Incidence of Golf Cart-Related Injury in the United States

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Background: **Golf carts have become a popular mode of transportation off of the links because of their small size, low maintenance, and ease of use. Case reports suggest severe, debilitating injuries as a consequence of golf cart incidents. To date, there has been no national population-based study of golf cart-related injuries.**

Methods: **The National Electronic Injury Surveillance System identified individuals who visited participating emergency departments from January 1, 2002 to December 31, 2005 for injuries sustained as a result of golf carts.**

Results: **An estimated 48,255 (95% confidence interval, 35,342–61,108) golf cart-related injuries occurred in the U.S. between 2002 and 2005; the injury rate was 4.14 of 100,000 population. The highest injury rates were observed in 10 to 19 year olds and those aged 80 and older. Male patients had a higher injury rate than female patients, and whites had a higher rate than blacks or Asians. Contusions/abrasions were the most common diagnosis for the hip and lower extremity region; fractures were the most common diagnosis for shoulder and upper extremity region; and intracranial injuries, including concussions, subdural hematomas, and hemorrhage, were the most common diagnosis for head and neck region. The two most common geographic settings of injuries were sports fields such as golf courses (45.0%) and places of residence (16.0%).**

Conclusion: **The popularity of golf carts as a means of transportation calls for mandatory safety standards to be met along with implementation of available safety courses for children who will potentially be operating these vehicles.**

Key Words: **Golf, Injury, Incidence, Epidemiology.**

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As defined by the National Highway Transportation Safety Administration a golf cart is a small passenger vehicle that has traditionally been intended for recreational or off-road-only use and has a top speed of 15 mph.[1] Although golf carts were originally designed exclusively to meet the transportation needs of golfers, recently, there has been a significant increase in their use as a means of transportation beyond the golf course.[2] A golf cart's small size and ease of use has led to their adaptation to an all around transportation option for people in retirement neighborhoods and communities. In fact, some communities encourage golf cart use as a primary means of public transportation because of their low emissions, quiet operation, and presumed safety.[3,4] There is little federal regulation of golf cart use, and in most states, it is not required that operators be of a certain age, wear any form of safety equipment, or obtain an operator's license.

Case reports suggest that golf cart-related injuries can be quite serious and debilitating.[5,6] For example, a 48-year-old man suffered severe periorbital hematoma and extensive bifrontal cerebral contusions resulting from an overturned golf cart. In another case, a 45-year-old man was thrown from an overturning golf cart and suffered both subdural and extradural hematomas, a subarachnoid hemorrhage, a parieto-occipital fracture, and bilateral frontal lobe contusions.

To date, there has been no national population-based study of golf cart-related injury. Although a 1996 study in a North Carolina island community reported that golf cart injuries, especially where golf carts are used on public roads, can be quite severe and debilitating, the scope of the study was very small.[3] Herein we present the epidemiology of golf cart-related injury treated in the U.S. emergency departments from 2002 to 2005.

MATERIALS AND METHODS

The data for this study were obtained from the 2002 to 2005 National Electronic Injury Surveillance System (NEISS). The NEISS is a national database that was created in 1971 by the U.S. Consumer Product Safety Commission's to monitor injuries associated with certain consumer products.[7] Since 2000, the NEISS has been expanded to include all injuries rather than just those that were product related. The NEISS is a probability sample of participating hospitals, and it is stratified according to the size and location of those hospitals. Ninety-six different hospitals that have 24-hour emergency departments currently contribute to the NEISS, most of which have trained, on-site NEISS-coding personnel who compile data daily and send it to the NEISS. Once received by the NEISS, each case is analyzed by quality assurance coders who review the data to assign any relevant product-related codes that correspond to direct or precipitating causes of each

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injury. Each consumer product is assigned a code, and golf carts are assigned the code 1213.

The rate of golf cart-related injury was calculated using the 2002 to 2004 U.S. population as estimated by the U.S. Census Bureau[8] as the denominator; because of unavailability of 2005 census data, the 2004 census data were used as a surrogate for the 2005 census. Injury rates were calculated according to age, gender, and race. To describe the anatomic location of injuries, four body regions were created: head and neck, trunk, shoulder and upper extremity, and hip and lower extremity. The distribution of injury types within each region was calculated; in addition, the distribution of places wherein injury occurred was also calculated.

