

The Epidemiology of Traumatic Brain Injury in Wisconsin, 2001

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ABSTRACT

Problem: Traumatic brain injury (TBI) is a leading cause of death and disability in the United States. To implement more effective injury prevention and treatment programs, it is important to identify the regional impact, causes, risk factors, and trends of TBI. This report summarizes the public health impact of TBI in Wisconsin.

Methods: Data on fatal and non-fatal TBI injuries in Wisconsin in 2001 were obtained from 2 separate data sources: National Center for Vital Statistics and the Wisconsin Bureau for Health Information. Rates of fatal and nonfatal TBI were calculated using 2000 population estimates as denominators.

Results: There were 1059 TBI fatalities and 4006 living TBI-related hospital discharges in Wisconsin in 2001. The overall rate of TBI in Wisconsin for 2001 was 94.4 per 100,000 people. The number of fatal and nonfatal TBI related injuries was higher for males than females, at all ages, except nonfatal injuries in persons older than 65 years. Fatalities from TBI were highest in young adults and the elderly.

Conclusions: TBI is a major cause of death and hospitalizations in Wisconsin. Male teens and young adults, and the elderly are high-risk groups for TBI. Preventive measures should be aimed at these high-risk groups.

INTRODUCTION

One-third of all injury-related deaths are the result of traumatic brain injury, and an estimated 1.5 million US residents suffer traumatic brain injury (TBI) each year, resulting in over 50,000 deaths.¹ TBI survivors often suffer

permanent disability. In the United States, an estimated 5.3 million Americans live with TBI-related disability.²

Age-adjusted TBI-related hospitalization rates for Wisconsin in 1999 were 67.4 per 100,000 people. The risk of TBI was highest among infants, adolescents, young adults, and people age 75 years and older.² Overall fatalities in Wisconsin due to TBI were estimated to be 19.6 per 100,000 people.² TBI is a leading cause of trauma-related costs to the health care system.³ Estimated lifetime costs of TBI in the United States in 1995 were \$56.3 billion.⁴

To implement more effective injury prevention and treatment programs, it is important to identify the causes, risk factors, and trends of TBI. The aim of this report is to provide current information on the scope and impact of TBI in Wisconsin.

METHODS

For this report, 2 data sources were used. Fatal injury data were obtained from the National Vital Statistics, multiples cause of death public use files for 2001.⁵ Nonfatal injury data were obtained from Wisconsin Bureau of Health Information for hospital discharges in 2001.

TBI Definitions

TBI fatalities were defined according to the case definition in the Central Nervous System Injury Surveillance Data Submission Standards⁶ as all deaths where injury was assigned as the underlying cause of death and which had any one of the following (ICD-10) codes present in any of the diagnosis fields (International Classification of Diseases, Tenth Revision⁷):

- S01.0-S01.9 (open wound of the head)
- S02.0, S02.1, S02.3, S02.7-S02.9 (fracture of the skull and facial bones)
- S04.0 (injury to optic nerve and pathways)
- S06.0-S06.9 (intracranial injury)
- S07.0, S07.1, S07.8, S07.9 (crushing injury of head)
- S09.7-S09.9 (other and unspecified injuries of head)

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Table 1. Number, Rate* and Case Fatality Rate† of Traumatic Brain Injury-Related Deaths and Hospital Discharges By Age and Sex, Wisconsin 2001

Age	Total TBI Cases (N)	Rate per 100,000*	Non-fatal TBI Discharges (N)	Rate per 100,000*	TBI Deaths (N)	TBI Death Rate per 100,000*	Case Fatality Rate† (%)
Male							
0-4	147	84.0	134	76.6	13	7.4	8.8
5-15	286	71.3	252	62.8	34	8.5	11.9
16-19	307	147.0	234	112.1	73	35.0	23.8
20-24	369	202.3	277	151.9	92	50.4	24.9
25-34	405	113.0	308	85.9	97	27.1	23.9
35-44	461	105.0	349	79.5	112	25.5	24.3
45-64	651	110.0	475	80.1	176	29.7	27.0
65+	714	244.9	511	175.3	203	69.6	28.4
Subtotal	3340	126.1	2540	95.9	800	30.2	24.0
Female							
0-4	97	58.0	89	53.2	8	4.8	8.2
5-15	147	38.5	135	35.4	12	3.1	8.2
16-19	106	53.4	91	45.9	15	7.6	14.2
20-24	89	50.9	62	35.4	27	15.4	30.3
25-34	114	32.8	90	25.9	24	6.9	21.1
35-44	187	42.8	156	35.7	31	7.1	16.6
45-64	257	43.0	224	37.5	33	5.5	12.8
65+	728	177.1	619	150.6	109	26.6	15.0
Subtotal	1729	63.7	1466	54	259	9.5	15.0
Total	5065	94.4	4006	74.7	1059	19.7	21.0

*Age adjusted rates per 100,000 people based on US Census 2000.

†Case fatality rate=(fatal injury/[fatal + nonfatal injury]) x 100.

