Alabama Head and Spinal Cord Injury Report 2024

ALABAMA DEPARTMENT OF PUBLIC HEALTH
EST. 1875

2024 Alabama Head and Spinal Cord Injury Registry (AHSCIR) Report

Data Period:
January 1, 2024 – December 31, 2024

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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 14,904 patients in the Year 2024. Of those 14,904 patients, 592 (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 - 2024 REPORT CRITERIA

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

***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, 2024. 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).

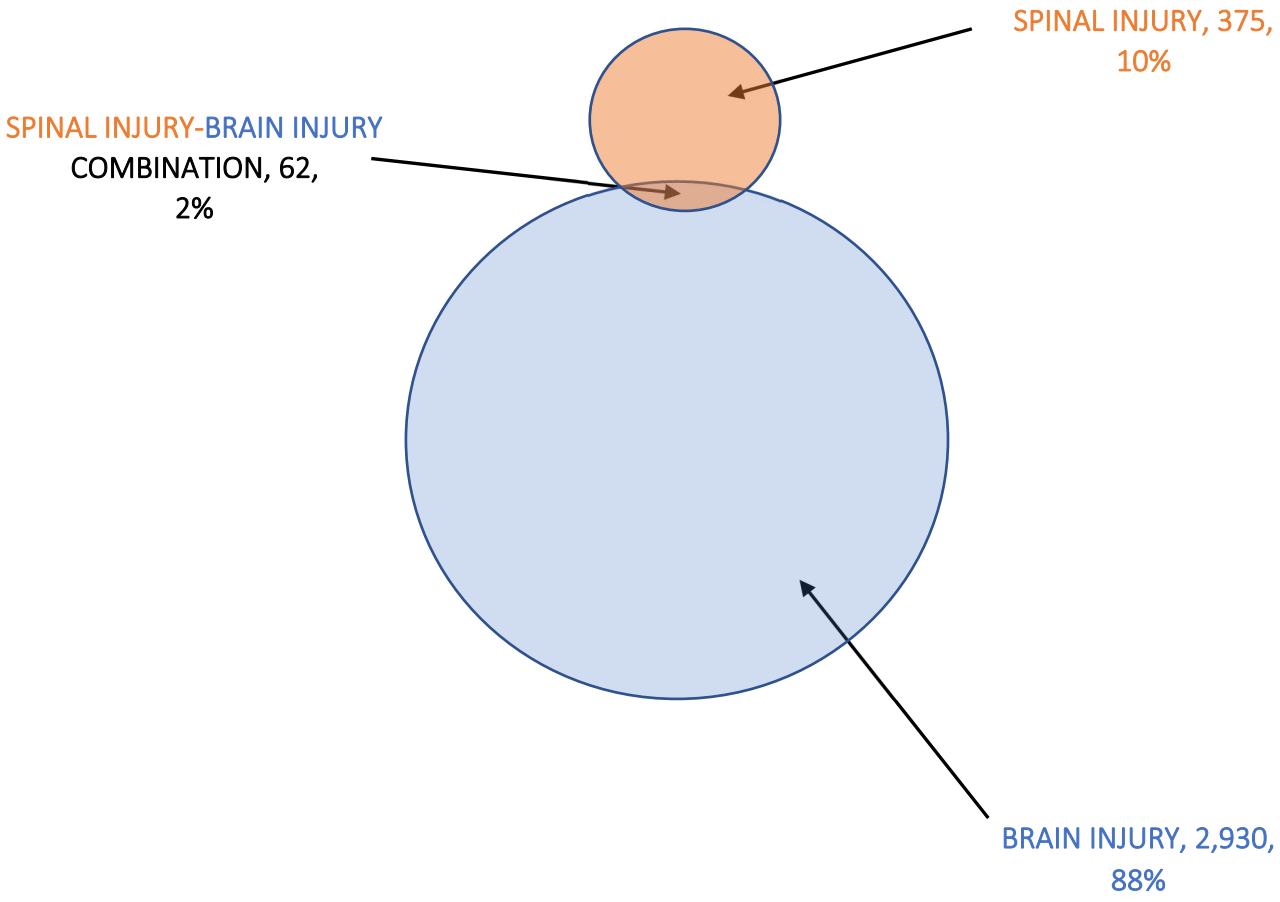
RESULTS

The ATR received reports of 3,243 neurological injuries of the head and spinal cord for Year 2024 compared to 3,491 reported head and spinal cord injury cases that were included in this report for Year 2023. The reduction of 8 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 2024 patient entry period.

TBI exclusively constituted approximately 90 percent (n = 2,930) of the reported cases and SCI exclusively constituted approximately 12 percent (n = 375). 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 concomitate spinal cord injury. Data extraction found that about 62 patients (approximately 2 percent) suffered from combination of TBI and SCI injuries. Of the patients who suffered any type of SCI, approximately 65 percent (n = 244) suffered spinal injury at the level of the cervical spine.

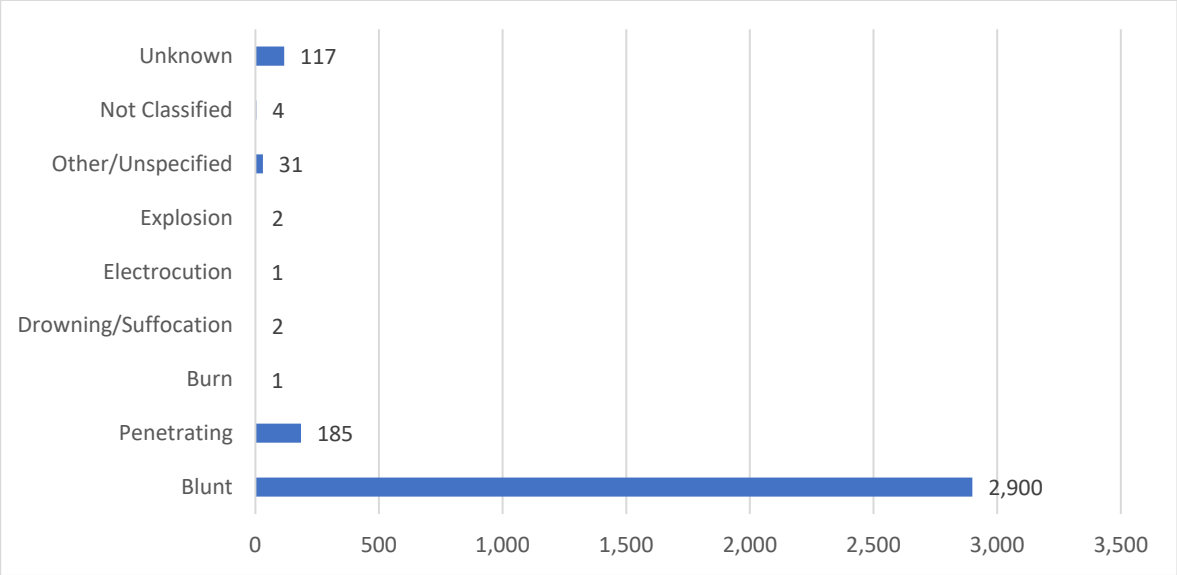
Disclaimer: Calculation for this report used Microsoft Excel for Office 365 (2016).

Type (Level) of Neurological Injury
January 1, 2024 – December 31, 2024
(n = 3,243)



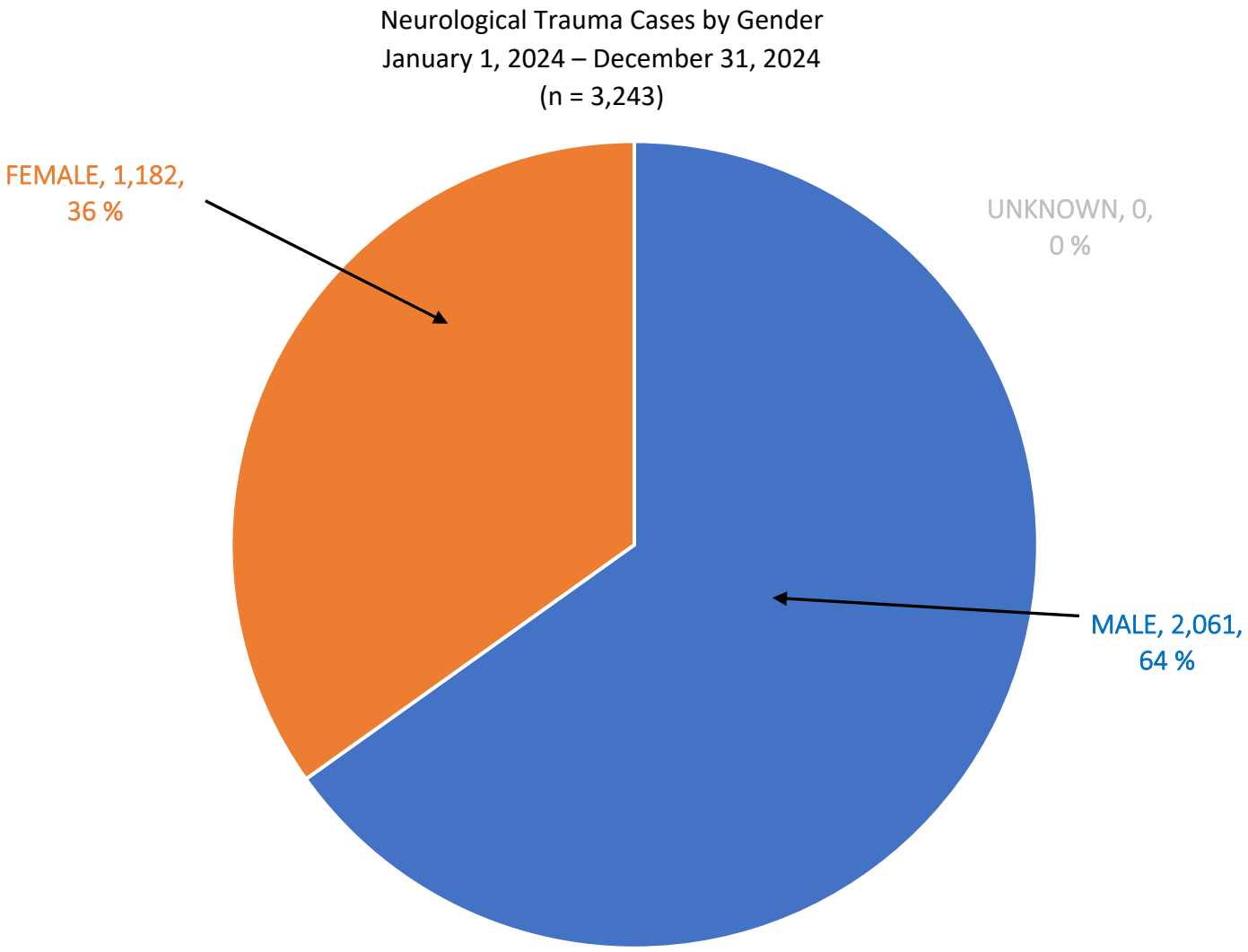
NOTE: This Venn diagram represents the presence of injury within individual patients. The injury level should be considered the primary area of traumatic neurological insult. Combination injuries are considered to be equally distributed between primary head injuries and primary spinal injuries for the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

Neurological Trauma Cases by Mechanism of Injury
January 1, 2024 – December 31, 2024
(n = 3,243)



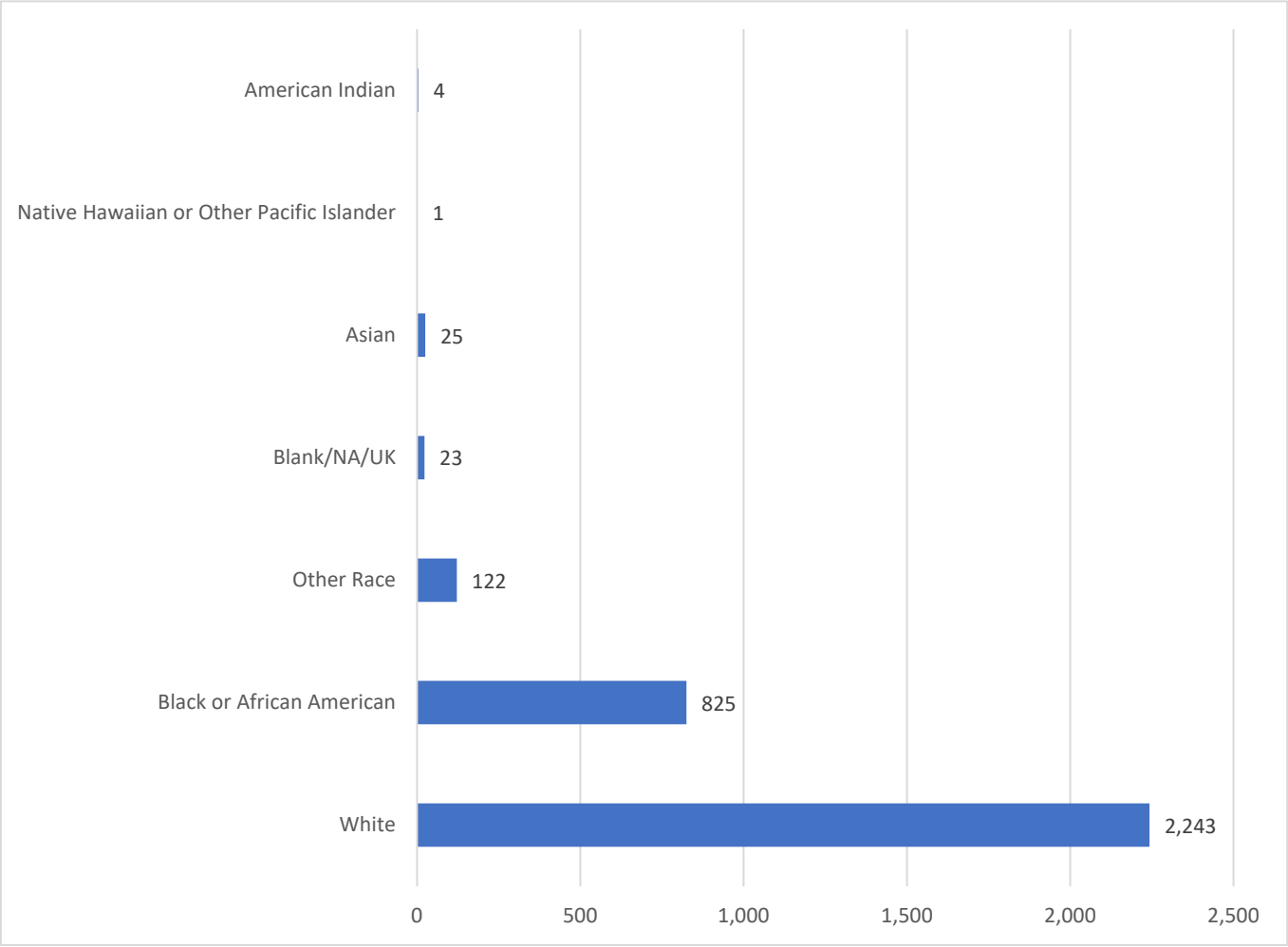
Eighty-nine percent (n = 2,900) of the cases were injuries due to blunt trauma. Penetrating injuries accounted for 6 percent (n = 185) of the traumatic neurological injury cases for 2024.

