



Trends in reporting injury as a cause of death among people with epilepsy in the U.S., 1981–2010



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ABSTRACT

Purpose: To examine trends in reporting injury as a cause of death among people with epilepsy in the U.S. during the past three decades.

Method: We analyzed the U.S. multiple causes of death data from death certificates in 1981–2010 to compare rate and odds ratios (OR) of reporting injury as cause of death among cases with vs. without mention of epilepsy across years.

Results: The trends in reporting epilepsy with and without injury were similar in most age groups but were inconsistent in most external causes of injury. The OR of reporting injury was 1.02 (95% confidence intervals (CI) 0.97–1.07) in 1981–1985 and decreased to 0.52 (95% CI 0.48–0.55) in 2006–2010. The decline in OR was prominent among people aged 15–24 followed by people aged 25–44. For the five external causes of injury, the OR of suffocation and drowning were 6.32 (95% CI 5.91–6.75) and 5.64 (95% CI 5.16–6.16) in 1981–1985 and decreased to 3.03 (95% CI 2.74–3.35) and 2.56 (95% CI 2.18–3.00) in 2006–2010. The OR for poisoning and traffic crashes were 0.70 (95% CI 0.57–0.85) and 0.08 (95% CI 0.07–0.09) in 1981–1985 and 0.21 (95% CI 0.18–0.25) and 0.06 (95% CI 0.05–0.08) in 2006–2010.

Conclusion: The risk of fatal injury among people with epilepsy decreased drastically during the past three decades in most age groups and for most external causes of injury except falls. People with epilepsy had lower risks of dying from injury due to poisoning or traffic crashes, had higher risks of dying from suffocation and drowning.

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1. Introduction

Injuries are slightly more frequent among people with epilepsy than among the general population.^{1–6} According to the review of Tomson et al.¹ people with symptomatic epilepsy and frequent seizures have increased risk of injury. Most injuries among people with epilepsy are trivial and commonly include contusions, wounds, fractures, abrasions, and brain concussions.¹ However, Beghi suggested that people with epilepsy have fairly low risk of injury compared to the general population, and that seizure frequency and type are the only factors associated with this risk.²

Specifically, uncontrolled seizures may present a serious threat in terms of injuries and their complications.

In regard to fatal injury, the standardized mortality ratio is 2–3 times higher for people with epilepsy compared to the general population, according to population-based studies. This increased mortality is largely related to the etiology of the epilepsy and is likely unrelated to the treatment of the epilepsy.¹ Cohort studies have indicated that 1–16% of deaths in people with epilepsy may be due to injury, and the most frequently occurring external causes of injury are drowning and falls.^{7–15} However, these previous studies were limited by the small number of deaths included in the study, which inhibited evaluation of the mortality risk by age and external cause of injury.

A further limitation is that cause-specific mortality is tabulated by underlying cause of death, which is defined by the World Health Organization as the disease or injury which initiated the train of

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morbid events leading directly to death.¹⁶ For example, consider a death certificate with these causes of death:

- (a) Head injury
- (b) Fall from ladder
- (c) Epileptic seizure

In this case, epilepsy would be selected as the underlying cause of death for mortality tabulation. Information on the fall and head injury as additional underlying causes of death would not be available in traditional mortality data. Use of “multiple causes of death” mortality data resolves this issue by allowing analysis of all information reported on death certificates.^{17–19} “Multiple causes of death” mortality data have been used previously to analyze epilepsy-related fatal injury.^{20–22} However, no study has systematically examined changes in risk of fatal injury among people with epilepsy during the past three decades. Thus we examined reports of injury as cause of death among people with epilepsy using “multiple causes of death” mortality data for the U.S. from 1981 to 2010. We further examined these trends by age and external causes of injury. As recent advances have improved the quality of care for people with epilepsy, and many guidelines have been recommended to reduce the risk of death from injury,^{1,3,5} we hypothesized that risk of dying from injury for people with epilepsy has declined over the past three decades.

2. Methods

2.1. Data source

We used “multiple causes of death” mortality data of the U.S. for the years 1981 through 2010. The datasets were compiled by the U.S. National Center for Health Statistics; they include all diagnoses (up to a maximum of twenty) reported on death certificates and are publicly available for research.²³

2.2. Classification of injury deaths

Injury is defined as “the physical damage that results when a human body is suddenly subjected to energy in amounts that exceed the threshold of physical tolerance—or else the result of a lack of one or more vital elements, such as oxygen”.²⁴ Injury deaths are usually classified according to the *International Classification of Disease* (ICD) scheme, which includes the external cause of injury (e.g., traffic crashes, falls, poisoning, or drowning), the intent of the injury (e.g., unintentional, homicide/assault, suicide/self-harm, or undetermined), the body region that was injured (e.g., head or lower extremity), the nature of injury (e.g., fracture, laceration, or contusion), places of injury, and the engaged activity at the time of injury.²⁵ In this study we confined our analysis to the external cause of injury, which is most relevant to injury prevention.

