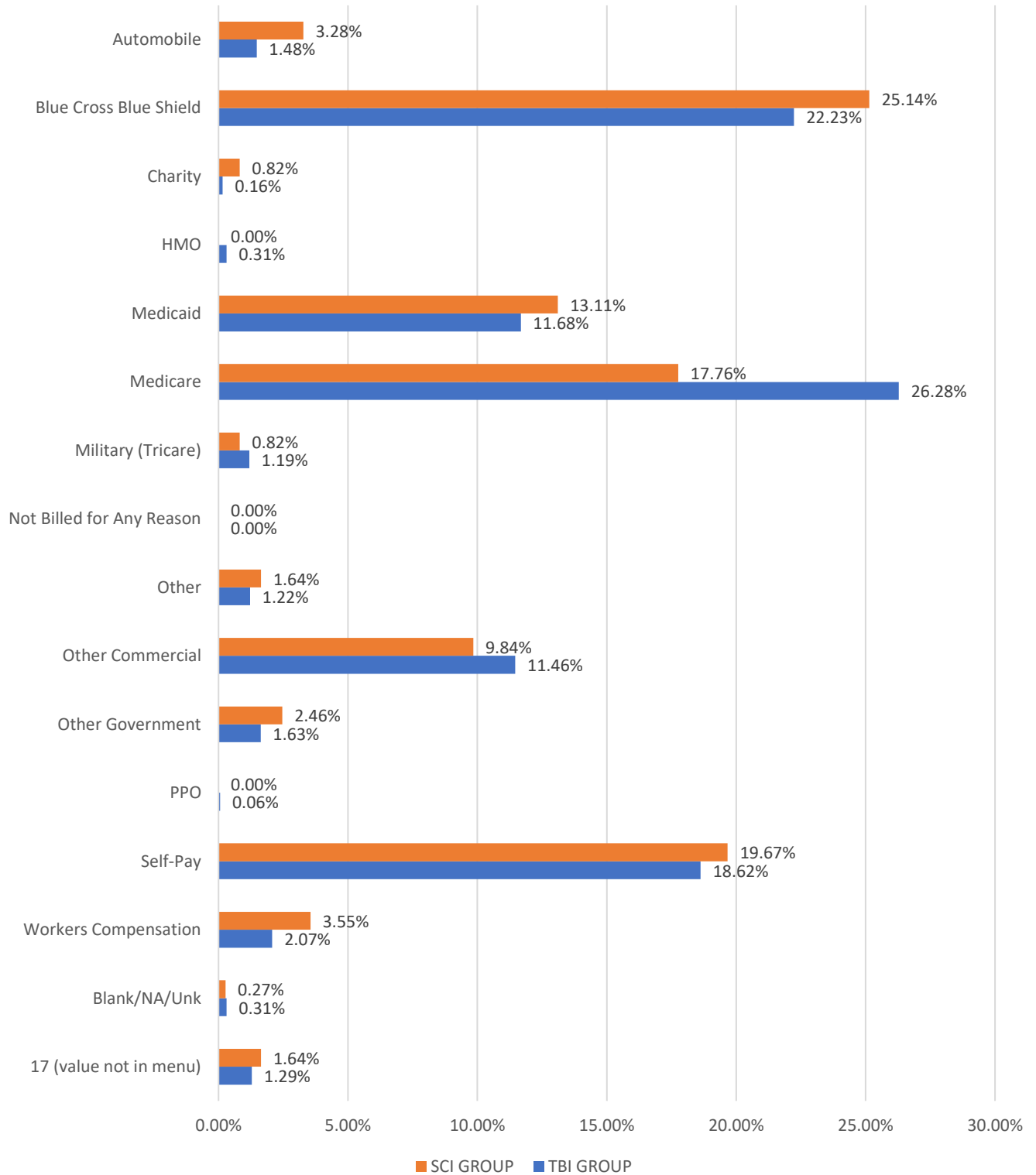
The average injury count per month for SCI in 2023 was 30.5 (high of 36 in December and a low of 21 in June). The average monthly SCI fatality rate for 2023 was 8 percent (high of 19 percent in July and low of 3 percent in December). Given the small numbers per month, it appears that the occurrences and fatality rate variation do not reflect any seasonal changes in incidence or lethality and that variation is likely random statistical variation.

SCI Cases by Payer Source
January 1, 2023 – December 31, 2023
(n = 366)



Of the 366 SCI patients, all patients were billed for services. Source of payment is not known or not clear on 7 patients (2 percent). Three patients were written off for charity. Two hundred ninety-one patients (80 percent) were billed to some sort of insurance or were otherwise covered for charges. The remaining 72 patients (20 percent) were billed as “self-pay” which is typically done when there is no billable insurance. The largest single payer of all categories is Blue Cross-Blue Shield (92 patients or 25 percent of all SCI patients).

PAYER SOURCE PROPORTION COMPARISON **TBI GROUP VERSUS SCI GROUP**



SCI Case Primary Payer Source and Fatality Statistics
(n = 366)

Primary Payer	Count	Percent	Deaths	Fatality Rate
Automobile	12	3.28%	2	16.67%
Blue Cross Blue Shield	92	25.14%	4	4.35%
Charity	3	0.82%	0	0.00%
HMO	0	0.00%	0	0.00%
Medicaid	48	13.11%	3	6.25%
Medicare	65	17.76%	7	10.77%
Military (Tricare)	3	0.82%	0	0.00%
Not Billed for Any Reason	0	0.00%	0	0.00%
Other	6	1.64%	0	0.00%
Other Commercial	36	9.84%	3	8.33%
Other Government	9	2.46%	0	0.00%
PPO	0	0.00%	0	0.00%
Self-Pay	72	19.67%	7	9.72%
Workers Compensation	13	3.55%	1	7.69%
Blank/NA/Unk	1	0.27%	1	100.00%
17 (value not in menu)	6	1.64%	2	33.33%
TOTALS	366	100.00%	30	8.20%

Conclusion

In 2023, participating Alabama hospitals entered a total of 3,491 patients meeting the defined ICD-10 diagnosis criteria for injury of the central nervous system. The ICD-10 selection criteria were designed to isolate those patients of interest who had suffered TBI or SCI. The 2022 study considered that 2 percent of patients were likely to have suffered a combination of injuries; however, due to problematic differential diagnoses all patients were assigned either TBI or SCI designations depending upon the primary injured areas. Combination of injury was excluded in this study. It was determined that 89 percent of neurological injury patients were primarily TBI, 9 percent of patients were primarily SCI, and 2 percent of patients suffered combination of the two. The two major subgroups were compared and contrasted to search for differences in causes, severities, financial burden, and outcomes including mortality. Survival status was especially considered for potential entry into the Alabama Department of Rehabilitation Services.

Studies in previous years were completed with a different database and likely with wider inclusion criteria and included a larger number of patients. Reduction of patient numbers, therefore, should not be suspected to have any other causality. Beginning in 2021 our reviews have isolated those patients with injury diagnosis specifically of interest. Such patients are traditionally found to have experienced devastating or potentially devastating injuries. Overall survivability was found to be at or around 91 percent in general and hospitalization potential, and thus the potential for rehabilitative services was found to be significant.