Type	Count	Percentage
Blunt	2,900	89%
Penetrating	185	6%
Burn	1	0%
Electrocution	1	0%
Drowning/Suffocation	2	0%
Explosion	2	0%
Not Valued	152	5%
Total	**3,243**	**100%**
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other	



Gender	Count	Percentage
Male	2,061	64%
Female	1,182	36%
Not Valued	0	0%
Total	**3,243**	**100%**
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other	

Neurological Trauma Cases by Race
January 1, 2024 – December 31, 2024
(n = 3,243)



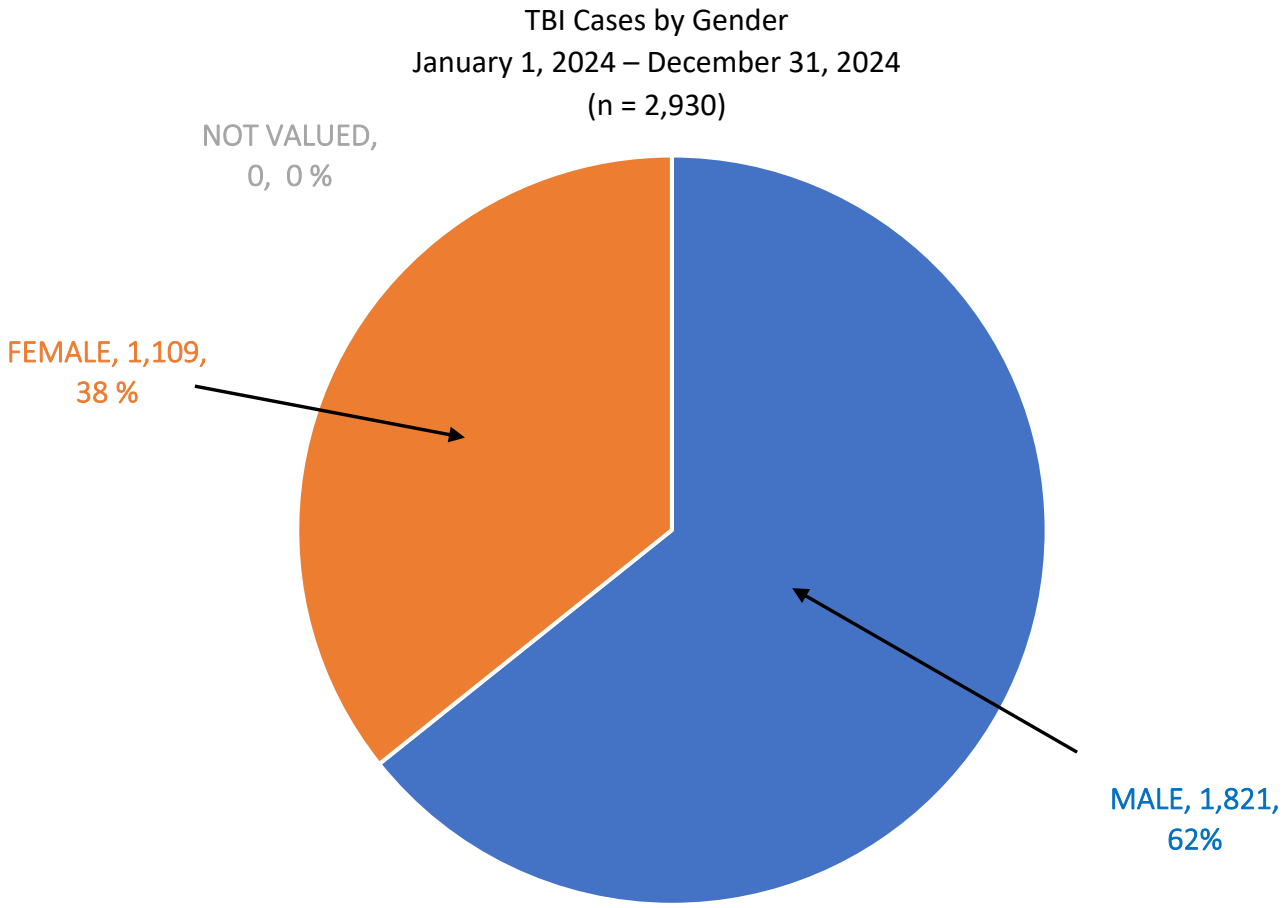
Race	Count	Percentage
Other Race	122	4%
Black/African American	825	25%
White	2,243	69%
Hawaiian/Pacific Islander	1	0%
Asian	25	1%
American Indian	4	0%
Not Valued	23	1%
Total	**3,243**	**100%**
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other	

Traumatic Brain Injury (TBI)

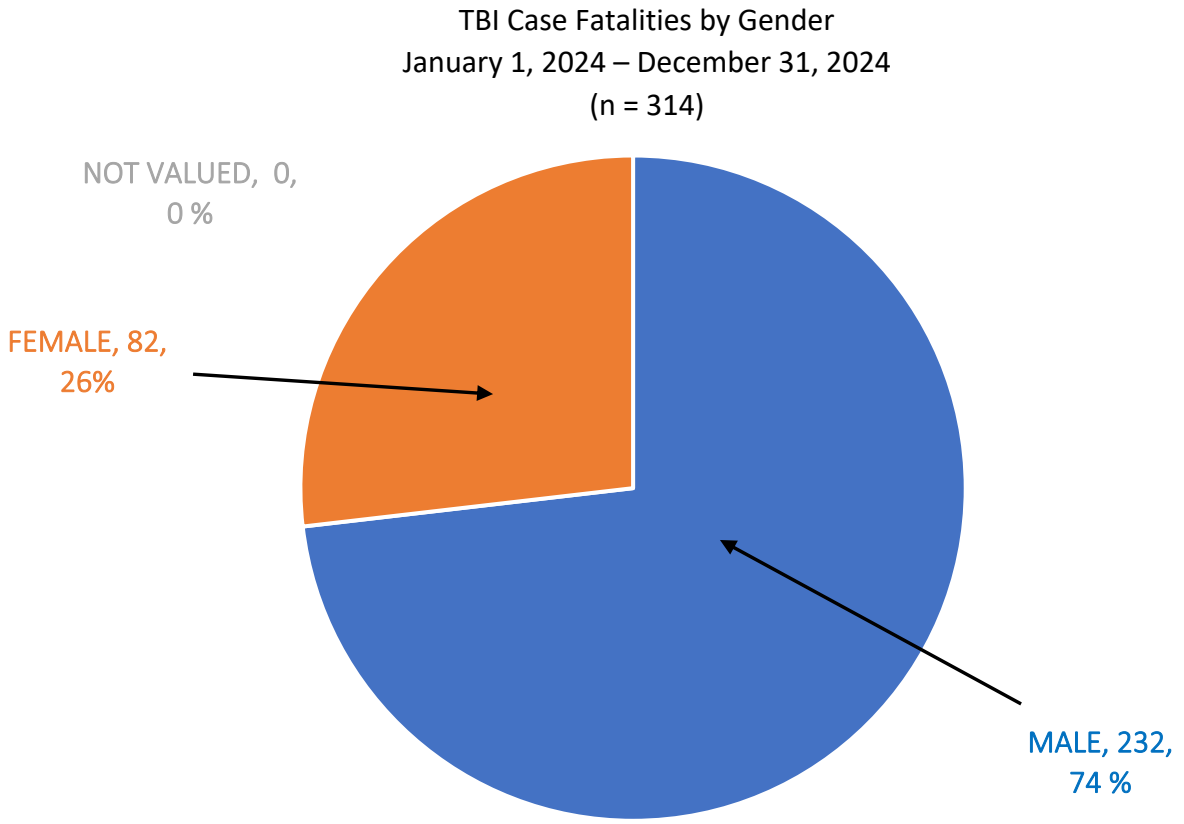
TBI occurs when an external mechanical force (either blunt or penetrating) causes a physical or physiological disruption and dysfunction of the brain. Blunt mechanical forces can be caused by a violent blow or jolt to the head particularly (being hit in the head by a baseball, for example) or applied 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 90 percent (2,930) of the 3,243 neurological injuries registered in 2024 in Alabama were diagnosed with TBI. Of the 2,930 TBI cases identified, 81 percent (2,636) were documented as occurring with blunt force trauma.

Of the remaining 20 percent (294) of TBI patients, 153 (5 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 153 penetrating trauma TBI patients, 143 (93 percent) were firearms injuries and 10 (7 percent) were documented as otherwise "cut or pierced." Of firearms related penetrating trauma, 71 patients died during treatment (49 percent fatality rate among firearms related injury) where 3 patients from the "cut or pierced" penetrating trauma group died (30 percent among cut or pierce related injury).

Neurological Injuries	TBI	Blunt	Penetrating	Firearms
3,243	2,930	2,636	153	143
% of Total Neurological Injury		**% of TBI**		**% of Firearms**
TBI = 90.35% Blunt TBI = 81.28% Penetrating TBI = 4.72% Firearms TBI = 4.41% Firearms TBI Fatality = 2.42%		Blunt = 89.97% Penetrating = 5.22% Firearms Penetrating = 4.88% Firearms Penetrating Fatality = 2.42%		Survived = 72 Died = 71 Survival = 50.34% Mortality = 49.65%



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 2024 outline that Alabama had a population of approximately 5,157,699 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.

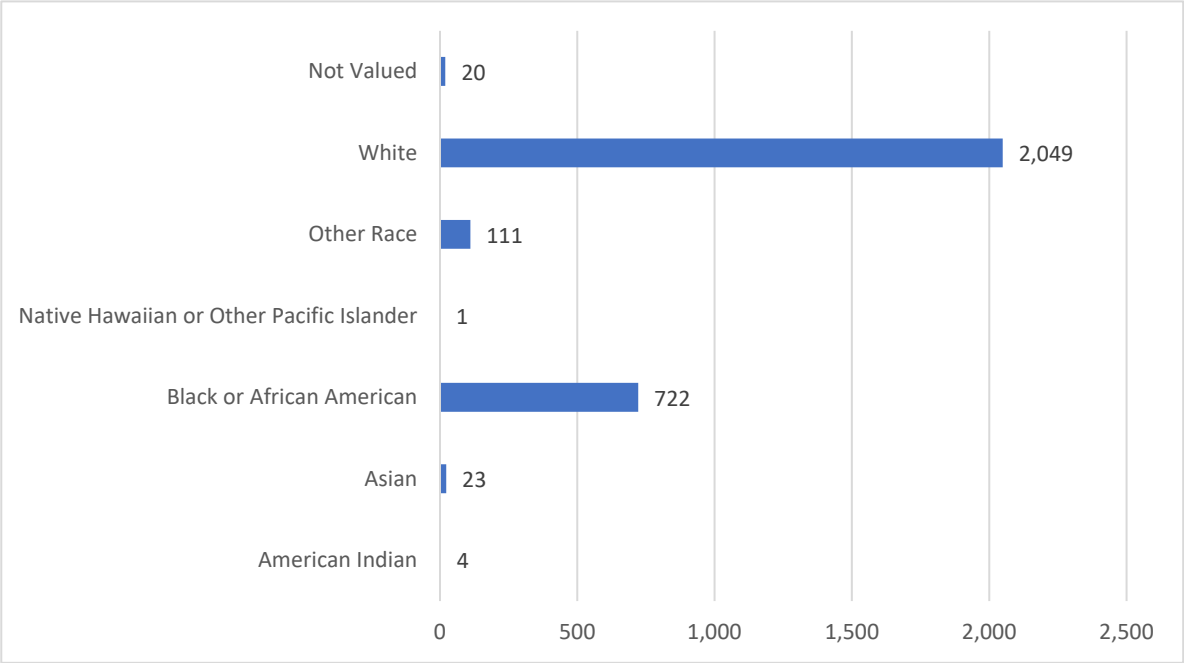


Gender	Count	Percentage	Fatalities	Population Percentage	Fatality Proportion
Male	1,821	62%	232	13%	74%
Female	1,109	38%	82	7%	26%
Not Valued	0	0%	0	0%	0%
Total	**2,930**	**100%**	**314**	**11%**	**100%**
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other				