Given that the NEISS is a probability sample of all hospitals in the United States, weights must be applied to the data to account for the probability of selection, annual number of emergency department visits for a hospital, and to account for nonresponse of hospitals. The weighted data provide estimates for the total number of golf cart injuries in the United States during 2002 to 2005. The sampling procedure used by the NEISS and the statistical basis for the calculation of national estimates based on the NEISS data are described in detail elsewhere.[7,9] The NEISS is a resource used extensively by government agencies and researchers and the validity of the hospital selection procedure and derivation of sampling weights is well established. To account for sampling errors,[9] 95% confidence intervals (CI) were calculated using the standard error of the national estimate as calculated using SUDAAN (RTI International, Research Triangle Park, NC), a statistical program that is able to create estimates based on probability-sampled data.

RESULTS

There were 1,187 cases (unweighted) of golf cart-related injury identified in the NEISS from 2002 to 2005; these cases represent an estimated 48,255 (CI 35,342–61,108) total cases in the United States during this time period resulting in an estimated injury rate of 4.14 per 100,000 population (CI 3.03/100,000–5.24/100,000) (Table 1). The injury rate was higher for men (5.36/100,000, CI 3.97/100,000–6.76/100,000) compared with women (2.95, CI 2.04/100,000–3.85/100,000). The rate was highest among whites (3.53/100,000, CI 2.21/100,000–4.85/100,000) and lowest among blacks (0.79/100,000, CI 0.34/100,000–1.25/100,000). Injury rates demonstrate a bimodal distribution with peaks among 10 to 19 year olds (7.78/100,000 for male patients and 5.01/100,000 for female patients) and those 80 and older (10.76/100,000 for men and 3.25/100,000 for women). Rates between genders are similar for ages 20 to 59, and a marked divergence is seen for the older age groups (Fig. 1).

Table 1 Estimated Number of Golf-Cart Related Injuries and Rates (Per 100,000 Person-Years) and 95% Confidence Intervals (CI) by Selected Demographic Characteristics, 2002–2005

	Estimate[1]	Rate[2]
Overall	48,225 (35,342–61,108)	4.14 (3.03–5.24)
Gender		
Female	17,460 (12,099–22,821)	2.95 (2.04–3.85)
Male	30,766 (22,757–38,775)	5.36 (3.97–6.76)
Race		
White	33,140 (20,741–45,539)	3.53 (2.21–4.85)
Black	1,178 (504–1,852)	0.79 (0.34–1.25)
Other	1,835 (657–3,012)	2.33 (0.84–3.83)

[1] Weighted data.
[2] Annual U.S. census estimates used to calculate rates.

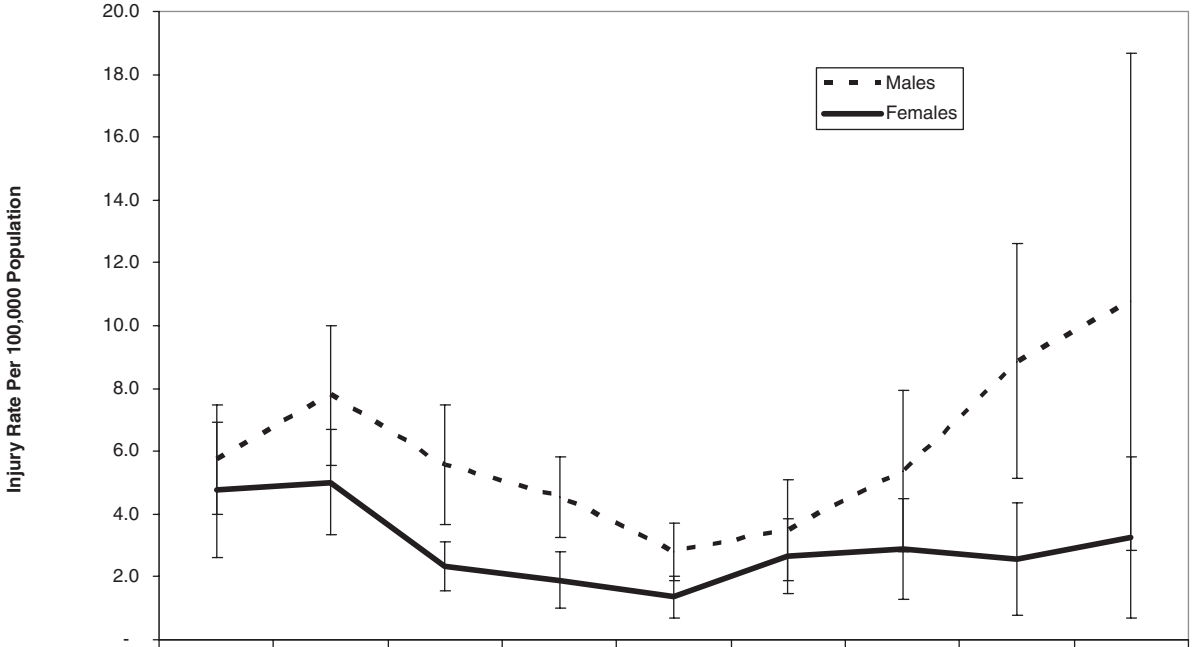
The greatest proportion (45.0%) of golf cart-related injuries occurred on a sports field (e.g., golf course), whereas the next most common setting was the home (16.0%). This distribution, however, varies by age, with injuries in the home setting, compared with all other age groups, occurring more frequently for those younger than 20 years and older than 70 years (Fig. 2).

