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Golf Cart–Related Injuries in the U.S.

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Background: Golf carts today are used in a variety of public and private settings. Injuries related to golf carts are an important and increasing problem for people of all ages. This study analyzes trends and potential causes of nonfatal golf cart–related injury on a national level.

Methods: The National Electronic Injury Surveillance System database was used to examine all cases of nonfatal golf cart–related injury treated in U.S. emergency departments (EDs) from 1990 to 2006. Analysis was conducted in 2007.

Results: An estimated 147,696 (95% CI=144,404; 150,987) injuries, involving individuals aged 2 months to 96 years, were treated in EDs in the U.S. for golf cart–related injuries during the study period. Injuries to children (aged <16) constituted 31.2% of the cases. The most common type of injury was soft tissue damage (47.7%). Patients required hospitalization in 7.8% of the cases. Falling from a golf cart was the most common cause of injury (38.3%). Of golf cart–related injuries with a reported location, 70.3% occurred at sports facilities, 15.2% occurred on streets or public property, and 14.5% occurred around a home or farm. The number of golf cart–related injuries increased steadily each year, with an increase of 132.3% over the 17-year study period.

Conclusions: Given the growing capabilities and popularity of golf carts, coupled with the marked increase in golf cart–related injuries observed over the study period (>130%), intensified efforts are needed to prevent these injuries, especially among children.
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Introduction

Golf cart–related injuries in the U.S. have increased dramatically over the past several years.¹ While no data currently exist to track usage and exposure rates, it is likely that this increase is the result of a combination of factors—the carts' increased power and versatility, their rising popularity, and a lack of regulation. Over time, golf carts have become much faster and more powerful; newer models travel at speeds up to 25 mph, and have battery lives that last in excess of 40 miles.^{2,3} As the capability of golf carts increases, so does their potential number of uses. In addition to their traditional role on the golf course, golf carts are now routinely used for transportation purposes at sporting events, hospitals, airports, national parks, college campuses, businesses, prisons, and military bases. In many gated and retirement communities, golf carts have become the primary means of transpor-

tation. In some states, golf carts may be operated legally on public roadways and on some portions of the highway.^{3–7} Most golf carts are not subject to federal regulation, and state and local regulations for golf carts vary widely by region.^{3,8}

Previous studies on golf cart injuries have focused on a small geographic region or on a relatively small patient base (<150 patients).^{1,9,10} These studies have shown that golf cart–related injury is an important cause of serious and fatal injury among both adults and children.^{1,9,10} Falls from golf carts and cart overturns are leading causes of golf cart injury.¹¹ Many injuries are due to insufficient safety features, such as the lack of seat belts and front-wheel brakes.^{11,12} Children are particularly at risk for golf cart injury.^{1,9} Children aged <16 years are permitted by law to operate golf carts on private property.³ Infants and young children are allowed to ride in carts that do not have seat belts, doors, or any means of child restraint.^{3,8}

The objective of this research was to determine the trends and patterns of golf cart–related injuries to patients treated in U.S. emergency departments (EDs) between January 1, 1990, and December 31, 2006. To our knowledge, this is the first study to comprehensively examine golf cart–related injuries in the U.S. using a nationally representative sample.

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Methods

Data were obtained from the National Electronic Injury Surveillance System (NEISS), which is operated by the U.S. Consumer Product Safety Commission (CPSC). The NEISS dataset provides information on consumer product-related and sports and recreation-related injuries treated in U.S. EDs. The NEISS receives data from a network of approximately 100 hospitals, representing a stratified probability sample of 6100 hospitals in the U.S. and its territories, each with at least six beds and a 24-hour ED.¹³ Urban, suburban, rural, and children's hospitals are represented.¹⁴ Data from the NEISS are weighted to allow calculation of national estimates of injuries treated in U.S. EDs.

