

Injury Epidemiology Brief

Bicycle-Related Traumatic Brain Injury

Colorado children ages 5-12

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What is traumatic brain injury?

A traumatic brain injury (TBI) includes such injuries as concussions, skull fractures, and intracranial injuries resulting from an external impact or forces of acceleration/ deceleration.^{1,2} The information in this brief addresses traumatic brain injuries that resulted in hospitalization or death. The data used in this report come from the Colorado Traumatic Brain Injury Surveillance, the Colorado Health and Hospital Association inpatient discharge data set, and death certificate data from the Colorado Department of Public Health and Environment.

Overview

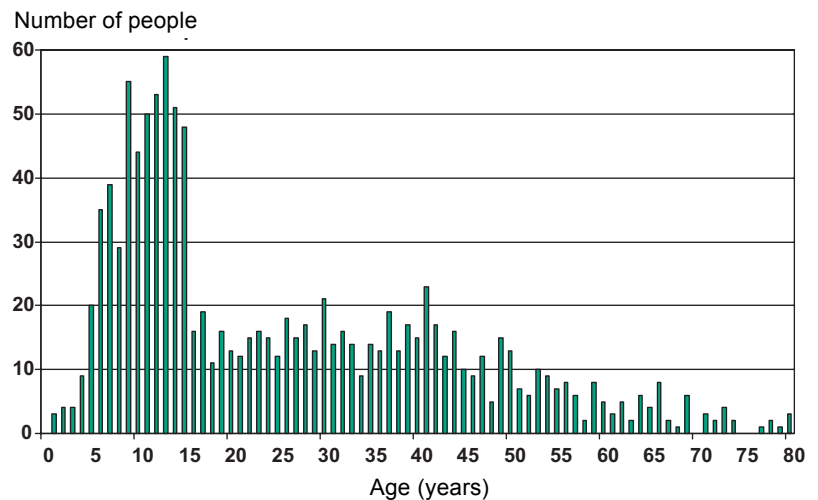
From 1994 to 2000, 1,131 Colorado residents were hospitalized or died from a bicycle-related traumatic brain injury. Of these individuals, 325 (29 percent) were children ages 5-12 years old.

- Thirty-eight percent of these children were ages 5-8; 62 percent were ages 9-12.
- Sixty-six percent of these children were boys.
- Of the 325 cases, 309 (95 percent) survived and 16 (five percent) died.
- Fifty percent of the injury events occurred in the Denver-Boulder metropolitan area.
- Children who were hospitalized or who died from a bicycle-related traumatic brain injury were more likely to be injured in the summer (45 percent) and spring (27 percent).
- An estimated 87 percent of the injury events occurred on a public street, while 11 percent occurred in a public area and two percent occurred in a driveway or at home.
- Forty percent of the injury events involved a collision with a motor vehicle.
- Only 15 percent of these children were known to be wearing a helmet at the time of the injury. Children with severe traumatic brain injuries were twice as likely to be unhelmeted at the time of injury compared to children with less severe traumatic brain injuries.

**Causes of hospitalized/fatal TBI,
Colorado children ages 5 to 12,
1994-2000**

Motor vehicle	606	37%
Falls	381	23%
Bicycle	325	20%
Other	288	17%
Unknown	59	3%
Total	1659	

**Coloradans hospitalized for bicycle-related traumatic brain injury,
by age, 1994-2000**



Who's at risk?

The majority (66 percent) of the 325 children who were hospitalized or died from bicycle-related traumatic brain injury in 1994 to 2000 were boys.

Most of these 325 children (64 percent) were white, non-Hispanic, while 18 percent were Hispanic or Black. Information on race/ethnicity was not available

From 1994 to 2000, 325 children ages 5-12, an average of 46 per year, were hospitalized or died due to bicycle-related head injuries in Colorado. Injuries sustained while riding a bicycle are the third leading cause of traumatic brain injury among children ages 5-12.

for 16 percent of the cases. In Colorado in 2000, 68 percent of all children ages 5-14 were white, non-Hispanic; 22 percent Hispanic; and five percent Black.³

Half of the injured children lived in the Denver-Boulder metropolitan area, which is home to 56 percent of all Colorado children ages 5-12.⁴

From 1994 to 2000, the number of hospitalizations and deaths each year due to bicycle-related traumatic brain injury in this age group has been relatively constant.

When, where, and how do bicycle injuries happen?

Most of these hospitalizations and deaths due to bicycle-related traumatic brain injury occurred in the summer (45 percent) and spring (27 percent). Fewer events occurred in the autumn (22 percent) and winter (six percent).