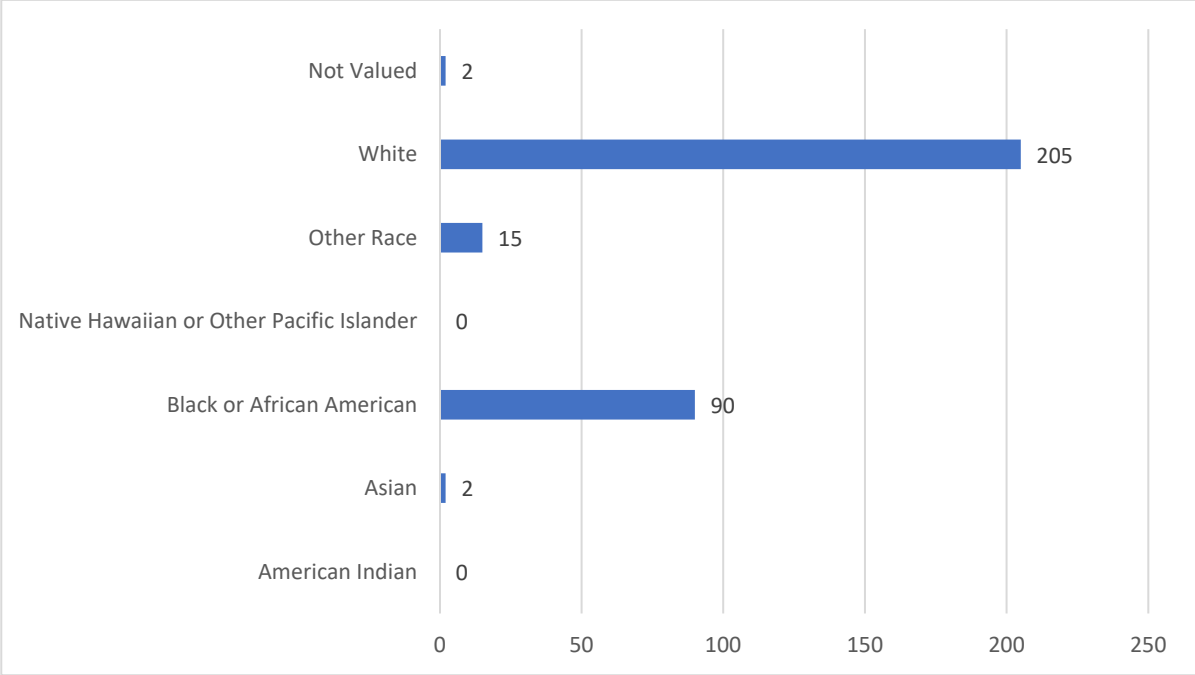
While males predominate the injury population in general, they also significantly predominate the TBI fatality proportion. Odds ratio calculation regarding gender and fatality finds that the odds of male TBI patients dying during the treatment phase is 83 percent higher than female TBI patients. It is noteworthy to point out that slightly greater than 10 percent of TBI patients died because of their injuries, where slightly less 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, 2024 – December 31, 2024

TBI Incidence by Race
(n = 2,930)



TBI Mortality by Race
(n = 314)



TBI Race and Mortality Statistics
(n = 2,930)

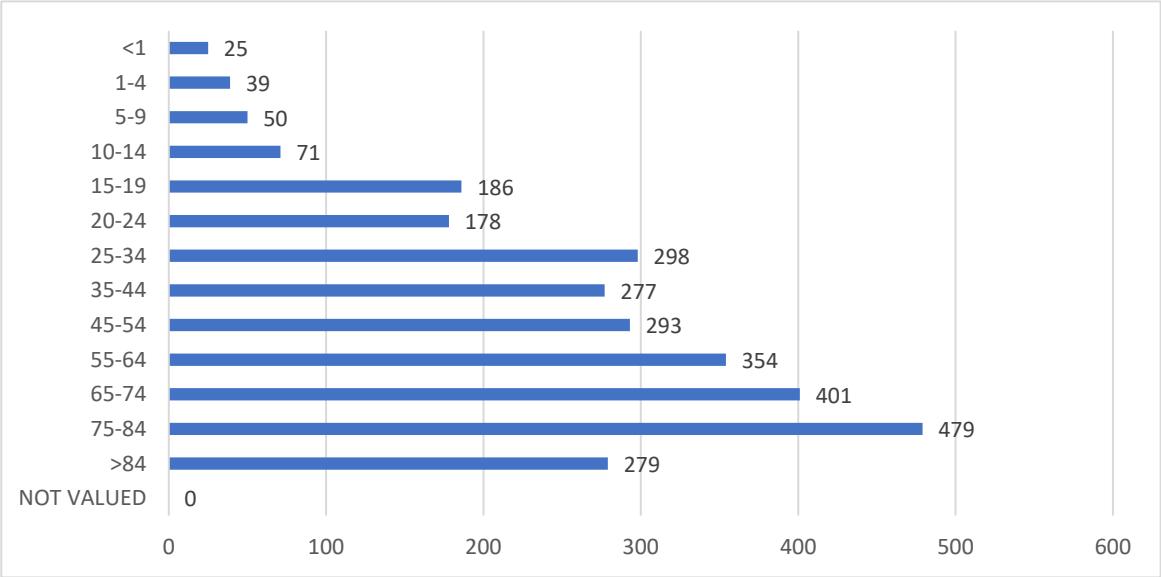
Race	Count	Population Percentage	Fatalities	Fatality Proportion
American Indian	4	0%	0	0%
Asian	23	1%	2	1%
Black/African American	722	25%	90	29%
Native Hawaiian/Pacific Islander	1	0%	0	0%
Other Race	111	4%	15	5%
White	2,049	70%	205	65%
Not Valued	20	1%	2	1%
Omitted from Calculation	0	---	---	---
Total	**2,930**	**100%**	**314**	**100%**

As established earlier, 2,930 observations of TBI were recorded from the 2024 patient group of 3,243 neurological trauma patients entered into the Registry database. 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.

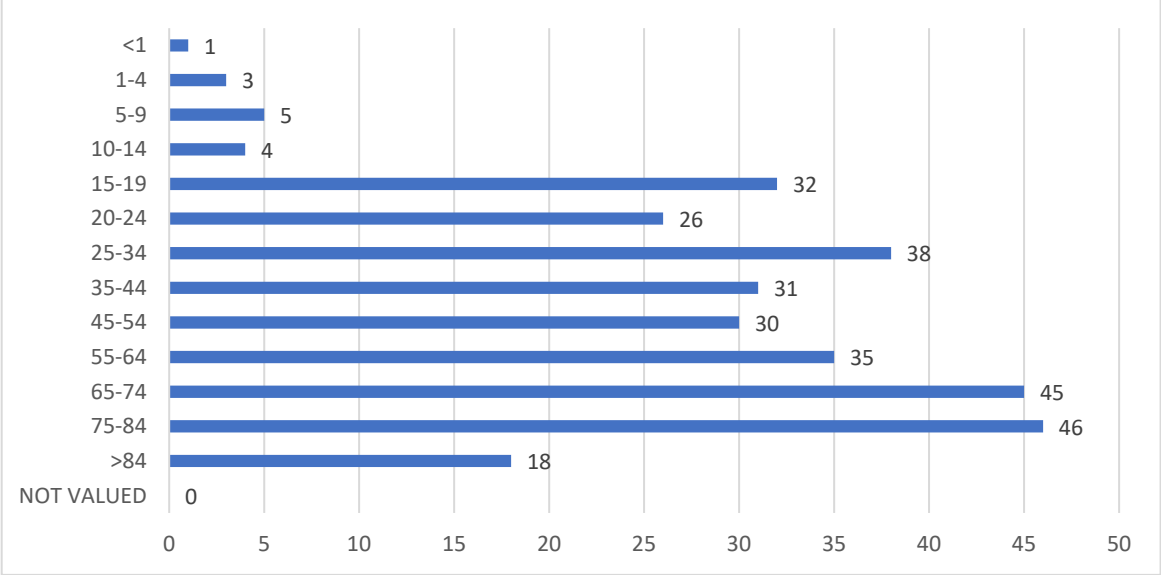
Odds ratio analysis of race and outcome of mortality was performed in comparison of black/African American (n = 722) versus white race (n = 2,049) combined with all non-black/African American race (n = 159) as control and no statistical evidence was found for influence of race in outcome of mortality. Further, U.S. Census 2024 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 64 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 25 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, 2024 – December 31, 2024

TBI Incidence by Age
(n = 2,930)



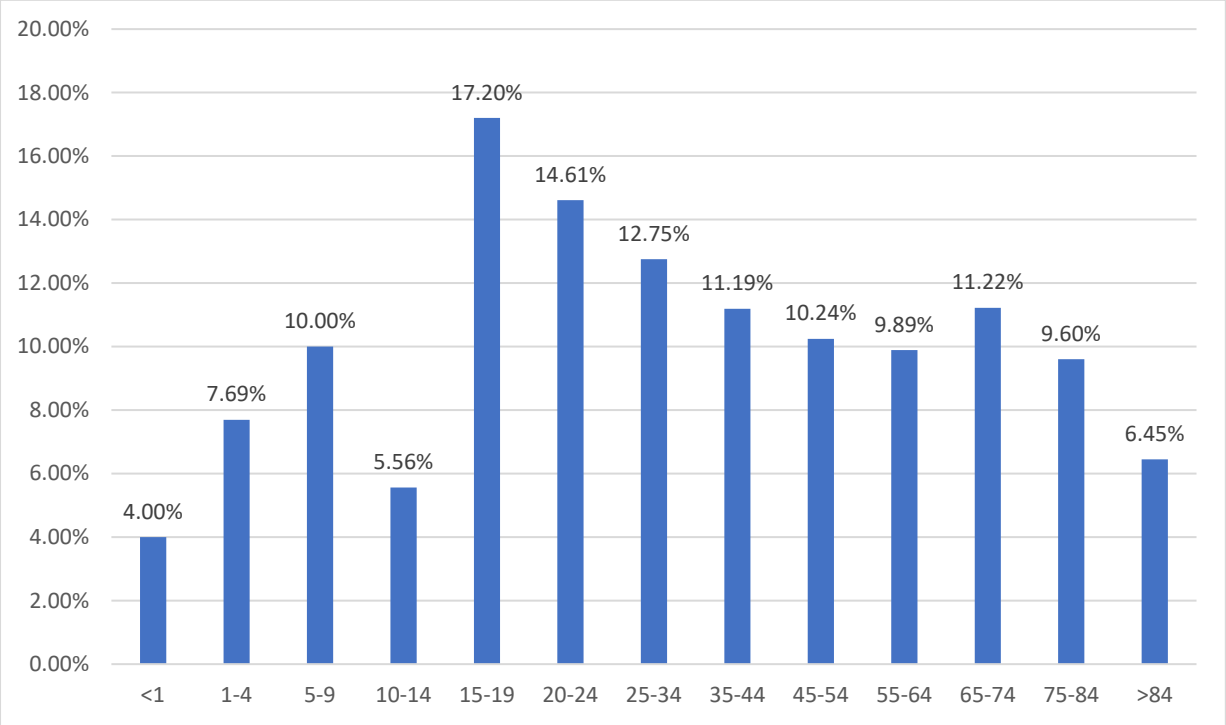
TBI Mortality by Age
(n = 314)



TBI Age and Mortality Statistics
(n = 2,930)

AGE GROUP YEARS	COUNT	PERCENT	DEATHS	FATALITY RATIOS
< 1	25	0.85%	1	0.32%
1 – 4	39	1.33%	3	0.96%
5 – 9	50	1.71%	5	1.59%
10 – 14	71	2.42%	4	1.27%
15 – 19	186	6.35%	32	10.19%
20 – 24	178	6.08%	26	8.28%
25 – 34	298	10.17%	38	12.10%
35 – 44	277	9.45%	31	9.87%
45 – 54	293	10.00%	30	9.55%
55 – 64	354	12.08%	35	11.15%
65 – 74	401	13.69%	45	14.33%
75 – 84	479	16.35%	46	14.65%
> 84	279	9.52%	18	5.73%
NOT VALUED	0	0.00%	0	0.00
TOTALS	**2,930**	**100.00%**	**314**	**OVERALL %**

TBI Fatality Rate by Age Group Comparison
(n = 314)