Established in 1972, the NEISS sampling frame was revised in 1978, 1990, and 1997. At all sampled hospitals, ED medical records are viewed by professional NEISS coders, and data regarding each patient's age, gender, race, injury diagnosis, body part injured, the product(s) involved, the treatment received, and a brief narrative describing the incident are recorded. Data reported in this study were adjusted to account for the sampling frame change and to provide a valid estimation of golf cart-related injuries.¹⁴ Analysis for the present study was conducted from June 2007 to September 2007.

Golf cart-related injuries were identified by the NEISS product code for golf carts (1213). The estimates in this study were based on weighting data from 3412 patients treated in U.S. EDs between January 1, 1990, and December 31, 2006. Patients of all ages were included. Reported cases involving fatal injury (seven cases) were excluded from the analysis because of their small number and the fact that NEISS does not capture fatal injuries that occur in the prehospital setting. All NEISS data narratives were reviewed to classify the primary cause of injury: (1) cart overturn, (2) falling/jumping from a moving golf cart, (3) collision with another vehicle or stationary object, (4) patient struck/run over by a cart, (5) injury while getting into or out of the cart, (6) injury to a protruding limb, or (7) other/not documented. In instances of potential overlap among these categories, the cause that occurred first in a sequence of events was considered the primary cause; for example, if an injury was caused by falling from a golf cart that had overturned, the primary cause was considered to be the cart overturn.

Data were analyzed using SPSS version 14.0 with the complex-samples module, with adjustment for sample weights and the stratified survey design, as recommended by the CPSC.¹⁴ Computation of relative risks (RR) with 95% confidence intervals (CIs) was performed. All data reported in this article are national estimates unless otherwise specified. Injury rates were calculated using the U.S. Census Bureau's intercensal data for each sampling year.^{15,16} This study was approved by the IRB of The Research Institute at Nationwide Children's Hospital.

Results

From 1990 through 2006, an estimated 147,696 people (95% CI=144,404; 150,987) were treated in U.S. EDs for golf cart-related injuries. Patients were aged 2 months to 96 years. The mean age was 33.6 years, and

the median age was 28 years. Injuries to children (aged <16 years) constituted 31.2% of the cases. Injuries to male drivers/passengers predominated (63.1%; Table 1). The number of golf cart-related injuries increased steadily and significantly over the study period ($p<0.001$; Figure 1); there were an estimated 5772 cases (95% CI=4411, 7132) of golf cart-related injury in 1990, compared to an estimated 13,411 (95% CI=11,675; 15,147) cases in 2006. This represents a 132.3% increase during the 17-year study period.

For cases in which the location of the injury was documented, the majority (70.3%) occurred at a sports or recreational facility. Injuries that occurred on the street, however, more often resulted in concussions (RR=1.58, 95% CI=0.71, 3.52), and were more likely to require hospitalization (RR=1.78, 95% CI=1.24, 2.56) than injuries that occurred in other locations. Children (aged <16 years) were most likely to be injured at home (RR=3.15, 95% CI=2.49, 3.98), while adults (aged ≥ 16 years) were most likely to be injured at a sports or recreational facility (RR=1.47, 95% CI=1.33, 1.61).

Falling or jumping from a golf cart was the most common cause of injury for both adults and children (38.3%; Table 2). However, children were at greater risk than adults for falls from a golf cart (RR=1.70, 95% CI=1.54, 1.87). Injuries caused by falls were more than twice as likely to result in injury to the head or neck (RR=2.17, 95% CI=1.87, 2.52), and more than six times as likely to result in concussion than injuries due to other causes (RR=6.22, 95% CI=3.35, 11.55). Adults were more likely than children to be injured while getting into or out of the cart (RR=5.02, 95% CI=2.53, 9.95), and patients struck by a golf cart were more likely to sustain injury to the legs or feet (RR=2.22, 95% CI=2.01, 2.44) compared to other body regions.

