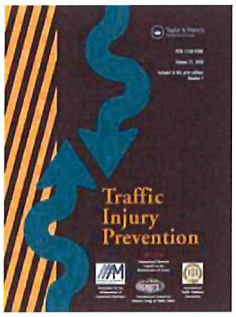

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Analysis of death and disability due to golf cart crashes in The Villages, Florida: 2011-2019

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ABSTRACT

Objective: More than 18 000 Golf Cart (GC)-related injuries occur in the United States (US) annually. However, very few studies have analyzed the causes of such crashes. This study represents the largest single-center analysis of GC crashes performed within the largest GC community in the US, a community in which they are used extensively for local transportation. We examine the nature of these crashes and present potential preventative measures.

Methods: All GC crashes reported in The Villages, Florida, from July 1, 2011 to July 1, 2019 were analyzed in this study. Data were obtained from multiple sources to create a comprehensive collection of all recorded GC crashes in the area of study. Sources included The Villages Property Owners' Association (POA), The Villages Sun Daily Newspaper, The Villages Public Safety Department (VPSD), Police Dispatch records, and the Sumter County Police data base.

Results and conclusions: During the observation period, a total of 875 GC-related crashes occurred, representing an average of 136 crashes, 65 hospitalizations, and 9 dead or disabled annually. Of all crashes, 48% resulted in hospitalization, severe trauma, or death. Of these, ejection occurred in 27%, hospitalization in 55%, and death or disability in 15% of crashes. Virtually all death and disability occurred within the setting of GC used on streets or road pathways. Death and disability, particularly due to ejection during GC crashes, occur at an alarming rate when GCs are used for local transportation. We believe public awareness and the use of 3-point seatbelts in these vehicles would significantly reduce death and disability caused by these crashes.

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Golf cart; 3-point occupant restraint; countermeasure; golf cart crash; injury prevention

Introduction

Golf carts (GCs) are engineered to be used primarily on golf courses but are increasingly being used for transportation on roadways within the US communities (Passaro et al. 1996). With speeds limited to 20 mph, they are commonly considered safe and economical, and an environmentally friendly means of transportation, and are thus not subject to the state and federal safety regulations that apply to motor vehicles.

Unfortunately, this departure from their original purpose as a means of golf course transportation has caused a surge in GC-related injuries. The Consumer Product Safety Commission (CPSC) estimated that, nearly 18 000 GC-related injuries reported nationwide in 2015 required emergency treatment (McGwin et al. 2008). Watson et al., using the National Electronic Injury Surveillance System (NEISS), reported a 132% increase in GC injuries during 1990–2006. According to Watson's report, 15% of crashes occurred on streets and only 7.8% required hospitalization, reflecting the fact that their database was heavily weighted toward GCs used for recreational purposes (Watson et al. 2008).

Similarly, Sciaretta et al. (2016) reported the data on a single institution in Myrtle Beach, South Carolina over a 32-month period. Their report detailed 75 GC crashes that required admission to a level 2 trauma center, 76% of which occurred on public streets. The absence of safety features, such as 3-point seat belts and front-wheel brakes, has been suggested as a critical factor causing majority of the reported injuries (Kelly 1996; Watson et al. 2008; Sciaretta et al. 2016).

The Villages, located in central Florida, at 60 miles west of Orlando, is the largest GC community in the world and provides an excellent test ground to assess the safety of GCs used for transportation in a 55-year-old and older retirement community. The community has approximately 140 000 residents and more than 50 000 GCs as of 2018. The entire community was designed to be GC-accessible, either via GC lanes on streets or designated GC paths that run parallel to streets. Presently, there are approximately 70 smaller GC communities like The Villages in the US that are also designed to be GC-accessible. Other cities that allow street-legal GCs to be driven are distinct from these GC

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Table 1. GC crash severity score in the scale of 0-5 defined by type of injury.