The most frequent body location injured was the hip and lower extremity (32.1%) followed by shoulder and upper extremity (28.9%), head and neck injuries (25.6%) and trunk injuries (11.7%). Contusions and abrasions were the most common diagnosis for hip and lower extremity (36.8%) and trunk injuries (37.8%). The most common diagnosis for a shoulder or upper extremity injury was a fracture (40.8%), and the most common diagnosis for a head or neck injury was intracranial injury (37.4%), which includes concussions, subdural hematomas, and intracranial hemorrhage (Table 2).

DISCUSSION

According to data from the NEISS, the rate of golf cart-related injury in the United States from 2002 to 2005 was 4.14 per 100,000 population. To place this into context, data from the NEISS have been used to quantify the rate of nonfatal horseback riding related injuries in the United States from 2001 to 2003 as 35.7 per 100,000 population[10] and the rate of nonfatal drownings in recreational settings in the United States from 2001 and 2002 as 1.5 per 100,000 population.[11] Perhaps a more relevant comparison is to all-terrain vehicle injuries, of which there are approximately 127,000 emergency department visits annually[10] compared with approximately 12,000 golf cart-related injuries.

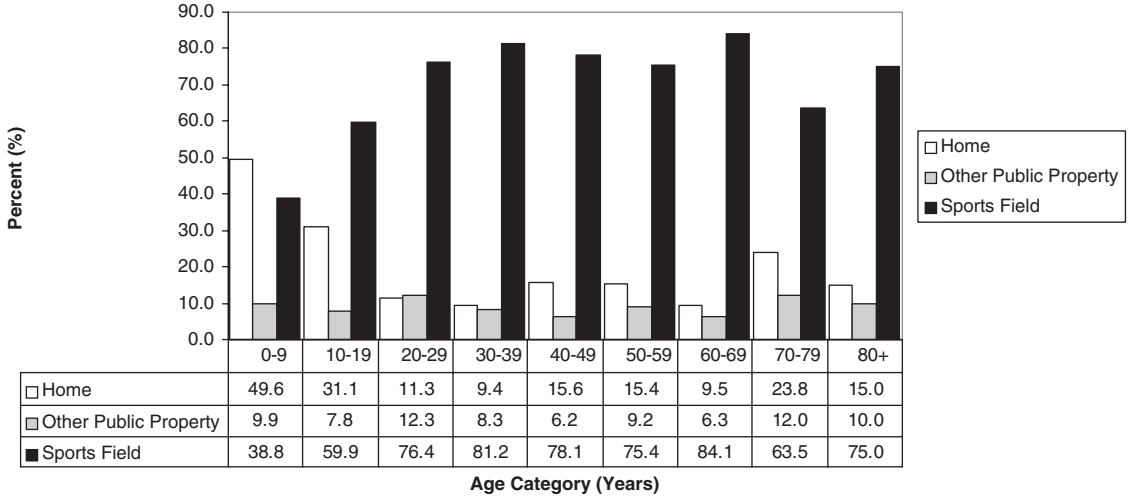
The results of this study suggest that younger and older individuals have the highest rates of golf cart-related injury. There are several possible explanations for this observation. Individuals in these age groups may be at increased risk because of physical or cognitive limitations that prevent the safe operation of a golf cart. There is a higher proportion of injuries occurring at the home in those younger ($\leq$20) than any other age range, suggesting that children are being injured while using golf carts for means other than its primary intended use on a golf course. This may increase their exposure to motor vehicles and other hazards not experienced on a golf course, thereby increasing their risk of a collision or a subsequent injury. Although we do not know whether those