The most common type of injury was soft tissue damage (47.7%). The majority of soft tissue injuries occurred to the legs and feet (45.6%). The vast majority of patients with soft tissue injuries (97.9%) were treated and released without hospitalization. Fractures were the second most common type of injury, constituting 22.3% of the cases. Fractures to the arms and hands were most common (41.3%), followed by fractures to the legs and feet (37.9%). Fractures were associated with a high likelihood of hospitalization compared to other types of injury (RR=3.90, 95% CI=3.02, 5.04), as were concussions (RR=2.72, 95% CI=1.54, 4.78) and internal injuries (RR=4.25, 95% CI=3.12, 5.79). Lacerations accounted for 15.5% of injuries. Nearly half of these laceration injuries (46.5%) occurred to the head and neck. The head and neck were the most commonly injured body regions among children (32.1%). Leg and foot injuries were the most common among adults (40.9%).

Table 1. Golf cart–related injuries treated in U.S. emergency departments (1990–2006)

Description	Cases (n)	Weighted estimate (%)	95% CI
Age (years)			
Children (<16)	1169	46,117 (31.2)	43,170; 49,064
Adults (≥16)	2243	101,578 (68.8)	98,013; 105,144
Gender			
Male	2178	93,264 (63.1)	89,759; 96,768
Female	1234	54,432 (36.9)	51,270; 57,593
Diagnosis			
Soft tissue injury ^a	1553	70,523 (47.7)	67,102; 73,943
Fracture	798	32,914 (22.3)	30,370; 35,458
Laceration/amputation	494	22,926 (15.8)	20,666; 25,187
Concussion	86	3,176 (2.2)	2,348; 4,004
Internal organ injury	217	6,412 (4.3)	5,304; 7,520
Other ^b	264	11,745 (7.7)	10,134; 13,357
Body-part injured			
Head/neck ^c	856	33,262 (22.5)	30,735; 35,789
Trunk ^d	539	24,624 (16.7)	22,310; 26,937
Arm ^e	715	32,959 (22.3)	30,326; 35,591
Leg ^f	1226	53,948 (36.5)	50,840; 57,056
Other ^g	76	2,903 (2.0)	2,097; 3,709
Disposition			
Treated/released	3052	135,278 (91.6)	131,792; 138,764
Hospitalized ^h	340	11,544 (7.8)	10,031; 13,057
Other ⁱ	20	873 (.6)	419; 1,328
Location of injury			
Home/farm	326	14,979 (14.5)	13,108; 16,851
Street/public property	357	15,649 (15.2)	13,788; 17,510
Sports/recreational facility	1571	72,592 (70.3)	69,141; 76,042

^aIncludes sprain, strain, contusion, abrasion, hematoma

^bIncludes burns, crushing, dislocation, foreign body, dental injury, puncture, anoxia, poisoning, hemorrhage, electric shock, submersion, avulsion, not documented

^cIncludes head, neck, face, mouth, ear, eye

^dIncludes upper trunk, lower trunk, shoulder

^eIncludes upper arm, lower arm, elbow, wrist, hand, finger

^fIncludes upper leg, lower leg, knee, ankle, foot, toe

^gIncludes pubic region, injury to ≥20% of body, not documented

^hIncludes admitted, transferred, held <24 hours for observation

ⁱIncludes left against medical advice, not documented

Discussion

This study is the first to examine golf cart–related injuries in the U.S. using a nationally representative sample. The few studies to date advocate increased safety measures because of the serious and growing nature of this problem.^{1,9–12,17} As golf cart use migrates off the golf course into more nontraditional settings and onto public roads, it is likely that the number of golf cart–related injuries will continue to rise.

Almost half (47.2%) of golf cart–related injuries were due to either falls from golf carts (38.3%) or to cart overturns (8.9%). One recent study¹¹ showed that golf carts moving at speeds as low as 11 MPH could readily eject a passenger during a turn. A similar study by Seluga et al.¹² suggested that current golf cart safety features are insufficient to prevent passenger falls. For example, rear-facing golf cart seats are associated with high rates of passenger ejection,¹¹ and most golf carts do not have brakes on all four wheels. It has been shown that rear-wheel-only brake designs can cause directional instability and reduced braking effective-

ness, leading carts to “fishtail”; such designs also can cause the brakes to lock, so that the driver loses control of the vehicle. This can be a problem on the hilly terrain of most golf courses.¹⁷ While the Federal Motor Vehicle Safety Standard No. 500 requires that low-speed vehicles (golf carts capable of 20–25 MPH maximum speed) be equipped with safety features and pass safety inspections and performance tests in order to operate on public roads,³ there is little legal regulation regarding the operation of golf carts intended for nonroadway use, and there is no generally accepted safety-rating system for golf carts. The high percentage of injuries due to falls from carts underscores the need for more effective safety features, such as improved passenger restraints.