Level of injury	Definition	Severity
0	No injury	None
I	Soft tissue damage not limiting activities of daily living	Minor
2	Emergency department visit, hospitalization for less than 3 days, or bone fractures with recovery	Moderate
3	Loss of consciousness (LOC) for < 30 min, multiple bone fractures, or organ injury that requires one of the following: Surgery, hospitalization for > 3 days or, short term disability / inpatient rehab.	Severe
4	Neurological injury with brain or spinal cord injury, or sufficiently severe to require transfer to a Level 1 trauma center.	Critically severe with survival
5	Death within 60 days of crash	Critically severe resulting in death

communities as they are not designed around the use of GCs as a primary means of transportation. Florida state law permits road-use of GCs, provided the drivers are 14 years of age or older and the GCs are driven in designated lanes or GC lanes where available. There are no safety requirements for these vehicles and a valid motor vehicle (MV) driver's license is not required to drive them on public roads. While most GCs in The Villages are fitted with adjustable lap belts, they are seldom used and virtually none are equipped with 3-point restraints.

This study analyzes the crash data of the GCs in The Villages obtained over eight consecutive years (2011-2019). To our knowledge, this is the first study that comprehensively examines all GC crashes, with or without injury, which occurred within the largest GC community in the US. The objective of this study is to examine the nature, rate, and injury-related outcomes of GC crashes within this community between June 1, 2011 and July 1, 2019, to better understand the means through which GC crashes can be prevented.

Methods

Additional references can be found in the bibliography in the Appendix.

To ensure that robust and accurate GC crash data were collected in the region and reduce the probability that any events were missed, the data for the current project were obtained and abstracted from multiple sources. All reviewed data were public and de-identified and were therefore exempt from the need for institutional review board (IRB) approval. Data sources included crash reports from The Villages Property Owners' Association (POA), The Villages Public Safety Department (VPSD), the Sumter County Police Records, and those that were reported in The Villages Daily Sun newspaper.

Once a crash was identified, the data that were recorded included the date of the crash, age of the driver, gender of the driver and the passengers, crash type, ejection status (ejection occurred: yes/no), location of the crash, GC occupant injury/severity (assessed on a scale of 0–5, see Table 1), and drug/alcohol status when noted (drugs/alcohol involved: yes/no).

The GC crashes were categorized as follows:

1. GC collisions with stationary objects
2. GC collisions with GCs (both in motion)
3. GC collisions with pedestrians
4. GC collisions with bicycles
5. GC collisions with motor vehicles
6. Rollover, not because of the crash
7. Ejection without collision or rollover

GC occupant injury was categorized into three groups:
None or Minor Injury (0 or 1),
Moderate Injury Requiring Hospitalization (2 or 3),
Severe Injury Causing Long–Term Disability or Death (4 and 5).

The data on front, side, or rear impacts in cases involving collisions between GCs and GCs, and between GCs and MVs, were also noted from the perspective of the driver involved in the crash, if the report commented on this particular information. Stationary objects included curbs, tunnel walls, buildings, parked cars, parked GCs, light poles, and trees. Once all incidents were abstracted, the data were verified for duplication to ensure that each crash was abstracted only once in the final record. Verification was performed by collating multiple sources detailing the crash report.

The collected data were entered in a Microsoft Excel (Version 16.3) spreadsheet. Descriptive statistics were examined to identify the incidence of GC crashes, along with outcomes such as injuries and associated factors (e.g., age, location, and crash type), as applicable across the period of interest.

Results

Crash totals

Over the 8-year observation period, 1084 GC occupants were involved in 875 GC-related crashes. Annually, 136 GC crashes occurred on average, resulting in 65 hospitalizations and death or disability of 9 persons. Of these crashes, 48% resulted in hospitalization, disability, or death per year (Table 2).

Crashes by age, gender and alcohol

Of the 875 crash injury cases, 2.9% were cited as alcohol-related (Table A in the Appendix). The GC driver age was established in 391 cases and ranged from 12–94, with a mean age of 68 (median age of 71). Of the 542 cases where the gender of the driver was identified, 63% were male and 37% were female.