An estimated 87 percent of the injury events occurred on a street or roadway; 11 percent occurred at public places such as parks, recreation areas, and schools; and only two percent occurred in the driveway or yard where the child lived.⁵

Bicycle crashes can occur in a variety of ways including crashes with a motor vehicle in use (motor vehicle-related) or from losing control, falling off a bike or striking another bicyclist, pedestrian, or fixed object (non-motor vehicle-related).

Most of these 325 children were injured in non-motor vehicle-related events. An estimated 60 percent of the children who were hospitalized or died from a bicycle-related traumatic brain injury were injured in a non-motor vehicle-related event, while 40 percent were injured in a collision involving a motor vehicle in use. Motor vehicle-bicycle collisions resulted in the most serious injuries with an estimated 11 percent of these events resulting in death. Only one percent of the events that did not involve a motor vehicle resulted in death.

Selected characteristics of bicycle-related hospitalized/fatal TBI Colorado children ages 5-12, 1994-2000

	Number	Percent
Age 5-8	123	38%
Age 9-12	202	62%
Male	216	66%
Female	109	34%
Winter	21	6%
Spring	89	27%
Summer	145	45%
Autumn	70	22%
Region of Residence*		
Denver Metro	163	50%
Other Metro	95	29%
Rural	42	13%
Unknown	25	8%

*Denver Metro included Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson counties (including what is now Broomfield County). Other Metro includes El Paso, Larimer, Mesa, Pueblo, and Weld counties. Rural includes the remaining counties of the state.

How well do bicycle helmets protect against head injury?

Based on a review of a sample of medical records, only

15 percent of the children hospitalized with a traumatic brain injury were known to be wearing a helmet at the time of injury. Information on helmet use was not available for 28 percent of the cases. None of the children who had been wearing a helmet at the time of injury died in the hospital, whereas four percent of the non-helmeted children died in the hospital.⁶

The percent of children who sustained a severe traumatic brain injury was higher for children not wearing a helmet.⁷ More than half (63 percent) of the non-helmeted children suffered a severe TBI, compared to 42 percent of children wearing a helmet.⁸

Children who were hospitalized with a severe traumatic brain injury were twice as likely to be unhelmeted at the time of the injury compared to children with a less severe traumatic brain injury.⁹

What are the health care costs of bicycle-related TBI?

For children ages 5-12, the average length of stay for patients with head injuries only was 2.5 days, with an average hospital charge¹⁰ of \$5,941. For children with head injuries plus other injuries, the average length of stay was 5.1 days, with an average hospital charge¹⁰ of \$12,598.^{11, 12}

From 1994 to 2000, in Colorado, the total hospital charges for children ages 5-12 who were hospitalized with a bicycle-related traumatic brain injury were more than \$4.8 million. Various insurance and private sources paid for the care of these injuries. For the majority of these hospitalizations (72 percent), payment came from commercial or liability insurance, while 15 percent were covered by Medicaid or other government funds and 12 percent were self-pay (uninsured).¹³

Upon discharge from the acute care hospital setting, seven percent of the children hospitalized for bicycle-related traumatic brain injury were either sent to a skilled nursing facility, another acute care facility or required some type of home health care services, two methods of ongoing care that can be costly. Although the majority (86 percent) of the children hospitalized with a bicycle-related traumatic brain injury were discharged to home and did not need skilled home care assistance, some of these children may continue to have difficulty in adjusting to life after a head injury.

In addition to financial costs and loss of a productive life, traumatic brain injuries may result in significant costs to families that can not be easily measured in dollars. Even mild head injuries may result in lost days from school, and long-term memory, learning, and life-adjustment problems. A death of a child or even disabling injuries leads to great emotional costs to families and communities.

In 1999 in Colorado, adult household members reported 57 percent of 5 to 8 year-olds and 40 percent of 9 to 12 year-olds as always wearing a bicycle helmet.^a

A bicycle helmet can reduce the risk of serious head and brain injury by 70 to 88 percent.^b

Universal use of bicycle helmets by U.S. children ages 4-15 would annually prevent: 135 to 155 deaths; 39,000 to 45,000 head injuries; and 18,000 to 55,000 scalp and face injuries.^c

If all bicycle riders in Colorado wore helmets, an estimated 1,568 bicycle-related head injuries could have been prevented in 1997. This represents an estimated \$1.2 million in direct and \$3.5 million in indirect costs.^d

a. Health Statistics Section. Colorado Department of Public Health and Environment. 2001. Child bicycle helmet use: Colorado BRFSS, 1999. (Unpublished raw data.)