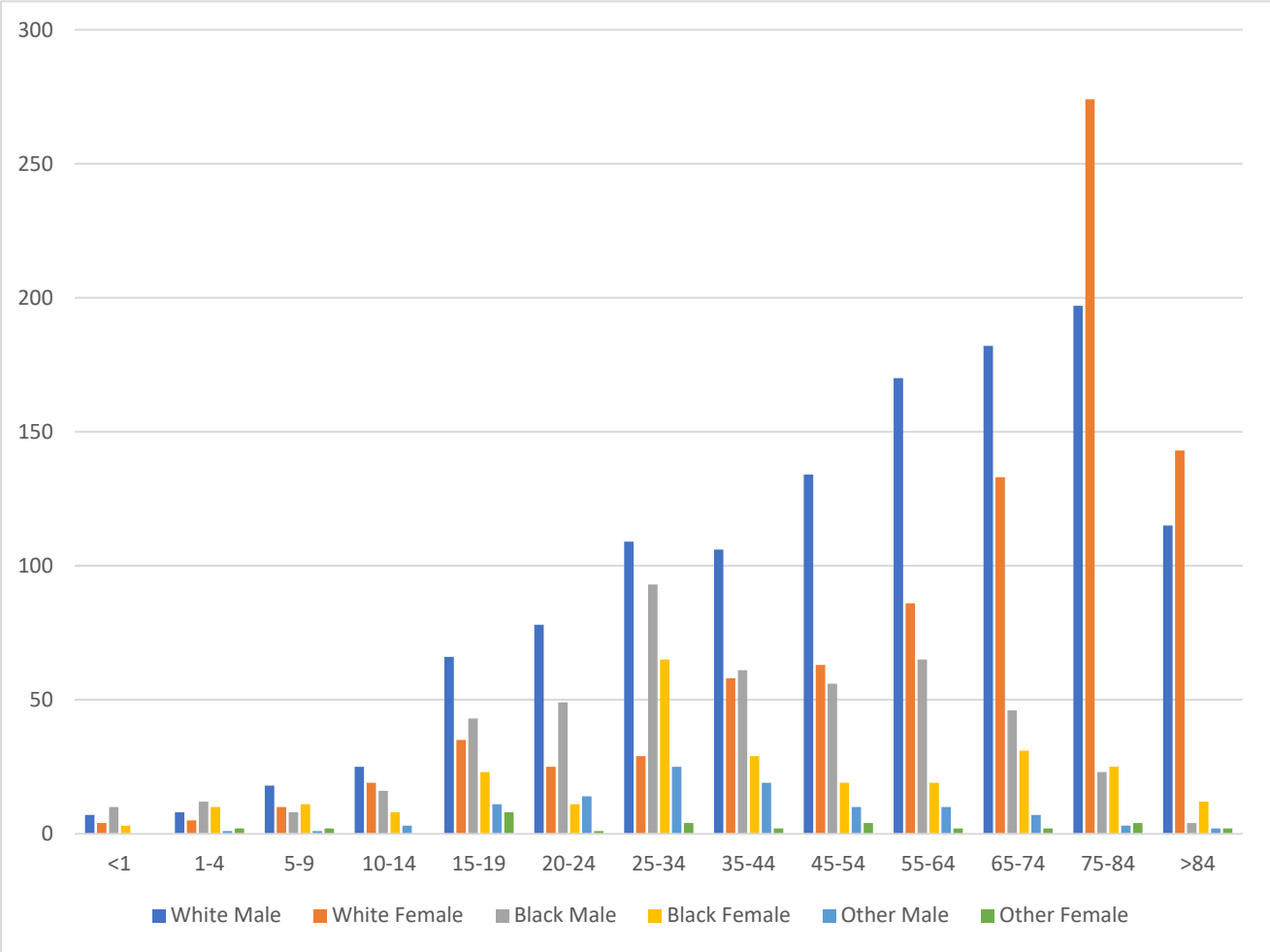
Incidence of TBI below 15 years of age is far lower than other categories (6 percent of cases) and with categorical fatality being sparse, but with rates approaching the lower end of equivalence across the age categories. Injury rate peaks 65 to 84 years, while categorical fatality rate peaks at 15 to 19 years of age.

TBI Cases by Age, Gender, and Race: Comparison Table
January 1, 2024 – December 31, 2024
(n = 2,930)

Upon query for observations regarding combination factors (gender, race, and age), it was determined that 20 individuals were not valued regarding race, but that all were placed into an age category. Proportional analysis was conducted upon the remaining 2,910 observations and are compared below.

Age	White Male	White Female	Black Male	Black Female	Other Male	Other Female	NO Race Value	Total	% Total
< 1	7	4	10	3	0	0	1	**25**	0.85%
1-4	8	5	12	10	1	2	1	**39**	1.33%
5-9	18	10	8	11	1	2	0	**50**	1.71%
10-14	25	19	16	8	3	0	0	**71**	2.42%
15-19	66	35	43	23	11	8	0	**186**	6.34%
20-24	78	25	49	11	14	1	0	**178**	6.08%
25-34	109	29	93	35	25	4	3	**298**	10.17%
35-44	106	58	61	29	19	2	2	**277**	9.45%
45-54	134	63	56	19	10	4	7	**293**	10.00%
55-64	170	86	65	19	10	2	2	**354**	12.08%
65-74	182	133	46	31	7	2	0	**401**	13.69%
75-84	197	224	23	25	3	4	3	**479**	16.35%
>84	115	143	4	12	2	2	1	**279**	9.52%
NOT VALUED	0	0	0	0	0	0	0	**0**	0.00%
Total	**1,215**	**834**	**486**	**236**	**106**	**33**	**20**	**2,930**	**100.00%**
Approximate % Total	**41.47%**	**28.46%**	**16.59%**	**8.05%**	**3.62%**	**1.13%**	**0.68%**	**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. It is noteworthy that females predominate all races in the greater than 84 years age category, likely due to the relatively large numbers of females compared to males in the general population of that age category.

Discharge Disposition (From Emergency Department Phase of Care) Following TBI
January 1, 2024 – December 31, 2024
(n = 2,930)

Emergency Department Discharge Disposition	Facility Count	Facility Percentage
Acute Care Facility	105	3.58%
Another Type of Inpatient Facility Not Defined Elsewhere	0	0.00%
Burn Center	0	0.00%
Burn Unit	0	0.00%
Child Protective Agency	0	0.00%
Correctional Facility/Court/Law Enforcement	4	0.14%
Floor	522	17.82%
Home or Self-Care (Routine Discharge)	348	11.88%
Home with Services	7	0.24%
Hospice	1	0.03%
Intensive Care Unit	1,481	50.55%
Intermediate Care Facility	0	0.00%
Interventional Radiology	5	0.17%
Labor and Delivery	0	0.00%
Left Against Medical Advice (AMA)	12	0.41%
Long-Term Care	0	0.00%
Mental Health/Psychiatric Hospital (Inpatient)	2	0.07%
Morgue	48	1.64%
Neonatal/Pediatric Care Unit	0	0.00%
Nursing Home	0	0.00%
Observation Unit	30	1.02%
Operating Room	200	6.83%
Rehab (Inpatient)	0	0.00%
Skilled Nursing Facility	2	0.07%
Step-Down Unit	157	5.36%
Telemetry Unit	0	0.00%
Blank/NA/Unk	6	0.20%
TOTALS	**2,930**	**100.00%**

Of the 2,930 patients observed to have suffered TBI, 2,516 (86 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 86 percent of all patients remained under medical care following the ED phase of intervention and with a combined proportion of 66 percent (approximately 1,943 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 statements outlined by the CDC *Report to Congress on Traumatic Brain Injury in the United States: Epidemiology and Rehabilitation* in 2015. The report references that rehabilitation is typically indicated for patients with moderate to severe traumatic brain injury. The document is available online at link below. **(https://www.cdc.gov/traumaticbraininjury/pdf/tbi_report_to_congress_epi_and_rehab-a.pdf)**.

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 2024 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.

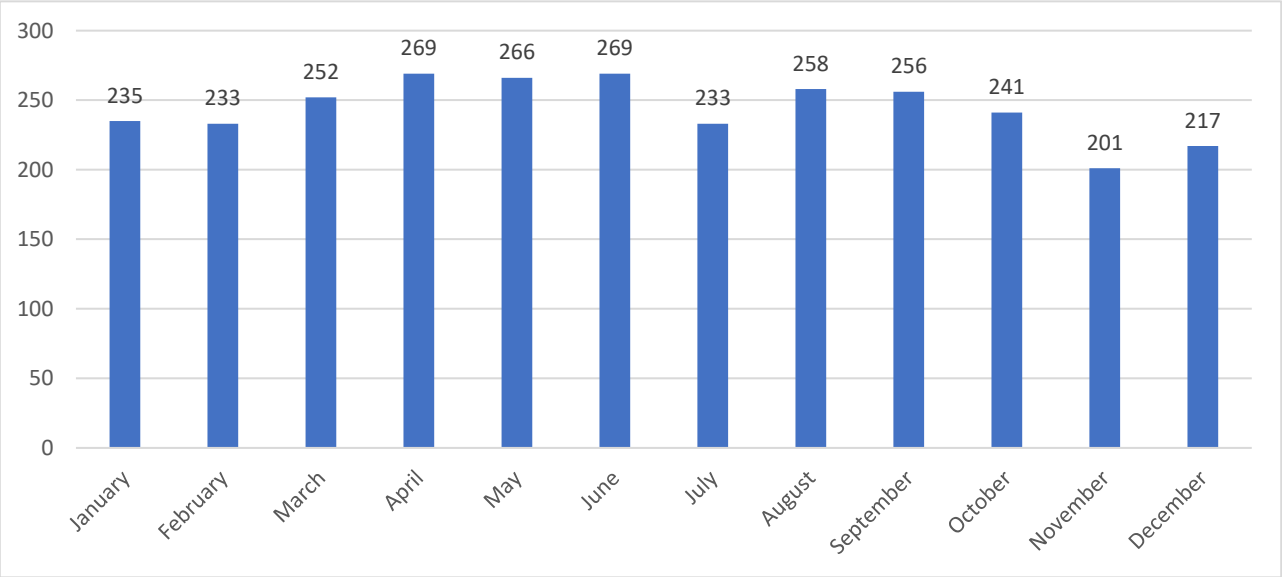
Mechanism of Injury Occurrence in TBI Cases
and Fatality as Outcome by Gender
January 1, 2024 – December 31, 2024
(n = 2,930)

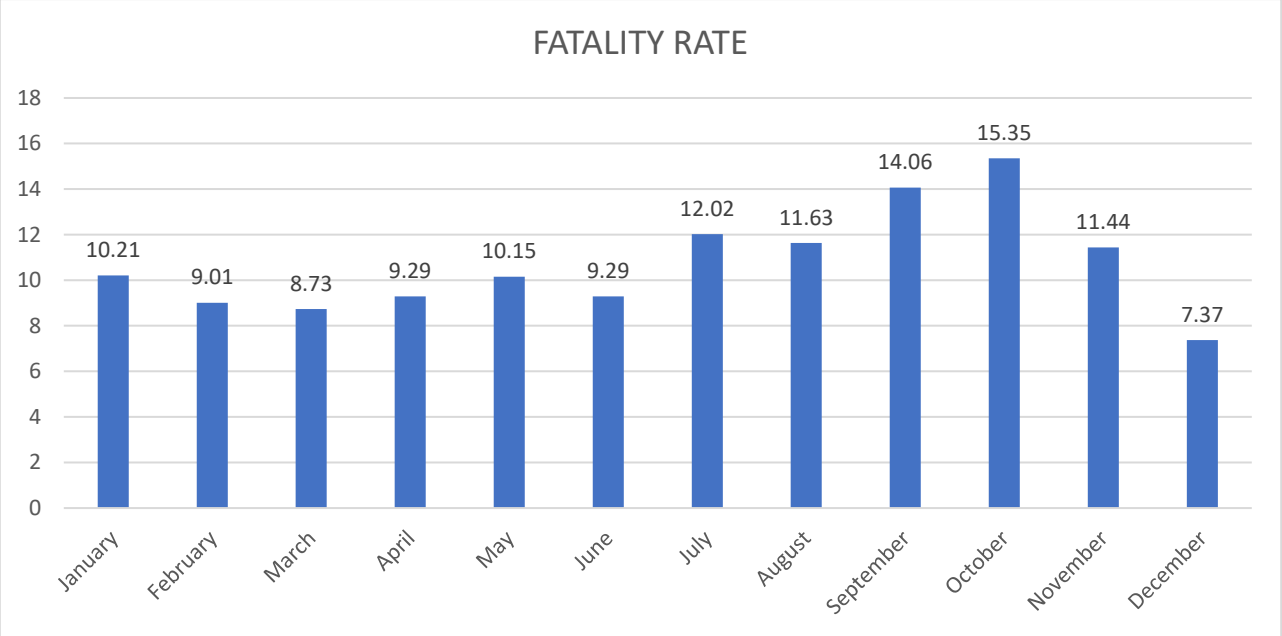
Mechanism Of Injury	Percent of Females	Percent of Males	Fatality Rate Female	Fatality Rate Male
Cut or Pierce	0.18%	0.44%	0.00%	37.50%
Drowning/Submersion	0.09%	0.00%	100.00%	0.00%
Fall	53.20%	38.66%	5.93%	9.94%
Fire or Flame	0.09%	0.00%	0.00%	0.00%
Hot Object or Substance	0.00%	0.00%	0.00%	0.00%
Firearm	2.07%	6.59%	30.43%	53.33%
Machinery	0.00%	0.33%	0.00%	16.67%
*MVT-Occupant	26.42%	22.68%	7.17%	9.20%
MVT-Motorcyclist	0.18%	1.26%	50.00%	13.04%
MVT-Pedal Cyclist	0.45%	0.49%	20.00%	22.22%
MVT-Pedestrian	2.25%	3.02%	12.00%	27.27%
MVT-Other	0.00%	0.00%	0.00%	0.00%
MVT-Unspecified	1.80%	1.87%	20.00%	8.82%
Pedal Cyclist, Other	0.18%	0.88%	0.00%	6.25%
Pedestrian, Other	0.90%	0.55%	20.00%	10.00%
Other Land Transport	6.40%	7.58%	4.23%	4.35%
Other Transport	0.00%	0.11%	0.00%	0.00%
Natural or Environmental	0.18%	0.33%	0.00%	0.00%
Overexertion	0.00%	0.00%	0.00%	0.00%
Poisoning	0.00%	0.00%	0.00%	0.00%
Struck by or Against	2.80%	8.40%	3.23%	4.58%
Suffocation/Asphyxiation	0.00%	0.00%	0.00%	0.00%
Other Specified, Classifiable	0.18%	0.05%	100.00%	100.00%
Other Specified, Not Elsewhere Classified	0.00%	0.33%	0.00%	16.67%
Pedestrian Conveyance	0.36%	0.33%	0.00%	0.00%
Electrical	0.00%	0.05%	0.00%	0.00%
Mechanical	0.00%	0.00%	0.00%	0.00%
Explosion	0.00%	0.11%	0.00%	50.00%
Abuse	0.00%	0.05	0.00%	0.00%
Not Classified	0.63%	1.04%	0.00%	31.58%
Blank/NA/Unk	1.62%	4.83%	5.56%	10.23%

**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; 53 percent of females and 39 percent of males incur TBI by falling. As a result of a fall, 6 percent of the females who fall and 10 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, 26 percent incurred TBI via a motor vehicle crash, while 23 percent of males likewise incurred TBI. Of females incurring TBI via a motor vehicle crash, 7 percent died as a result, while 9 percent of males died. The mortality rate for motorcycle accidents was 13 percent for males and 50 percent for females and bicycle accidents were 22 percent fatal for males and 20 percent fatal for females. The rate for pedestrian accidents is 1 percent in females and 1 percent in males and the resulting death rates are 20 percent in females and 10 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 2 percent of females and 7 percent of males, the resulting death rates are 30 percent and 53 percent respectively.