Table 2. GC injuries by severity from July 1, 2011 to July 1, 2019.

Year	None/Minor (0–1) (%)	Hospitalized (2–3) (%)	Disabled/Dead (4–5) (%)	Total People Involved	Total injured	Total Number of GC Crashes
2011	18 (39%)	26 (57%)	2 (4%)	46	28	40
2012	48 (39%)	64 (52%)	10 (8%)	122	74	108
2013	43 (38%)	56 (50%)	14 (12%)	113	70	95
2014	51 (43%)	60 (50%)	9 (8%)	120	69	107
2015	43 (42%)	52 (50%)	8 (8%)	103	60	80
2016	61 (46%)	61 (46%)	12 (9%)	134	73	115
2017	140 (63%)	74 (33%)	7 (3%)	221	81	156
2018	115 (73%)	39 (25%)	3 (2%)	157	42	117
2019	44 (65%)	20 (29%)	4 (2%)	68	24	57
Overall	563 (52%)	452 (42%)	69 (6%)	1084	493	875

Number of GC crashes and severity of injuries suffered by GC occupants involved in crashes from July 1, 2011 to July 1, 2019.

Table 3. Injury severity with respect to GC crash location.

Location	None/Minor (0-1)	Hospitalization (2-3)	Disability/Death (4-5)	Total
Golf course	5	3	0	8
GC Path or Lane	155	140	19	314
Public Street	341	287	46	674
Parking Lot/ Home	58	21	2	81
Total	559	451	67	1077

Injury severity with respect to GC crash location involving a total of 1077 occupants (7 unaccounted because location was unknown).

Crash location, severity, and type

Out of the 870 cases involving injury, in which the location of the GC crash was described, 63% of the crashes occurred on public streets and intersections and 28% occurred on designated GC paths and lanes along streets. Less than 1% of crashes occurred on golf courses (Table A in the Appendix). The type of collision was identified in all 875 crashes. Collisions with MVs occurred in 28% of the cases (n = 248), collisions with stationary objects occurred in 19% of cases (n = 169), and collisions with other GCs occurred in 9% of cases (n = 83). Collisions with pedestrians and bicycles occurred in 1% (n = 9) and 2% (n = 17) of cases, respectively (Table A in the Appendix). The injury severity data with respect to the GC crash location are summarized in Table 3.

Rollover and ejection

At least 27% of all GC crashes involved the ejection of at least one occupant (Table 4 and Table B in the Appendix). Of this, 15% resulted in disability or death and another 55% in hospitalization. On comparison, in cases where ejection did not occur, only 3% of crashes resulted in death or disability and 37% required hospitalization.

When GCs collided with stationary objects and at least one occupant was ejected, 23% of incidents resulted in disability or death, with an additional 47% requiring hospitalization for serious injuries. When GCs were involved in crashes with MVs resulting in at least one GC occupant being ejected, 16% of incidents resulted in disability or death. Overall, among the ejection cases involving MVs, 82% of GC occupants suffered at least moderate injuries (Table B in the Appendix).

Rollover, not as a result of a crash, was cited as the chief cause of crashes in 10% of cases (Table A). These crashes typically occurred when drivers performing an evasive maneuver turned the GCs at speeds that were too fast for them to remain in control of the vehicle. Of the 107 rollover crashes that were reported, 55 resulted in hospitalization, one in death, and one in disability. Rollover injury as a function of ejection from the GC is shown in Table 4.

Discussion

The purpose of this study was to examine GC crashes in The Villages to better understand the frequency of serious injury and, where possible, to identify factors that were associated with these injuries. While not identifying the root cause of these crashes, this study illuminated many potentially modifiable risk factors for GC injuries that can raise community awareness and promote better safety, especially within environments that promote the use of GCs for local transportation needs.