- T01.0 (open wounds involving head with neck)
- T02.0 (fractures involving head with neck)
- T04.0 (crushing injuries involving head with neck)
- T06.0 (injuries of brain and cranial nerve with injuries of nerves and spinal cord at neck level)
- T90.1, T90.2, T90.4, T90.5, T90.5, and T90.9 (sequelae of injuries of head)

Non-fatal TBI cases were identified from hospital discharge data and were included if the patient was alive at discharge and had one of the following codes, based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM),⁸ in any of the diagnosis fields:

- 800.0-801.9 (fracture of the vault or base of the skull)
- 803.0-804.9 (other and unqualified multiple fractures of the skull)
- 850.0-854.1 (intracranial injury, including concussion, contusion, laceration, and hemorrhage)
- 950.1-950.3 (injury to the optic chiasm, optic pathways, and visual cortex)
- 959.01 (head injury, unspecified)
- 995.55 (shaken infant syndrome)

All newborns born in the hospital were excluded from analysis.

ANALYSIS

The mechanism of fatal injury was classified by external cause of injury in to major cause-of-injury groupings using ICD-10 codes.⁹ The mechanism of nonfatal injury was classified by external cause of injury (E codes) according to standards in the CDC guidelines.¹⁰

The rates of fatal and nonfatal TBI were calculated using 2000 population estimates from the US Bureau of Census¹¹ as denominators. Age-, mechanism-, and gender-specific rates were calculated for fatal and nonfatal TBI using 2000 population figures. Case fatality rates were calculated using the following formula: Case fatality rate=(fatal injury/[fatal + nonfatal injury]) x 100. SAS version 8.0 software (Cary, NC) was used for all analyses.

RESULTS

There were 1059 TBI fatalities and 4006 living TBI-related hospital discharges in Wisconsin in 2001. The overall rate of TBI in Wisconsin for 2001 was 94.4 per 100,000 people. The TBI-related hospital discharge rate was 74.7, an increase of 10.8% from 67.4 in 1999, and slightly higher than the national age-adjusted hospital discharge rate for TBI of 69.7.¹² The rate of fatalities due to TBI—19.7—showed no corresponding increase from

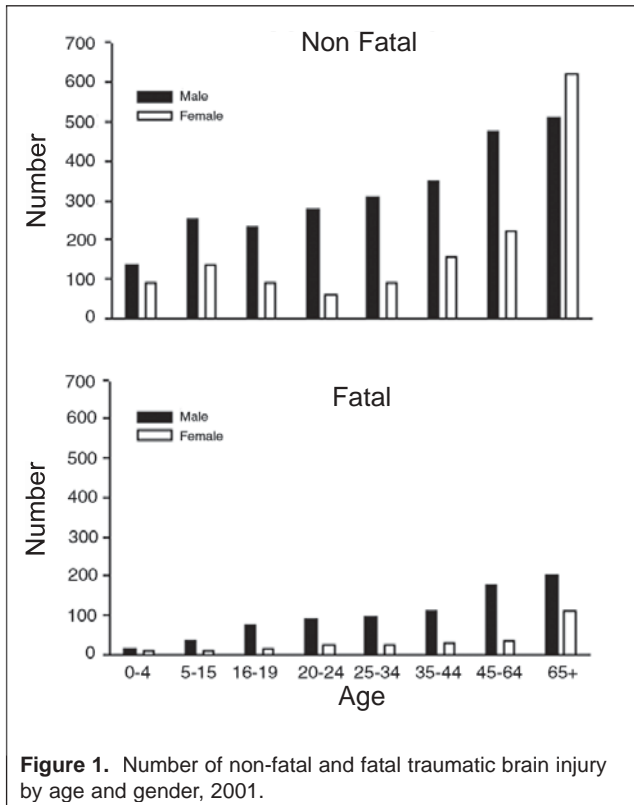


Figure 1. Number of non-fatal and fatal traumatic brain injury by age and gender, 2001.

the 1999 estimate of 19.6,² and is similar to the national rate of 19.8. (Table 1).

The number of fatal and nonfatal TBI-related injuries was higher for males than females, at all ages, except non-fatal injuries in persons older than age 65 (Figure 1). The hospital discharge rate for males was almost 2 times than for females, and fatality rates from TBI occurred 3 times more frequently in males than females (Table 1). Case fatality rates were similar between males and females. Males aged 16-24 had the highest rates of TBI fatalities and hospital discharges (Table 1). Hospital discharge rates were highest for adolescents, young adults, and the elderly. Fatalities from TBI were highest in young adults and elderly.

The racial distribution of TBI fatalities was similar to the demographic composition of Wisconsin. Whites accounted for just over 90% of all TBI fatalities, while blacks accounted for approximately 7%. Information about race was not available for hospital discharges.

Most TBI fatalities were the result of unintentional injuries (64%), but nearly one-quarter were due to suicide (22.7%), and just over 10% were the result of homicide. Motor vehicle crashes, firearms, and falls were the leading causes of death from TBI. Falls and motor vehicle-related incidents were the leading causes of non-fatal TBI-related hospital discharges (Tables 2).