ICD-9 was used for the years 1980–1998 and ICD-10 was used for the years 1999–2010 for mortality tabulation in the U.S. The ICD-9 and ICD-10 codes were 345 and G40&G41 for epilepsy; E800–E928 and V01–X59 for any injury; E800–E848 and V01–V99 for traffic crashes; E850–E869 and X40–X49 for poisoning; E880–E888 and W00–W19 for falls; E910 and W65–W74 for drowning; and E911–E913 and W75–W84 for suffocation.

2.3. Statistical analysis

To interpret the trends of reporting both injury and epilepsy on death certificates over time, we calculated trends of reporting injury without mention of epilepsy and reporting epilepsy without mention of injury as references. By comparing rates of reporting

injury without mention of epilepsy to rate of reporting injury with mention of epilepsy, we can infer the influence of epilepsy on the risks of fatal injury among people with epilepsy.

As the number of deaths reporting both epilepsy and injury was small, we used one million population as the denominator for calculating mortality rate. For calculating mortality rates of epilepsy without injury and injury without epilepsy, we used ten thousand population as the denominator. The age demographics of the U.S. population in the year 2000 was used as the standard population to calculate the age-adjusted mortality rate.

Because absolute rates might change simultaneously and thus make comparison through time difficult, we also examined relative rates. For relative rates, we computed odds ratios (OR) and 95% confidence intervals (95% CI) of reporting injury as cause of death among cases with mention of epilepsy vs. those without mention of epilepsy. [Table 1](#) illustrates the calculation of OR and 95% CI of reporting injury as a cause of death. For each external cause of injury, we used a logistic regression model to estimate age-adjusted OR.

3. Results

In 1981–1985 there were 14,509 mentions of epilepsy on death certificates, of which 2382 (16.4%) reported injury as a cause of death. This reduced to 7.7% (1050/13,579) by 2006–2010. This declining trend was similar in most age groups except people aged 15–24 years old ([Fig. 1](#)). The decline in rate of reporting epilepsy with injury was steepest from 1981–1985 to 1996–2000. The rate of reporting epilepsy without injury on death certificates among people aged 15–24 years old increased from 0.32 (per 100,000 population) in 2001–2005 to 0.40 in 2006–2010. However the rate of reporting epilepsy with injury among people aged 15–24 years old showed a rapidly decreasing trend that leveled off from 2001–2005 to 2006–2010.

Trends in age-adjusted rates of reporting injury without epilepsy and injury with epilepsy on death certificates varied among external causes of injury ([Fig. 2](#)). The trend was increasing for suffocation and poisoning without mention of epilepsy, but was decreasing for suffocation and poisoning with mention of epilepsy. Similarly, the trend was mildly decreasing for drowning and traffic crashes without mention of epilepsy, but was substantially declining for drowning and traffic crashes with mention of epilepsy.

With regard to relative rates, the OR of reporting injury as a cause of death among cases with mention of epilepsy vs. without mention of epilepsy was 1.02 (95% CI 0.97–1.07) in 1981–85 and decreased to 0.52 (95% CI 0.48–0.55) in 2006–10 ([Fig. 3](#)). The decline in OR was most prominent among people aged 15–24 years old, from 0.42 (95% CI 0.37–0.47) in 1981–1985 to 0.13 (95% CI 0.11–0.17); followed by people aged 25–44 years old, from 0.90 (95% CI 0.83–0.97) in 1981–1985 to 0.31 (95% CI 0.28–0.35). However, no significant decrease in OR was noted among people aged 65 years old and above, which was 1.50 (95% CI 1.36–1.66) in 1981–1985 and 1.32 (95% CI 1.17–1.50) in 2006–2010.

For the five external causes of injury analyzed, the OR of suffocation and drowning decreased through time, respectively 6.32 (95% CI 5.91–6.75) and 5.64 (95% CI 5.16–6.16) in 1981–1985,

Table 1

Example of calculation of odds ratio (OR) and 95% confidence intervals (95% CI) in reporting injury as a cause of death among with mention of epilepsy vs. without mention of epilepsy on death certificates in the U.S., 1981–1985.

Reporting epilepsy	Reporting injury		OR	95% CI
	Yes	No		
Yes	2382	14,508	1.02	0.97–1.07
No	732,268	9,360,671	1.00	

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