	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Males	5.74	7.78	5.57	4.53	2.79	3.49	5.36	8.87	10.76
Females	4.78	5.01	2.32	1.90	1.37	2.66	2.89	2.56	3.25

Age Category (Years)

Fig. 1. *Golf cart injury rate among males and females by age category, NEISS, 2002–2005.*



	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Home	49.6	31.1	11.3	9.4	15.6	15.4	9.5	23.8	15.0
Other Public Property	9.9	7.8	12.3	8.3	6.2	9.2	6.3	12.0	10.0
Sports Field	38.8	59.9	76.4	81.2	78.1	75.4	84.1	63.5	75.0

Age Category (Years)

Fig. 2. *Geographic setting of golf cart injuries by age category, NEISS, 2002–2005.*

injured were operators or passengers, it is likely that some younger individuals were indeed operating the golf cart at the time of injury. The lack of driving experience among younger individuals may also therefore contribute to their increased rate.

With respect to the elevated injury rate among older adults, as with motor vehicle collisions, the elevated rate of golf cart-related injury among older adults may be the result declines in health and cognitive function.[12] This could manifest as a slowing in reaction time or a loss in physical strength that impairs the ability to safely operate a golf cart. Moreover, the increase in golf cart-related injury rates among older individuals may not solely be a result of an increased risk of golf cart incidents, but rather an increase in their susceptibility to injury as observed for motor vehicle collisions.[13]

Other groups with a high rate of golf cart-related injury are men and whites. This is most likely a function of an increase in both the amount of golf played and risk of golf cart-related injury. Previous studies have shown that males[14,15] and whites[15] are at an increased risk of sport-related injury. In addition, there have been studies suggesting that whites and men are the most common demographic playing golf. A study

Table 2 Characterization of Golf-Cart Related Injuries, 2002–2005

	Estimate[1]	%
Overall	48,225	
Setting		
Home	7,742	16.0
School	166	0.3
Sports field	21,689	45.0
Other public property	3,035	6.3
Missing	15,593	32.3
Body location and diagnosis		
Head and neck	12,348	25.6
Intracranial injury[2]	4,617	37.4
Contusion/abrasion	2,437	19.7
Laceration	3,244	26.3
Hip and lower extremity	15,485	32.1
Contusion/abrasion	5,700	36.8
Fracture	3,191	20.6
Strain/sprain	3,560	23.0
Shoulder and upper extremity	13,949	28.9
Contusion/abrasion	3,288	23.6
Fracture	5,693	40.8
Strain/sprain	1,682	12.1
Trunk	5,626	11.7
Contusion/abrasion	2,126	37.8
Fracture	1,119	19.9
Strain/sprain	1,573	28.0

[1] Weighted data.
[2] Includes concussion, subdural hematoma, and intercranial hemmorhage.

of minority golf participation[16] estimated that 14.9% of the U.S. white population age 18 or older plays golf, a threefold increase over the proportion of the U.S. black population age 18 or older who play golf (5.1%) and a 71% increase of the proportion of the U.S. Asian and Hispanic population age 18 and older who play golf (8.7%). A household survey[17] conducted in 2001 by the Professional Golf Association's Consumer Marketing department approximated that twice as many men than women considered themselves to be "Core Golfers" (8–24 rounds of golf in the past year) or "Avid Golfers" (25 or more rounds of golf in the past year).