Operator error likely also plays a role in golf cart–related injuries. Private golf cart drivers are not required to possess a driver’s license or to attend safety or operational training; further, there is no legal driving age for golf carts.³ While many country clubs, universities, and other private facilities have begun to establish their own training programs and safety policies on golf

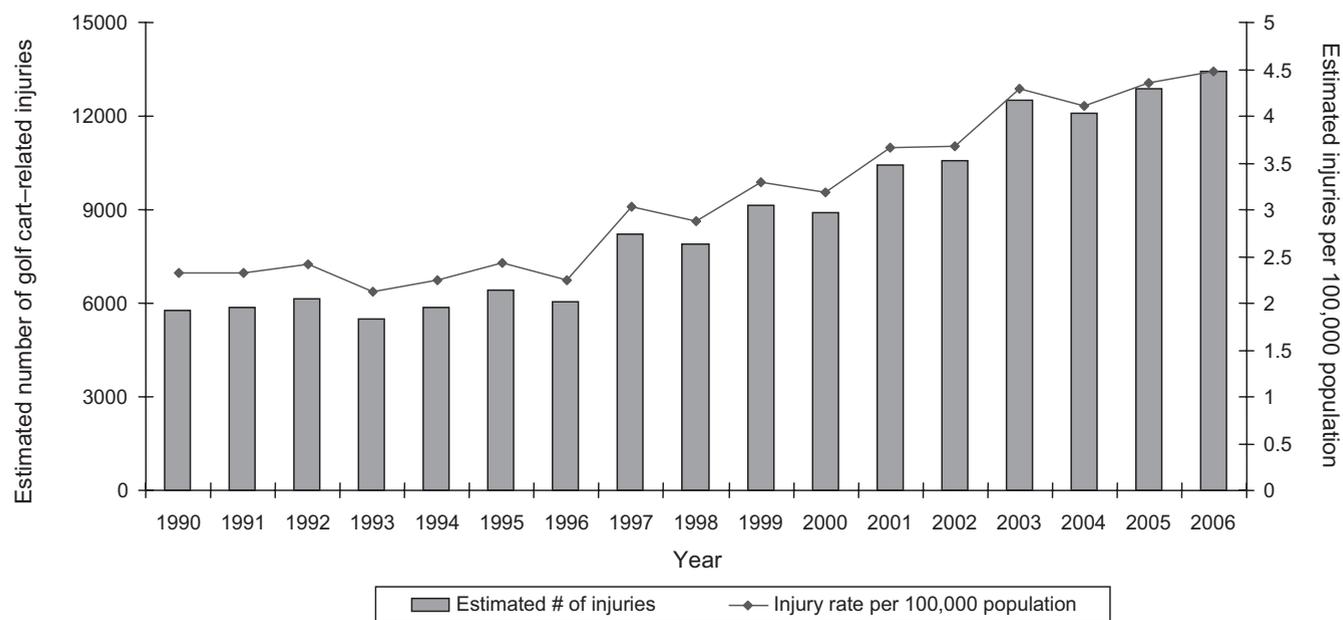


Figure 1. Estimated number and rate of U.S. golf cart-related injuries (1990–2006).

cart use,^{18–21} such programs likely vary in their intensity or comprehensiveness, as there is no national standardization in their content or enforcement.