b. Harborview Injury Prevention and Research Center. 2001. Bicycle Injury Interventions: Bicycle Helmet Effectiveness. Retrieved April 24, 2002 from <http://depts.washington.edu/hiprc/childinjury/topic/bicycles/helmeteffect.html>

c. Children's Safety Network Economics and Insurance Resource Center. (n.d.). Childhood Injury: Cost & Prevention Facts, Bicycle Helmets Save Medical Costs for Children.

d. Schulman J, Sacks J, Provenzano G. State level estimates of the incidence and economic burden of head injuries stemming from non-universal use of bicycle helmets. *Injury Prevention* 2002; 8:47-52.

How can we prevent or reduce bicycle-related traumatic brain injury?

- Buy a bicycle helmet that meets or exceeds the U.S. Consumer Product Safety Commission federal safety standard.¹⁴
- Wear a bicycle helmet correctly. A bicycle helmet should fit comfortably and snugly, but not too tightly. It should sit on top of the head in a level position, and it should not rock forward and back or from side to side. The helmet straps must always be buckled.¹⁴
- Learn the rules of the road and obey all traffic laws. Ride on the right side of the road, with traffic, not against; use appropriate hand signals; respect traffic signals; stop at all stop signs and stop lights; and stop and look left, right, and left again before entering a street.¹⁴
- Cycling should be restricted to sidewalks and paths until a child is age 10 and is able to show how well he or she rides and observes the basic rules of the road. Parental and adult supervision is essential until traffic skills and judgment thresholds are reached by each child.¹⁴
- Develop a community-wide bicycle helmet promotion program to include public education and information; school education; helmet give-away or discount programs; ordinances, laws and policies; improved design and availability of bicycle routes, lanes, and paths; and evaluation.¹⁵

References

1. Centers for Disease Control and Prevention. (1995). Guidelines for Surveillance of Central Nervous System Injury. Atlanta, GA: Thurman, DJ, Sniezek JE, Johnson D, Greenspan A, and Smith SM.
2. Traumatic brain injury hospitalizations are identified using appropriate codes from the *International Classification of Diseases, 9th Revision*. Traumatic brain injuries are identified by codes ICD-9-CM 800, 801, 802, 804, 805, 850-854, and beginning in 10/1/97, the new code 959.01 for hospitalized cases; ICD-9 codes 800, 801, 802, 804, 805, 850-854 and 873 for deaths from 1994-1998 and ICD-10 codes S01.0-S01.9, S02.0, S02.1, S02.3, S02.7-S02.9, S06.0-S06.9, S07.0, S07.1, S07.8, S07.9, S09.7-S09.9, T01.0, T02.0, T04.0, T06.0, T90.1, T90.2, T90.4, T90.5, T90.8, T90.9 for deaths in 1999 and 2000. Bicycle related events are identified by codes : ICD-9 E810-E825 with .6, E826.1, E826.8, E826.9, E800-E807 with .3, E827-E829 with .1 and ICD-10 only for deaths in 1999 and 2000, V10-V19.
3. U.S. Census Bureau. (2002). 2000 Summary File 2. Retrieved June 04, 2002 from <http://factfinder.census.gov/servlet/BasicFactsServlet>
4. Colorado Department of Local Affairs. (2002). Population Forecasts by Age. Retrieved June 04, 2002 from <http://www.dola.state.co.us/demog>
5. These data are for hospitalizations in 1994-1997.
6. These data are for hospitalizations in 1994-1999.
7. Severe injury was defined as a head injury assigned an Abbreviated Injury Scale (AIS) score of 3 or greater.
8. These data are for hospitalizations in 1994-1999.
9. Ibid.
10. The average hospital charge listed is the average of the 90 percent interval costs. In this calculation, the highest five percent and lowest five percent of charges are subtracted prior to calculating the average. This is a method used to deal with "outliers" (i.e., admissions with extremely high or extremely low charges). Injury Epidemiology Program. Colorado Department of Public Health and Environment. (2002). Unpublished raw data.
12. Hospital charges do not include physician's fees nor the costs of prehospital, emergency department or rehabilitation care.
13. These data are for hospitalizations in 1994-1999.
14. National Safe Kids Campaign. Bike/Helmet: Protecting Your Family. Retrieved April 24, 2002 from <http://www.safekids.org>
15. Shieber RA and Sacks JJ. Measuring community bicycle helmet use among children. Public Health Reports. 2001; 116: 113-121.



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