Narratives that accompany each NEISS entry have shown that a significant number of golf cart-related injuries occurred as a result of an individual losing control of a cart and then having the cart strike another object or overturn. It has been shown that a golf cart traveling downhill at speeds greater than 15 mph can easily become yaw-directionally instable and can easily enter a skid and overturn with improper braking.[18] It is also relatively easy for the consumer to modify their golf cart to have a maximum speed that is in the 20 mph to 25 mph range. When a golf cart has this higher maximum speed it is considered to be a low-speed vehicle (LSV) by the National Highway Traffic Safety Administration and is subject to some minor safety regulations from which regular golf carts are exempt. Because golf carts qualify as either LSVs or traditional golf carts (as defined by the National Highway Traffic Safety Administration) and are designated primarily as off-road vehicles, they do not have to conform to the same stringent federal motor vehicle safety standards that apply to motorcycles and automobiles. As a result, golf cart usage is largely controlled on the state level, and this has led to many different regulations that vary depending on each state's individual laws. For example, in the state of Alabama, it is illegal for any "nontaggable vehicle" such as a golf cart to be operated on any public thoroughfare; however, the Florida Department of Highway Safety has a statute that allows the use of a modified golf cart (LSV) that has a top speed of 20 to 25 mph on public roads with a speed limit of 35 mph or less.[18] The statute, however, also allows for any municipality or county to disallow this privilege if the governing body of the county or municipality determines that such prohibition is necessary in the interest of safety.[19] Currently, 17 states (Arizona, California, Colorado, Florida, Georgia, Hawaii, Iowa, Michigan, Nevada, New York, North Carolina, North Dakota, Oklahoma, Oregon, Tennessee, Utah, and Virginia) allow LSVs to be operated on public thoroughfares with a speed limit of 35 mph or less, whereas one state (Kansas) allows LSVs to be used on roads with a speed limit of up to 40 mph.[19] There are only six states (Connecticut, Idaho, Maine, Minnesota, Washington, and Wisconsin) that prohibit the operation of LSVs on any public road, whereas 27 other states do not have any laws that specifically address LSV use on public roads; however, their current laws allow LSV use on the roads.[19] The major problem with LSV operation on public roads is the fact that they are only required to have a minimum number of safety features including a windshield, headlights, signal lights, mirrors, tail and brake lights, reflectors, safety belts, and a parking brake.[20] More importantly, they are not required to have bumpers or doors, the lack of which poses a significant safety hazard, especially if a LSV were to be involved in a collision with a much heavier automobile.[21]

The results of this study should be interpreted in light of several potential limitations. Rates of golf cart-related injury were calculated using the U.S. population as the denominator. Not only did this result in an underestimate of the overall rate, but age, gender, and race specific rates will be underestimates and differentially so. This is attributable to the fact the golf cart usage varies according to these characteristics. Additionally, although we were able to characterize injuries with respect to location and type, information on injury severity was not available thereby preventing us from fully characterizing the true impact of these injuries. Finally, no information was available regarding the circumstances surrounding the injury event, e.g., type of golf cart, number of people involved and their seating position, or age of operator. Such information would be valuable in terms of identifying high-risk activities and settings and could be used to inform educational initiatives regarding golf cart safety.

The results of this study suggest several potential recommendations that may reduce the incidence of golf cart-

related injury. First, golf cart manufactures and resellers should be required to provide and explain safety education materials to all individuals purchasing a golf cart. This is perhaps most important for families, especially those with children, who will be purchasing a golf cart for use other than on a golf course. It is unknown whether the elevated injury rate among children, particularly boys, is attributed to their role as operator or passenger. In the case of the former, parents should ensure that children operating golf carts possess the appropriate skills to safely do so. With respect to the latter, as with automobiles, passengers in golf carts should remain properly seated when underway and seat belts, if available, should be worn. Second, because of the high rate of rollover injuries noted in the NEISS patient narratives, the design of golf cart paths should be evaluated and, where relevant, changes made that will improve safety. Third, given that injuries to the head are common, it is reasonable to recommend that operators and passengers wear helmets, particularly when operating golf carts on public roads wherein automobiles are also present. Finally, seat belts should be mandatory safety equipment on all golf carts, regardless of the vehicle's top speed. Seat belts are effective in reducing occupant ejection in a collision. However, they may also be useful in golf carts by preventing occupants from falling out of the vehicle during unanticipated maneuvers (e.g., hard cornering). In fact, certain municipalities that allow the use of golf carts on public roads also require that seat belts are installed and used.

Golf carts are an attractive transportation solution because of their low emissions and cost effectiveness when compared with a traditional motor vehicle. However, the rising interest in the use of golf carts and LSVs as a primary means of transportation calls for more stringent safety standards be applied to the design and use of golf carts, particularly those operated on public roads.

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