While the absolute number of injuries from golf carts to children aged <16 years is not as high as other non-automobile, motorized vehicles such as all-terrain vehicles (ATVs; Table 3), this study confirmed the findings from previous studies that children are at serious risk for golf cart injury.^{1,10} Children are more likely than adults to fall from the cart, and falls are associated with higher rates of head/neck injuries and hospitalization. Golf carts are not designed for children, and most offer no child safety features. Unlike seatbelts (which are designed to secure a passenger in place), hip restraints are typically rectangular or semi-circular bars that are attached to the side of the cart's seat and are meant to serve as both handholds and a means to stop passengers from sliding from the cart. Younger children tend to sit forward in a cart seat, which places them forward of a standard 10" hip restraint. Children also may not be strong enough to

effectively hold the hand grip to prevent ejection during turns.

This study has several limitations. The total number of golf cart injuries during the study period was under-represented because only injuries treated in EDs were included. For this reason, the findings of this study may not be representative of all golf cart injuries. NEISS data narratives may omit details regarding the circumstances of the injury such as alcohol use, driving experience, and the layout of the golf course. More research is needed to determine the role of these factors in golf cart-related injury events; such details might have provided more insight into potential preventive measures. Also, data regarding exposure to golf carts were not available, and therefore the rates of injury could not be calculated. Data regarding the total number of golf carts manufactured and sold in the U.S. are not routinely collected or available. In addition, there are currently no data available on the frequency of use or exposure to golf carts. Further research is recommended to explore how these factors affect golf cart-related injuries. Despite these limitations, the strength of this study is that it examined a large,

Table 2. Primary causes of U.S. golf cart-related injuries (1990–2006)

Cause of injury	Percentage of cases
Fell/jumped from cart	38.3
Struck/run over by cart	16.2
Collision with another vehicle or stationary object	9.6
Cart overturned	8.9
Injury getting into or out of cart	4.9
Injury to protruding limb	3.2
Other/not specified	18.9

Table 3. Estimated number of non-automobile, motorized vehicle-related injuries to children aged <16 years treated in EDs in the U.S. per year

Vehicle	Number of injuries
ATV ²⁵	40,400
Go-cart/buggy ²⁵	11,780
Golf cart	4,300
Snow-related ²⁵	2,750

ATVs, all-terrain vehicles; EDs, emergency departments

nationally representative sample over a long study period.

Golf cart users should be aware of the risks associated with golf cart use. Taking safety precautions during golf cart use may decrease the risk of injury. Drivers should operate golf carts at reasonable speeds and consider the terrain and weather conditions while driving. Drivers should brake slowly, especially on downhill slopes, and avoid sharp turns at high speeds because increasing the radius of a turn greatly decreases the risk of passenger ejection.^{11,17} Passengers should place both feet firmly on the floor, keep arms and legs inside the cart at all times, sit back in the seat to take advantage of hip restraints, and be prepared to use the handgrip to prevent a fall. Seat belts should be used when available. Post-factory alterations to make golf carts sit higher off the ground or run faster are not recommended. Disabling a golf cart's speed governor is illegal in all states, and could result in serious injury.^{3,8} Owners should ensure that carts are in good repair, and in compliance with federal, state, and local laws.

Because golf carts are not designed for the safe transportation of children, their use for transporting children should be strongly discouraged. While the American Academy of Pediatrics does not currently have a policy statement on golf cart use for children, it does recommend that (1) children aged <6 years not ride in vehicles similar to golf carts, such as ATVs, riding lawn mowers, and snowmobiles; and (2) children aged <16 should not be allowed to operate these vehicles.²²⁻²⁴ Based on these recommendations and the finding from this study that children aged <16 years account for almost one third of golf cart-related injuries, these guidelines should be considered for golf carts as well.

In addition, private and public facilities that allow golf cart use can help prevent cart-related injuries by requiring driver's licenses and safety/operations training, establishing safety policies, and considering golf cart safety in the design of pathways and golf course landscapes.

Conclusion

Given the large increase in golf cart-related injuries over the study period (>130%), greater efforts are needed to prevent these injuries, especially among children.

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