TBI Occurrence and Fatality by Month
January 1, 2024 – December 31, 2024
(n = 2,930)

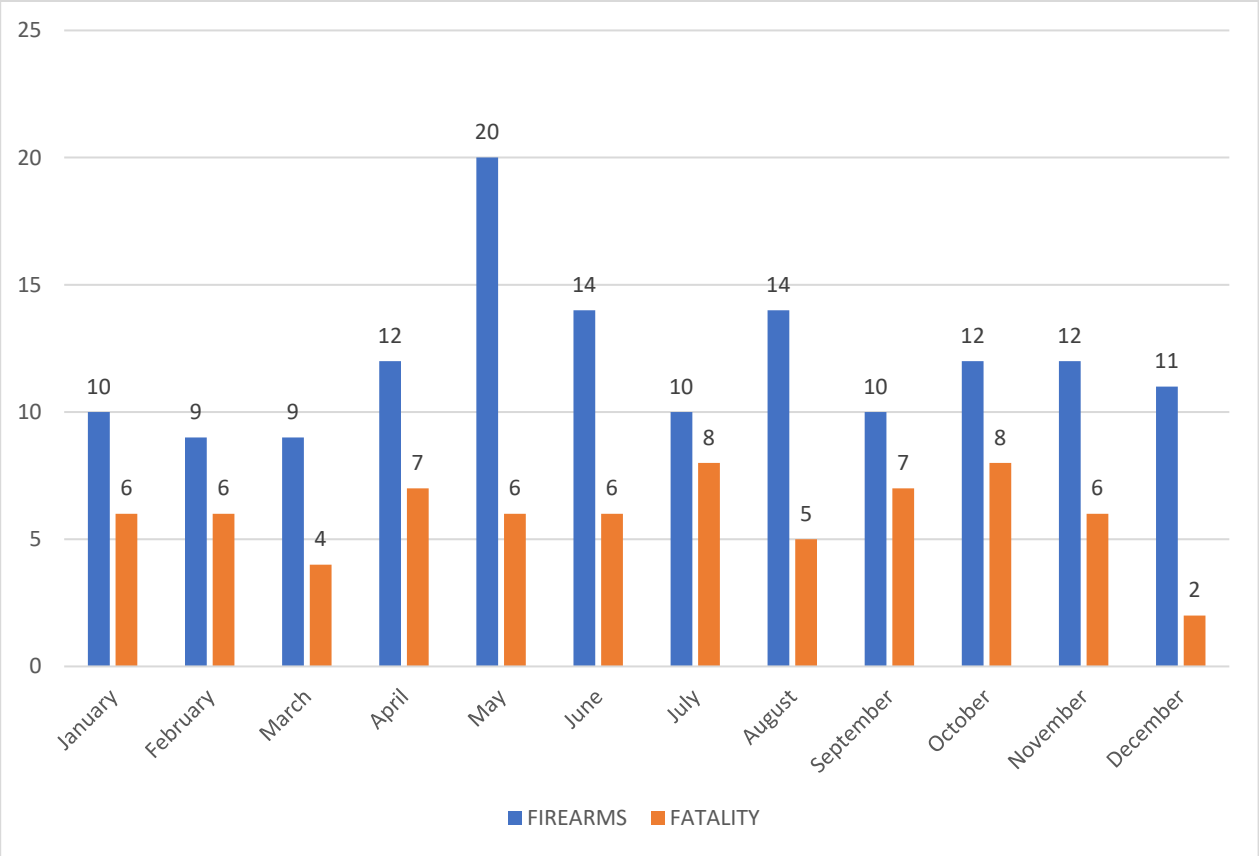




Of the 2,930 patients who experienced TBI in this study, only 143 (5 percent) experienced firearms injuries. Firearms injuries averaged 11.92 per month, with a low of 9 incidents in February and March and a high of 20 incidents in May. The highest fatality rate for firearms injuries was 8 out of 10 (80 percent) in July and the lowest was 2 out of 11 injuries (28 percent) in December. In the TBI subgroup, the greatest number of injuries were incurred from falls and motor vehicle accidents.

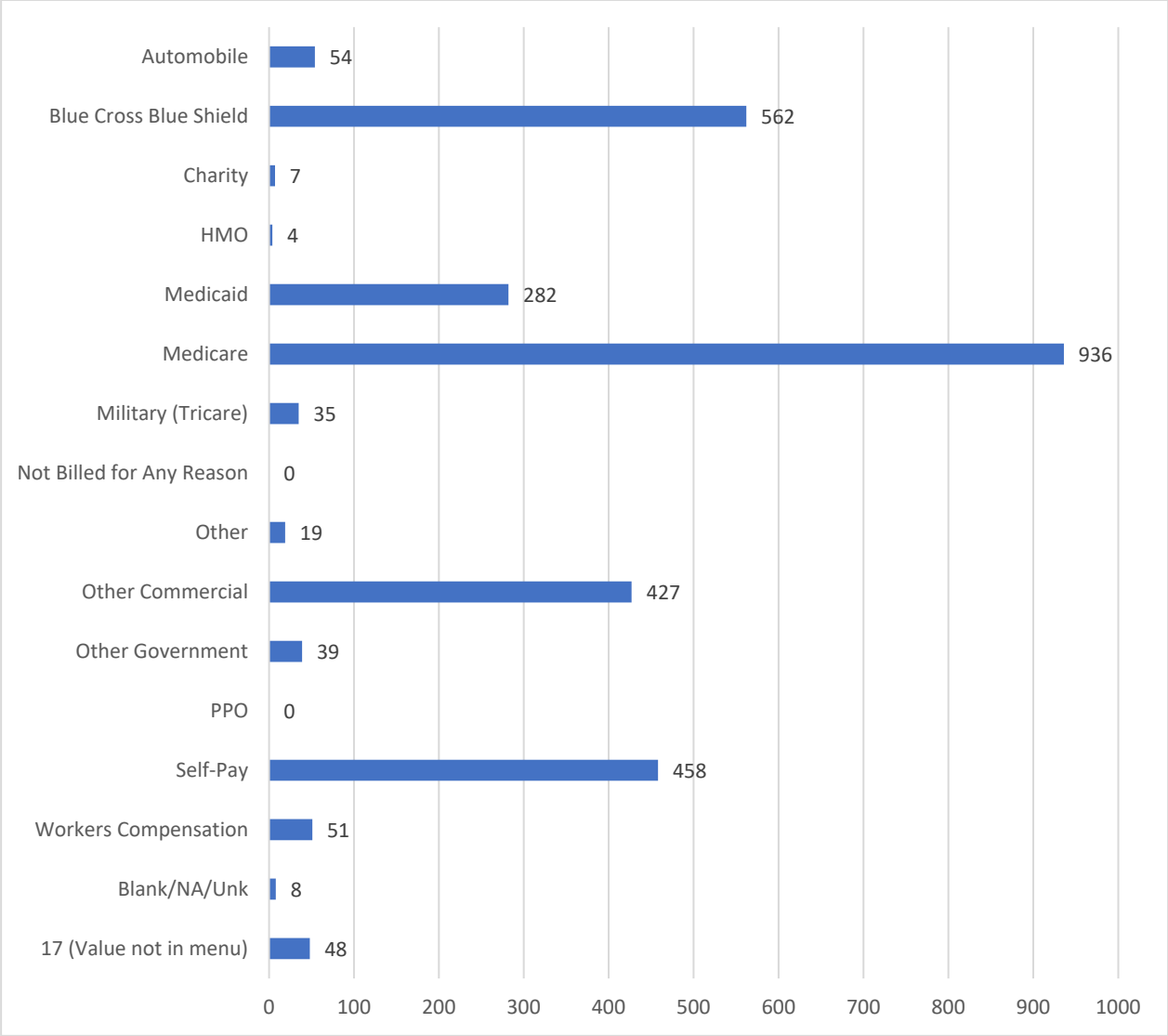
Firearms TBI Injury Per Month
January 1, 2024 – December 31, 2024
(n = 143)

Firearms TBI Fatality Per Month
(n = 71)



Firearms-related TBI averages 11.92 occurrences per month, ranging from 9 incidents in February and March to 20 incidents in May. Similarly, firearms-related TBI fatalities average 6 occurrences per month, ranging from 2 in December to 8 in July, 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, 2024 – December 31, 2024
(n = 2,930)



Of the 2,930 TBI patients, 2,923 patients were billed for services. Source of payment is not known or not clear on 56 patients (2 percent). Seven patients were written off as charity (<1 percent). Further, 2,409 patients (82 percent) were billed to some sort of insurance or were otherwise covered for charges. The remaining 458 patients (17 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 (936 patients or 32 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 = 2,930)

Primary Payer	Count	Percent	Deaths	Fatality Rate
Automobile	54	1.84%	3	5.56%
Blue Cross Blue Shield	562	19.18%	40	7.12%
Charity	7	0.24%	0	0.00%
HMO	4	0.14%	0	0.00%
Medicaid	282	9.62%	35	12.41%
Medicare	936	31.95%	87	9.29%
Military (Tricare)	35	1.19%	1	2.86%
Not Billed for Any Reason	0	0.00%	0	0.00%
Other	19	0.65%	4	21.05%
Other Commercial	427	14.57%	45	10.54%
Other Government	39	1.33%	8	20.51
PPO	0	0.00%	0	0.00%
Self-Pay	458	15.63%	78	17.03%
Workers Compensation	51	1.74%	9	17.65%
Blank/NA/Unk	8	0.27%	0	0.00%
17 (value not in menu)	48	1.64%	4	8.33%
TOTALS	**2,930**	**100.00%**	**314**	

It is noteworthy that 78 (25 percent) of the 314 fatalities were verified as “self-pay”; therefore, may or may not have the ability or resources to pay hospital charges for services rendered. Further, 458 (16 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) 2024 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.

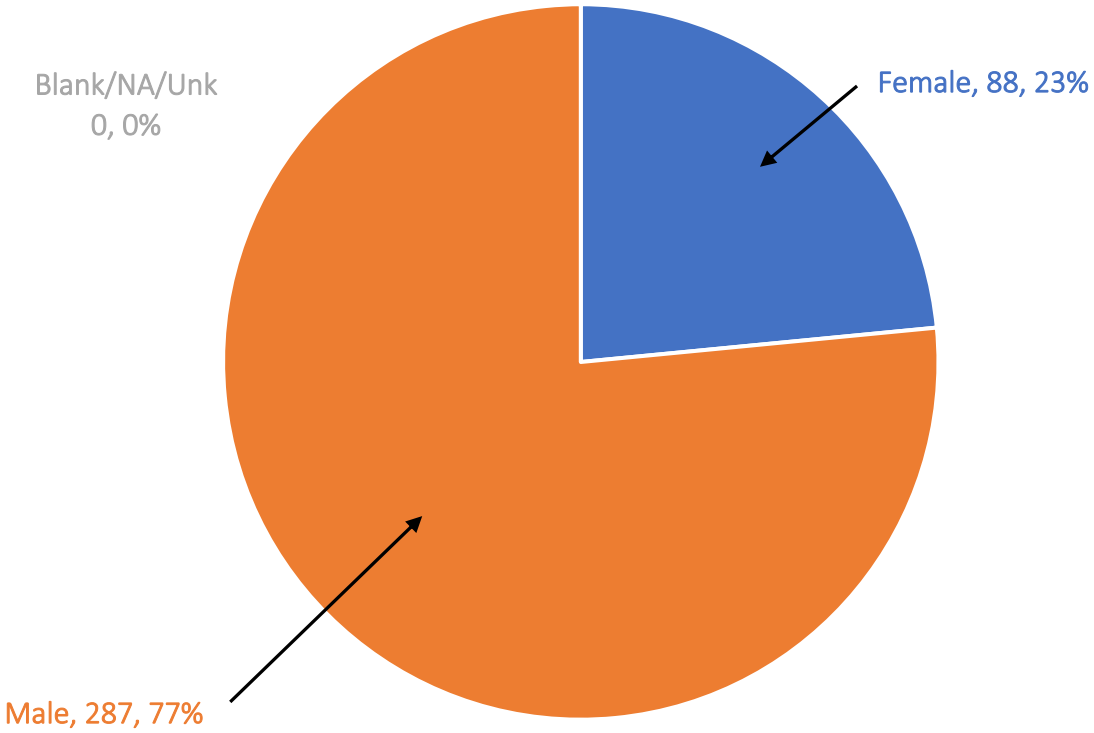
- Falls. Spinal cord injury after age 45 is most often caused by a fall. Overall, falls cause approximately one-quarter of spinal cord injuries.

- Acts of violence. Around 17 percent of spinal cord injuries result from violent encounters, often involving gunshot and knife wounds.