The rate of in-hospital death for TBI injuries was 6.2 per 100,000 people, which represents 7.7% of TBI ad-

missions. The majority of those hospitalized for TBI-related injuries were discharged to home and about one-quarter of TBI admissions were discharged to another care facility (Table 3).

DISCUSSION

The major findings of this report demonstrate the large number of persons surviving TBIs, many of whom live with TBI-related disabilities.² Male teens and young adults, and the elderly are high-risk groups for TBI. These findings emphasize the importance of TBI as a major public health and clinical problem, not only because of the deaths associated with TBI, but also because of the large number of persons who survive the injury but require extensive treatment and rehabilitation. Better information on the outcomes of nonfatal TBI, including the impact on quality of life, is needed to quantify the individual and societal impact.

Male teens and young adults, and the elderly are high-risk groups. It has been reported previously about the risk-taking behaviors associated with young adult males.¹³ Targeting this population for behavioral counseling regarding risk-taking behaviors and use of personal protective equipment may have an impact on future injury.¹⁴

The principal mechanism of fatal TBI or hospitalization for the elderly is falls. Many result in prolonged hospitalization and rehabilitation needs in intermediate care facilities. Some community interventions have been implemented to prevent the large number of falls and injuries in the elderly with some impact on the morbidity and mortality associated with falls.^{15,16}

While data sources used for this report did not provide information about the use of personal protective equipment for those injured as a result of motor vehicle-related and pedal cyclist incidents, we know from previous reports that the use of seatbelts, car seats, and bicycle helmets reduce injury risk, and the use of these devices can be influenced through educational, behavioral, and legislative strategies.^{17,18}

The information presented in this report has several limitations. Those individuals treated and released from an emergency department (ED) and those who did not seek or have access to medical care were not captured by this report. ED data is available from 2002; however, the mortality data for 2002 had not been released for public use at the time of this report. ED data would provide information on less severe TBI, which could have more subtle long-term neurological problems, such as learning disabilities and difficulties concentrating that could impair school or work performance.

Secondly, administrative data sources were used to

Table 2. Number, Percentage, and Rate* of Nonfatal and Fatal Traumatic Brain Injury by Mechanism, Wisconsin 2001

Characteristic	Nonfatal (N)	Rate per 100,000*	Fatal (N)	Rate per 100,000*	Case Fatality Rate†
Motor-Vehicle Occupant	946	17.6	283	5.3	23.0
Motorcyclist	192	3.6	46	0.9	19.3
Pedal Cyclist MVC	34	0.6	3	0.1	8.1
Pedestrian MVC	118	2.2	29	0.5	19.7
Falls	1708	31.8	218	4.1	11.3
Assault	296	5.5	113	2.1	27.6
Suicide/Self-inflicted	10	0.2	240	4.5	96
Struck By/Against	193	3.6	7	0.13	3.5
Bicycle	80	1.5	1	0.01	1.2
Other/Unspecified/Unknown	429	NA	119	NA	NA
Total	4006	74.7	1059	19.7	20.9

* Per 100,000 people based on US Census 2000.

†Case fatality rate=(fatal injury/[fatal + nonfatal injury]) x 100.

MVC = Motor Vehicle Crash; NA = Not Applicable

develop this report. Although this data is easily accessible and captures a large proportion of TBI-related deaths and hospitalizations, its variability in abstracting and coding of medical charts may lead to inconsistencies. The hospital discharge data is currently using the ICD-9-CM coding system and the mortality data was recorded using ICD-10. The ICD-10 external cause of injury mortality codes are very different, with variability in detail, than codes in ICD-9. ICD-10 has alphanumeric categories rather than numeric categories and some chapters have been rearranged, some titles have changed, and conditions have been regrouped. The new ICD-10 had almost twice as many conditions as the ICD-9-CM system. When comparisons were done between the ICD-9 code set (800-801,804-804, 850-854, 873, 905.0, 907.0) and the ICD-10 code set the agreement between the 2 systems is nearly 96.5% with a comparability ratio of 0.9985.⁶

This report may contain some duplicative reporting. Individuals who die during a readmission for a prior traumatic brain injury would be counted in both the mortality data and the hospital discharge data. Because patient identifiers are not available in these datasets, we were not able to identify how often this may have happened.

CONCLUSION

Traumatic brain injury is a significant cause of death and hospitalizations in Wisconsin. The incidence is highest in male adolescents and young adults, and the elderly. Adolescent and young adult males are at particularly high risk of TBI. The elderly are at very high risk of falls. Preventive measures focusing on these high-risk groups and mechanisms of injury may make it possible to impact the significant public health burden of TBI.

Table 3. Number, Percent and Rate for Disposition of Hospitalized Traumatic Brain Injury Patients, Wisconsin 2001

Disposition	No.	%	Rate*
Routine Home	2823	65.1	52.6
Transfer to Another Facility	1011	23.3	18.8
Home Under Care	131	3.0	2.4
Hospice Home	5	0.1	0.09
Hospice-Medical Facility	3	0.07	0.05
Left Against Medical Advice	33	0.8	0.6
Expired	332	7.7	6.2

* Per 100,000 people based on US Census 2000

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