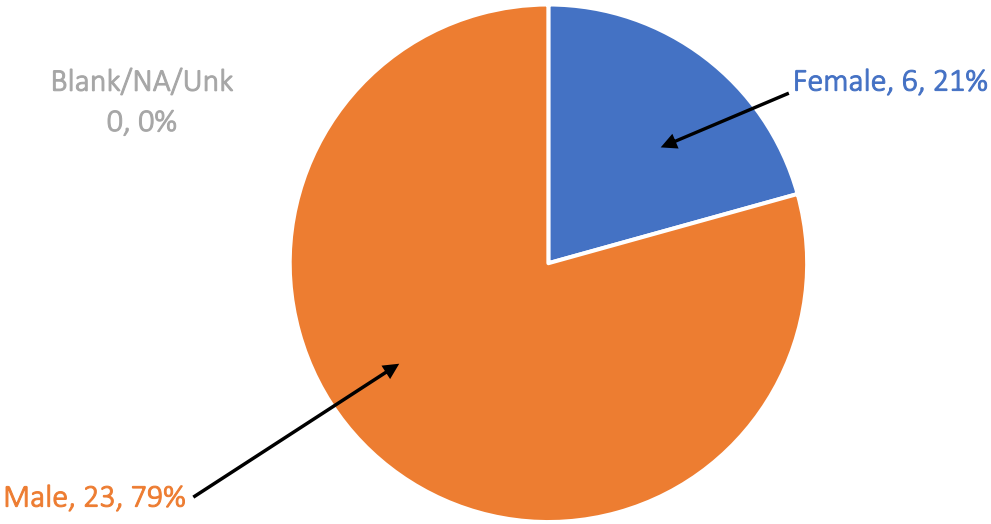
- Sports and recreation injuries. Athletic activities, such as impact sports and diving in shallow water, cause about 10 percent of spinal cord injuries.

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, 2024 – December 31, 2024
(n = 375)



SCI Case Fatalities by Gender
(n = 29)

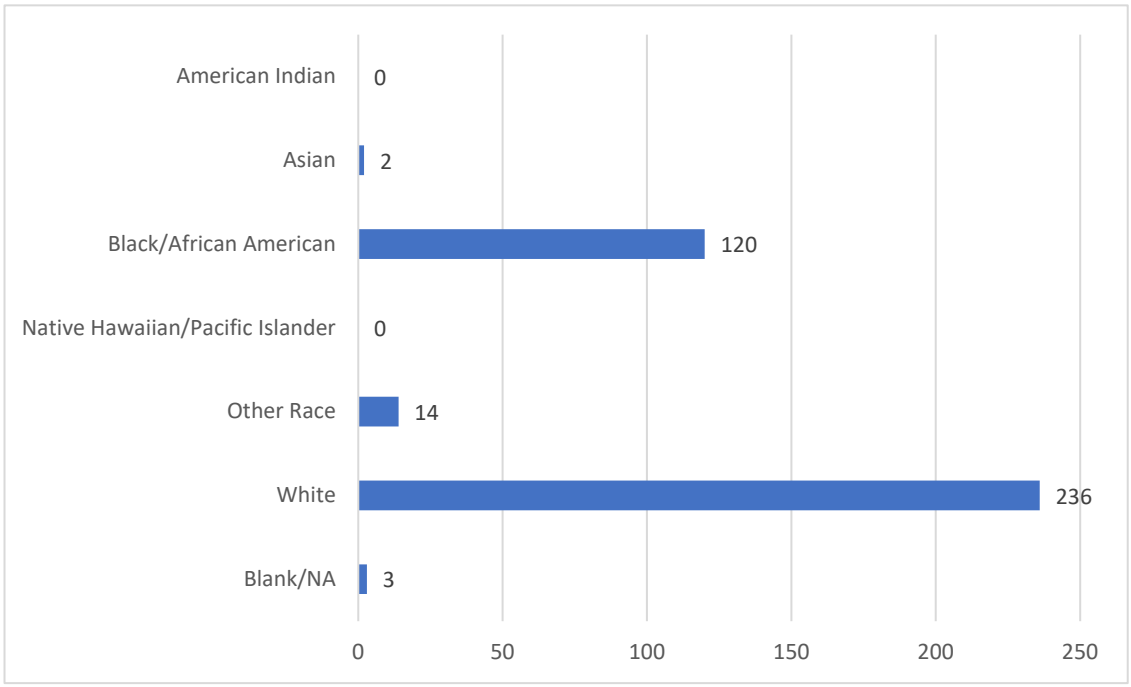


SCI Gender and Mortality Statistics
(n = 375)

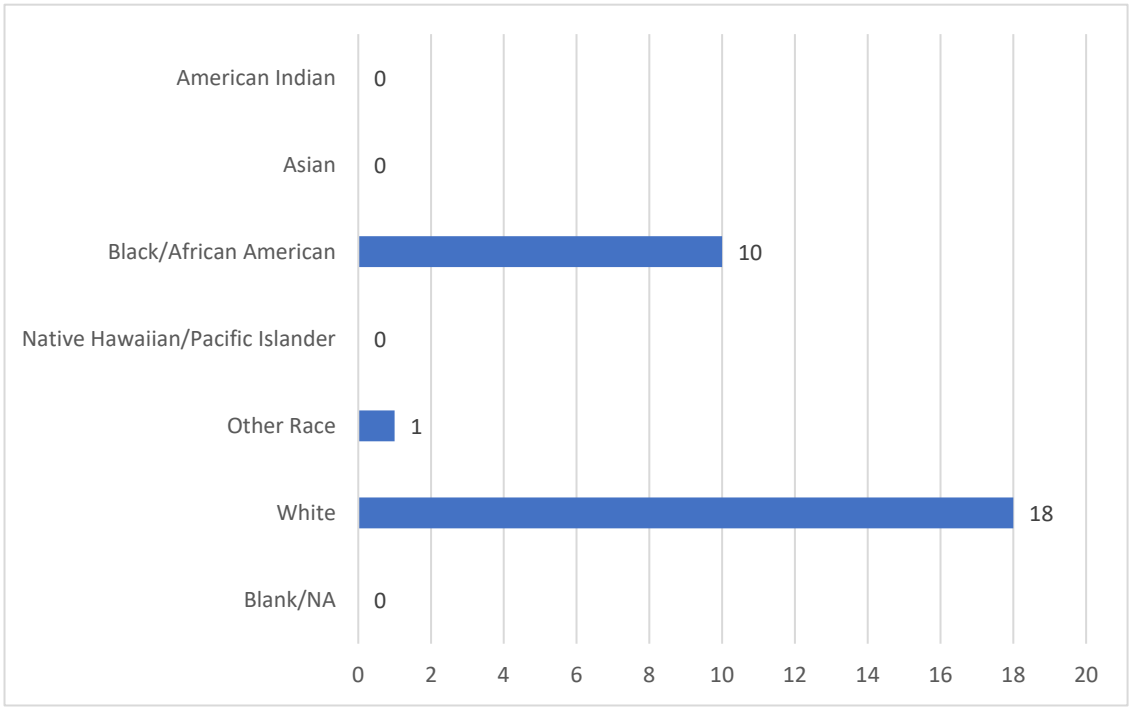
Gender	Count	Percentage	Fatalities	Population Percentage	Fatality Proportion
Male	287	77%	23	6%	79%
Female	88	23%	6	7%	21%
Not Valued	0	0%	0	0%	0%
Total	**375**	**100%**	**29**	**8%**	**100%**
Not Valued	Blanks/Unknown/Non-Applicable/Unspecified/Other				

Males predominate neurological injuries in general by a ratio of approximately 1.7:1, males to females, or 42 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, 2024 – December 31, 2024
(n = 375)



SCI Mortality by Race
(n = 29)

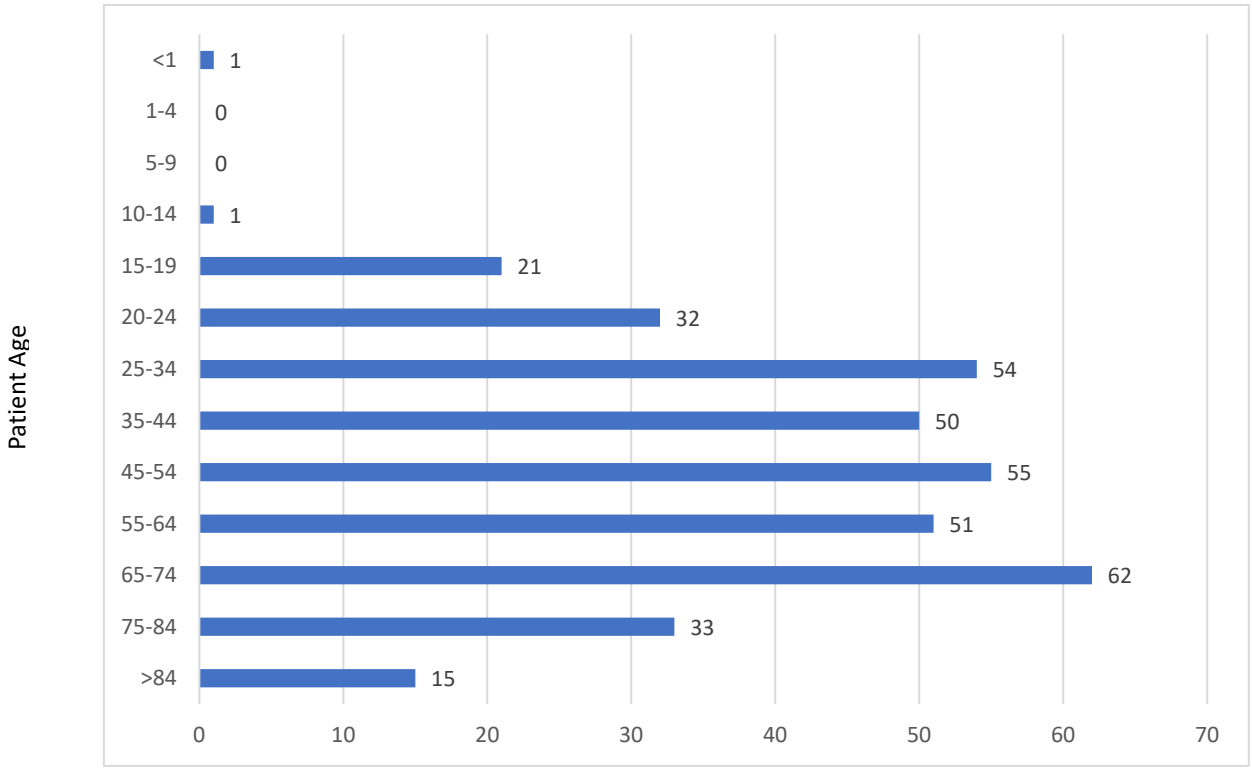


SCI Race and Mortality Statistics
(n = 375)

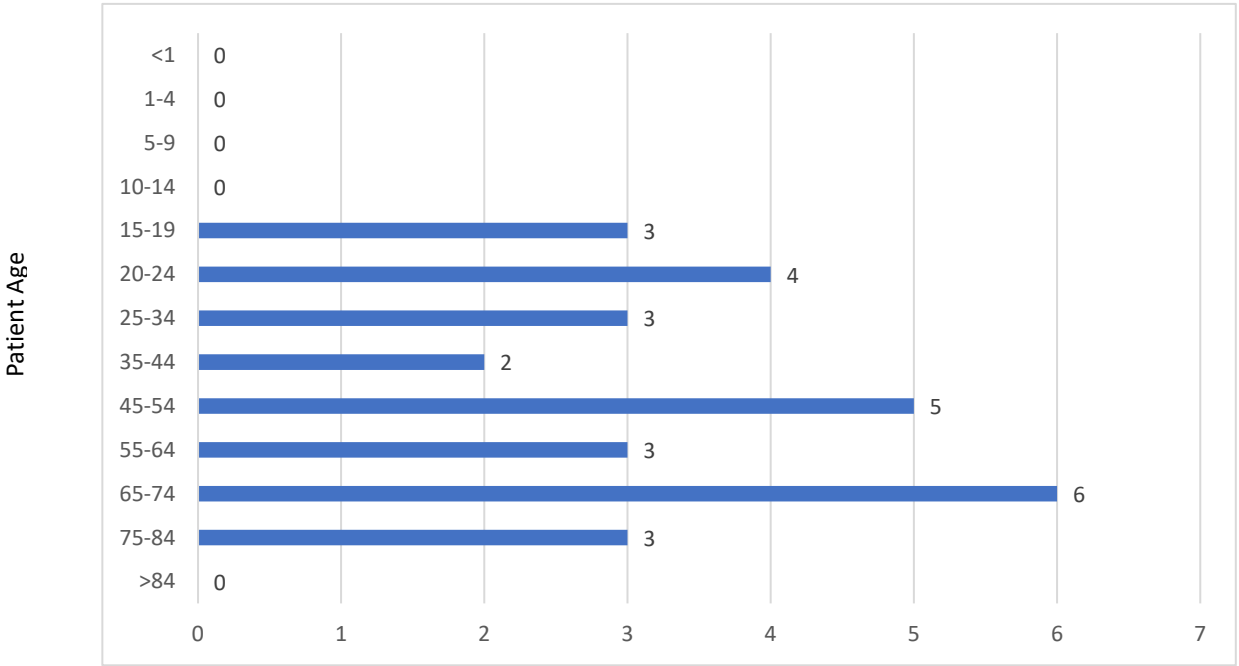
Race	Count	Population Percentage	Fatalities	Fatality Proportion
American Indian	0	0%	0	0%
Asian	2	1%	0	0%
Black/African American	120	32%	10	34%
Native Hawaiian /Pacific Islander	0	0%	0	0%
Other Race	14	4%	1	3%
White	236	63%	18	62%
Not Valued	3	0%	0	0%
Total	**375**	**100%**	**29**	**100%**
Not Valued	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, 2024 – December 31, 2024
SCI Incidence by Age
(n = 375)



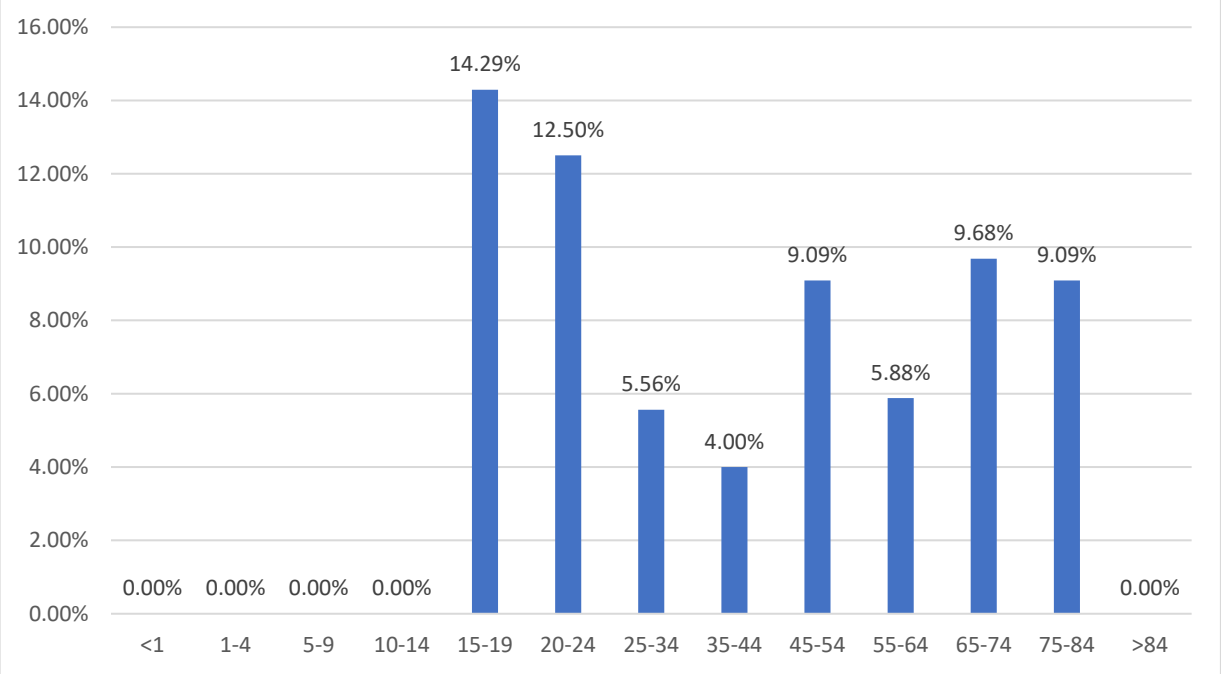
SCI Mortality by Age
(n = 29)



SCI Age and Mortality Statistics
(n = 375)

AGE GROUP YEARS	COUNT	PERCENT	DEATHS	FATALITY RATE
< 1	1	0.27%	0	0.00%
1 – 4	0	0.00%	0	0.00%
5 – 9	0	0.00%	0	0.00%
10 – 14	1	0.27%	0	0.00%
15 – 19	21	5.60%	3	14.29%
20 – 24	32	8.53%	4	12.50%
25 – 34	54	14.40%	3	5.56%
35 – 44	50	13.33%	2	4.00%
45 – 54	55	14.57%	5	9.09%
55 – 64	51	13.60%	3	5.88%
65 – 74	62	16.53%	6	9.68%
75 – 84	33	8.80%	3	9.09%
> 84	15	4.00%	0	0.00%
TOTALS	**375**	**100.00%**	**29**	**OVERALL 7.73%**

SCI Fatality by Age Comparison
(n = 29)



Fatalities are observed starting at age 15-19 years and initially peaks at 3 fatalities for the age category, then experiences a similar number at 20-34 years. The highest peaks are noted at 45-54 and 65-74 age categories. The initial peak is correlated with a fatality rate of approximately 14 percent, while the second peak correlated to a fatality rate of 13 and 10 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, 2024 – December 31, 2024
(n = 375)

Emergency Department Discharge Disposition	Facility Count	Facility Percentage
Acute Care Facility	4	1.07%
Another Type of Inpatient Facility	0	0.00%
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	73	19.47%
Home or Self-Care (Routine Discharge)	8	2.13%
Home with Services	0	0.00%
Hospice	0	0.00%
Intensive Care Unit	205	54.67%
Intermediate Care Facility	0	0.00%
Interventional Radiology	2	0.53%
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	4	1.07%
Musculoskeletal Rehabilitation	0	0.00%
Neonatal/Pediatric Care Unit	0	0.00%
Nursing Home	0	0.00%
Observation Unit	3	0.80%
Operating Room	71	18.93%
Rehab (Inpatient)	0	0.00%
Skilled Nursing Facility	0	0.00%
Step-Down Unit	4	1.07%
Telemetry Unit	0	0.00%
Blank/NA/Unk	1	0.27%
TOTALS	**375**	**100.00%**

Of the 375 SCI patients observed, 359 (96 percent) were known to have been transferred from the ED phase of care to another medical interventional environment; 205 (55 percent) went into intensive care unit (ICU) and 71 (19 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.

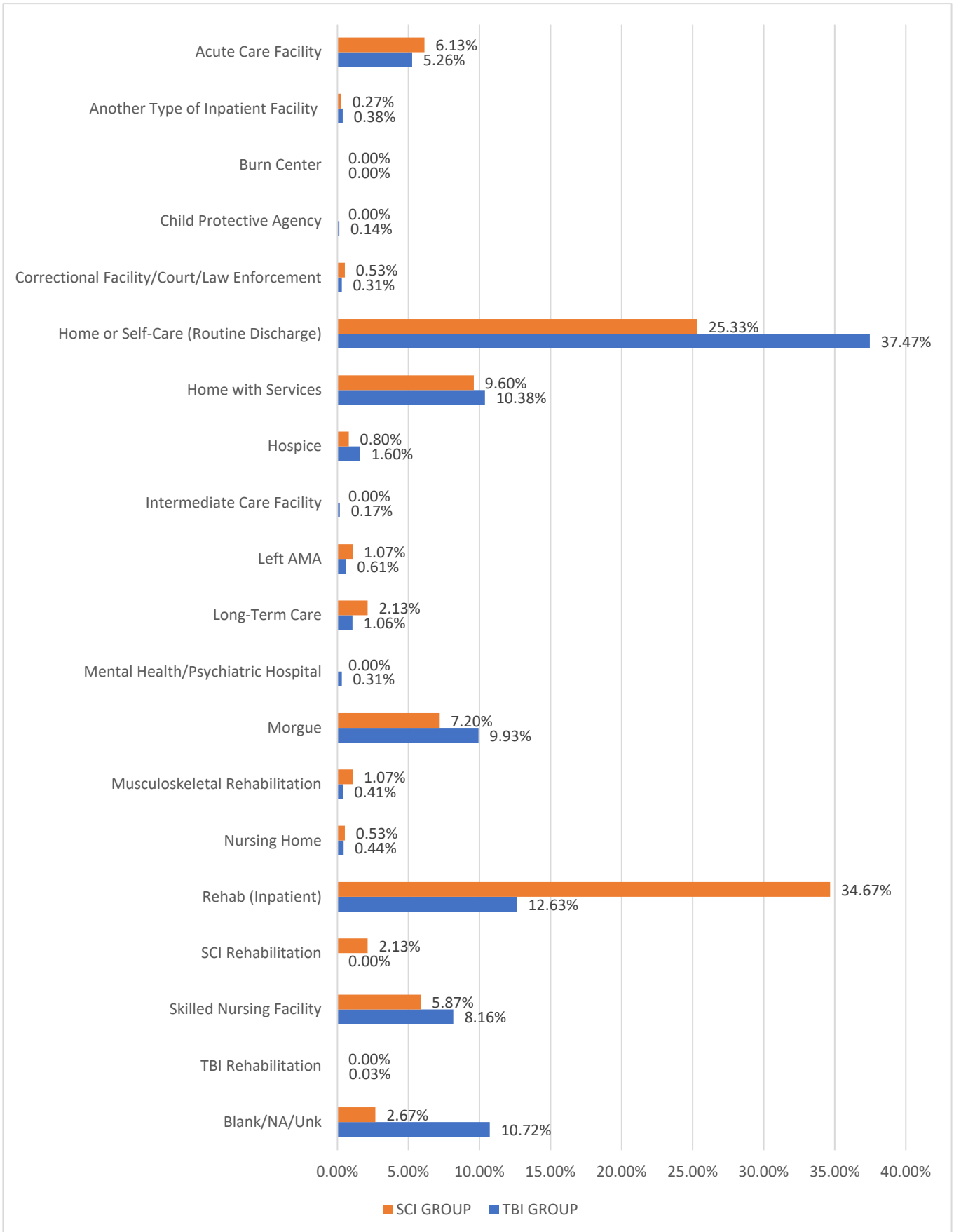
Hospital Discharge Dispositions of TBI and SCI Sub-Groups
January 1, 2024 – December 31, 2024
TBI (n = 2,930)
SCI (n = 375)

Hospital Discharge Disposition	TBI Group		SCI Group	
	Count	Percent	Count	Percent
Acute Care Facility	154	5.26%	23	6.13%
Another Type of Inpatient Facility	11	0.38%	1	0.27%
Burn Center	0	0.00%	0	0.00%
Child Protective Agency	4	0.14%	0	0.00%
Correctional Facility/Court/Law Enforcement	9	0.31%	2	0.53%
Home or Self-Care (Routine Discharge)	1,098	37.47%	95	25.33%
Home with Services	304	10.38%	36	9.60%
Hospice	47	1.60%	3	0.80%
Intermediate Care Facility	5	0.17%	0	0.00%
Left AMA	18	0.61%	4	1.07%
Long-Term Care	31	1.06%	8	2.13%
Mental Health/Psychiatric Hospital	9	0.31%	0	0.00%
Morgue	291	9.93%	27	7.20%
Musculoskeletal Rehabilitation	12	0.41%	4	1.07%
Nursing Home	13	0.44%	2	0.53%
Rehab (Inpatient)	370	12.63%	130	34.67%
SCI Rehabilitation	0	0.00%	8	2.13%
Skilled Nursing Facility	239	8.16%	22	5.87%
TBI Rehabilitation	1	0.03%	0	0.00%
Blank/NA/Unk	314	10.72%	10	2.67%
TOTALS	**2,930**	**100.00%**	**375**	**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 37 percent of TBI patients and 25 percent of SCI patients are listed, and those patients who were discharged to inpatient rehabilitation facilities for which 13 percent of TBI patients and 35 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

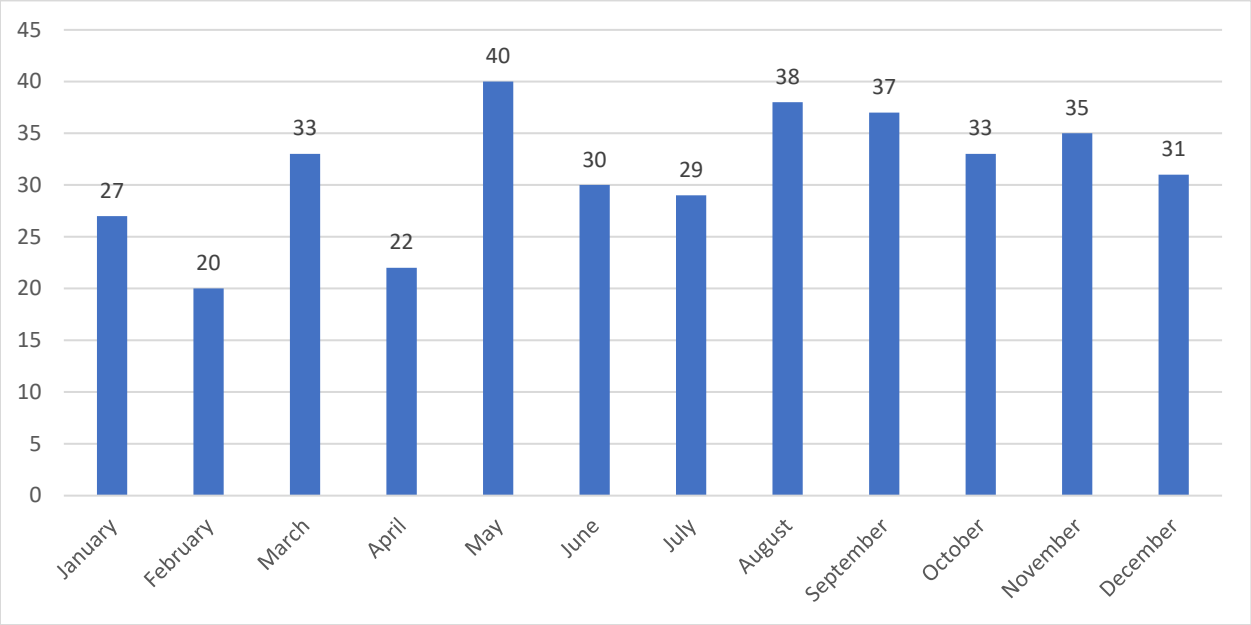


Mechanism of Injury Occurrence in SCI Cases and Fatality as Outcome
January 1, 2024 – December 31, 2024
(n = 375)

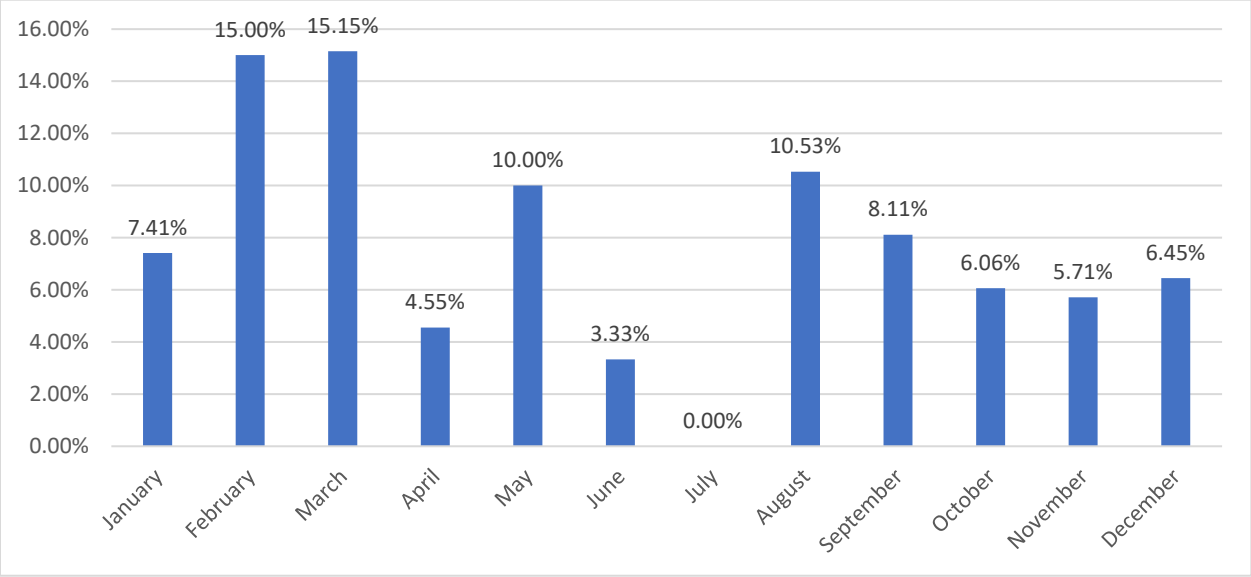
Primary Mechanism of Injury	Count	Percent	Deaths	Fatality Rate
Cut or Pierce	2	0.53%	0	0.00%
Drowning/Submersion	0	0.00%	0	0.00%
Fall	120	32.00%	6	5.00%
Fire or Flame	0	0.00%	0	0.00%
Hot Object or Substance	0	0.00%	0	0.00%
Firearm	33	8.80%	6	18.18%
Machinery	0	0.00%	0	0.00%
MVT-Occupant	131	34.93%	10	7.63%
MVT-Motorcyclist	6	1.60%	1	16.67%
MVT-Pedal Cyclist	3	0.80%	1	33.33%
MVT-Pedestrian	4	1.07%	0	0.00%
MVT-Other	0	0.00%	0	0.00%
MVT-Unspecified	9	2.40%	0	0.00%
Pedal Cyclist, Other	2	0.53%	0	0.00%
Pedestrian, Other	2	0.53%	0	0.00%
Other Land Transport	26	6.93%	4	15.38%
Other Transport	0	0.00%	0	0.00%
Natural or Environmental	1	0.27%	0	0.00%
Overexertion	0	0.00%	0	0.00%
Poisoning	0	0.00%	0	0.00%
Struck by or Against	14	3.73%	0	0.00%
Suffocation/Asphyxiation	1	0.27%	1	100.00%
Other Specified, Classifiable	2	0.53%	0	0.00%
Other Specified, Not Elsewhere Classified	1	0.27%	0	0.00%
Pedestrian Conveyance	0	0.00%	0	0.00%
Electrical	0	0.00%	0	0.00%
Mechanical	0	0.00%	0	0.00%
Explosion	0	0.00%	0	0.00%
Abuse	0	0.00%	0	0.00%
Not Classified	3	0.80%	0	0.00%
Blank/NA/Unk	15	4.00%	0	0.00%
TOTALS	**375**	**100.00%**	**29**	**7.73% Overall**

Of the 375 SCI patients observed, 140 (37 percent) were injured in motor vehicle accidents as either the driver or occupant. Further, 120 (32 percent) were injured during a fall. Thirty-three patients (9 percent) were injured by firearms, of which 6 (18 percent) died during treatment. Six patients (2 percent) were injured in motorcycle accidents, of which 1 died (17 percent). Whereas only 2 patients (1 percent) were injured in pedestrian accidents other than MVT related and 4 patients (1 percent) in MVT related pedestrian accidents. A pedestrian fatality was neither recorded within the MVT related category, nor within the Other-related category, with fatality rates of 0 percent respectively. A total of 153 (41 percent) injuries were related to motor vehicles in some way.

SCI Occurrence and Fatality by Month
January 1, 2024 – December 31, 2024
(n = 375)

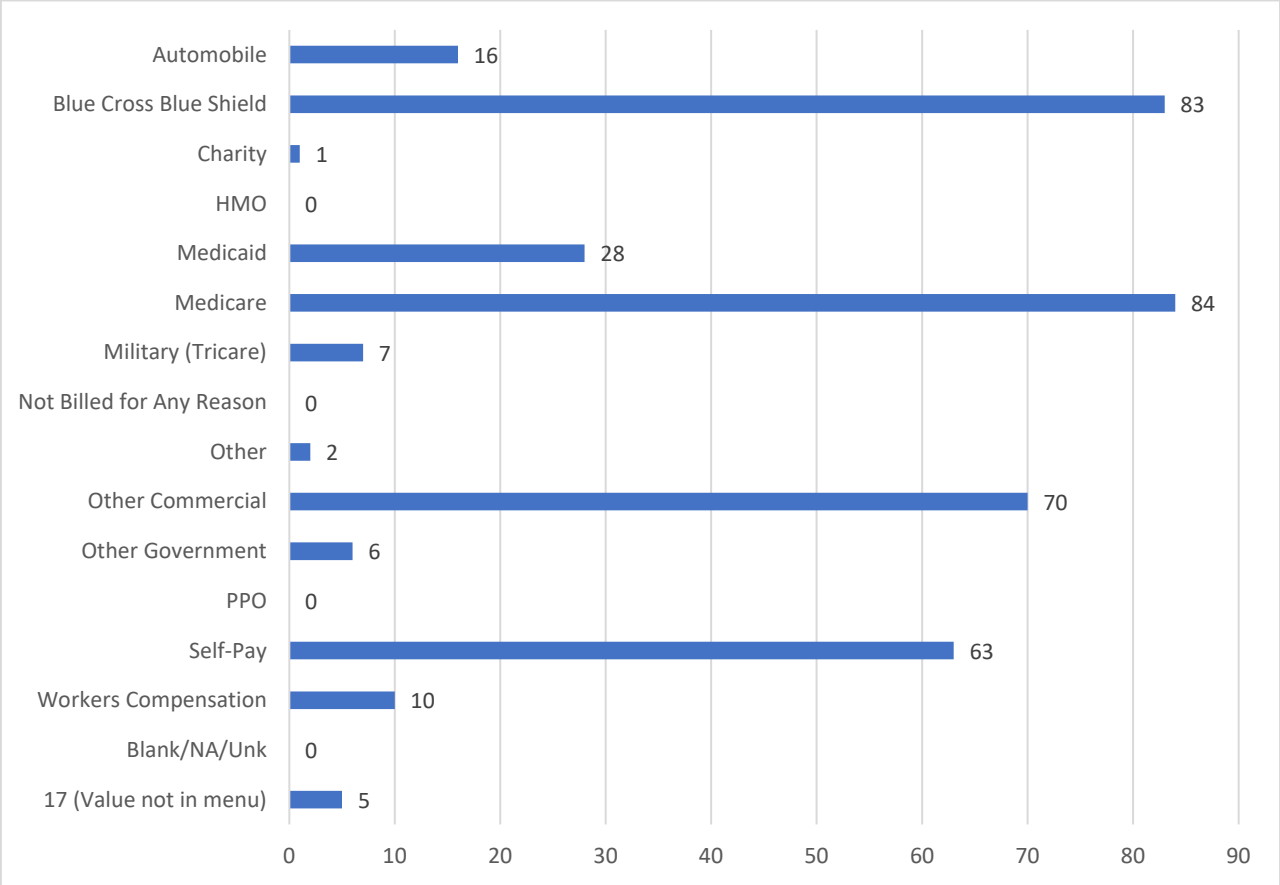


FATALITY RATE



The average injury count per month for SCI in 2024 was 31.25 (high of 40 in May and a low of 20 in February). The average monthly SCI fatality rate for 2024 was 8 percent (high of 15 percent in February and March, and low of 0 percent in July). 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.

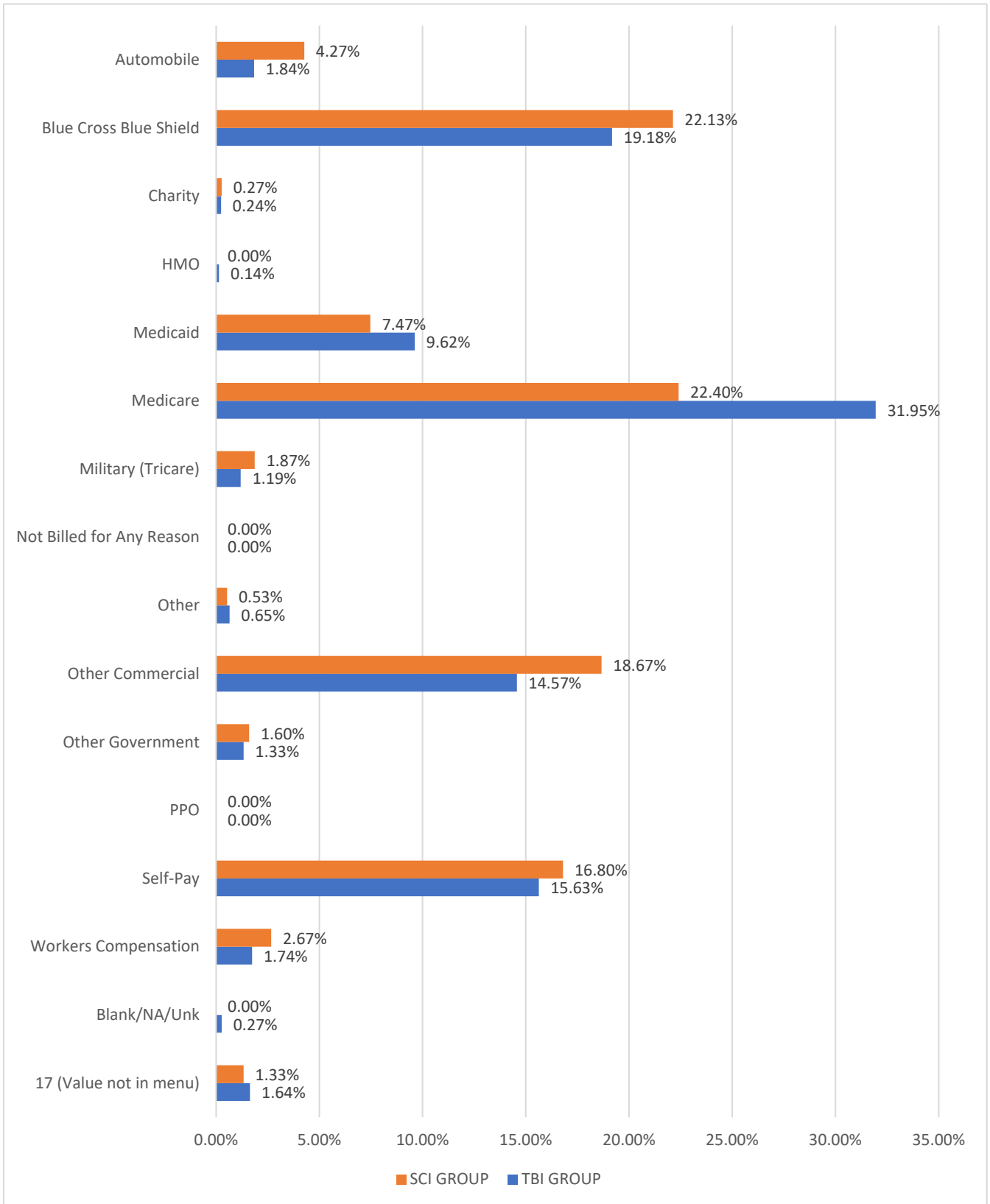
SCI Cases by Payer Source
January 1, 2024 – December 31, 2024
(n = 375)



Of the 375 SCI patients, all patients were billed for services. Source of payment is not known or not clear on 5 patients (1 percent). One patient was written off for charity. Three hundred patients (80 percent) were billed to some sort of insurance or were otherwise covered for charges. The remaining 63 patients (17 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 (83 patients or 22 percent of all SCI patients).

PAYER SOURCE PROPORTION COMPARISON

SCI GROUP VERSUS TBI GROUP



SCI Case Primary Payer Source and Fatality Statistics
(n = 375)

Primary Payer	Count	Percent	Deaths	Fatality Rate
Automobile	16	4.27%	1	6.25%
Blue Cross Blue Shield	83	22.13%	6	7.23%
Charity	1	0.27%	0	0.00%
HMO	0	0.00%	0	0.00%
Medicaid	28	7.47%	1	3.57%
Medicare	84	22.40%	8	9.52%
Military (Tricare)	7	1.87%	0	0.00%
Not Billed for Any Reason	0	0.00%	0	0.00%
Other	2	0.53%	0	0.00%
Other Commercial	70	18.67%	5	7.14%
Other Government	6	1.67%	0	0.00%
PPO	0	0.00%	0	0.00%
Self-Pay	63	16.80%	8	12.70%
Workers Compensation	10	2.67%	0	0.00%
Blank/NA/Unk	0	0.00%	0	0.00%
17 (value not in menu)	5	1.33%	0	0.00%
TOTALS	**375**	**100.00%**	**29**	**7.73%**

Conclusion

In 2024, participating Alabama hospitals entered a total of 3,243 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 2024 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 90 percent in general and hospitalization potential, and thus the potential for rehabilitative services was found to be significant.