Overall, we recognize a number of limitations to this study. Because this is a retrospective study of crashes performed by examining public reports, our study likely underestimates the total number of crashes involving GCs in The Villages. For example, minor incidents that did not require police or ambulance involvement would go undetected by the source records. As a result, our estimates likely suffer from under-reporting (Simpson et al. 2019). In addition, The Villages underwent an explosion in population growth in 2017, which likely affected the database and contributed to an increase in the number of crashes in 2017.

Death, disability, and serious injury occur in a high percentage of GC crashes that occur on roadways. On average, there were 9 disabled or dead and 65 hospitalized annually as a result of GC crashes. Of these crashes, 48% resulted in moderate to critically severe injury, hospitalization, disability, or death (Tables 2 and A in the Appendix). In 2019, Simpson et al. reported similar severity results in a study of 23 GC occupants who presented with a traumatic brain injury or other cranial trauma over a 5-year period.

Ejection from GC is a serious concern and often results in severe injury or death for those involved (McGwin et al. 2008). Ejection from a GC, without collision, occurred in 27% of crashes and resulted in 55% of occupants hospitalized with 15% left dead or disabled. While potentially the deadliest outcome, ejection from a GC is perhaps also the most preventable cause of GC injures. Installation and use

Table 4. Injury Severity of GC Crashes with respect to Ejection with and without Rollover Injury Severity.

Ejection total[a]	Minor (0-1)	Hospitalization (2-3)	Disabled/Dead (4-5)	Total
Yes	90 (31%)	161 (55%)	43 (15%)	294 (27%)
No	474 (60%)	290 (37%)	26 (3%)	790 (73%)
Total	564 (52%	451 (42%)	69 (6%)	1084
Ejection-rollover[b]				
Yes	14 (44%)	17 (53%)	1 (3%)	32 (30%)
No	36 (48%)	38 (51%)	1 (1%)	75 (70%)

[a]GC crashes showing numbers of people injured by ejection from the vehicle during the observation period of July 1, 2011 to July 1, 2019.
[b]GC crashes as a result of rollover showing severity of injury and ejection from the vehicle.
Injury severity depicted as a function of crash ejection and rollover from July 1, 2011 to July 1, 2019.

of 3-point seatbelts would keep riders in their carts during a collision or rollover and could greatly reduce ejection-related injury and death.

Virtually all crashes resulting in death or disability occurred within the setting of a street or paths along a street. We found that 28% of crashes occurred in GC paths and 63% on street roadways/intersections. Less than 1% of crashes occurred on golf courses (Table A). Our study finding that GC-related injuries occurred to a greater degree outside of the golf course setting is unique to our community, where GCs are used extensively for transportation. In nationwide studies, most crashes involving GCs are reported on golf courses and result only in minor, personal injuries (McGwin et al. 2008; Miller et al. 2016).

While lap belts are often sold along with GCs in The Villages, they are only used 15% of the time. The American National Standards Institute–National Golf Car Manufacturers Association (NGCMA) has stated that "seat belts are more of a safety detriment to the occupant than beneficial." It was the position of the NGCMA that a vehicle without a rollover protection system required that the occupants be afforded the ability to "jump from a moving cart during a rollover event." This statement has led to a culture of GC drivers who feel that seat belts are cumbersome and unnecessary. Our data would suggest this is specious reasoning when applied to GCs used as a mode of transportation on public roads. Whereas ejection accounted for the greatest number of dead and disabled occupants, rollover crashes, despite representing 15% of all crashes, resulted in only 2 dead or disabled within the 8-year period. Miller support our findings in their research, which showed that, in relation to rollovers and stationary object collisions, ejections resulted in more severe injuries to the head and neck region of GC occupants (Miller et al. 2011; 2016).

In 1997, The National Highway Traffic Safety Administration (NHTSA) indicated that it did not intend to regulate GCs primarily because they were low–speed vehicles and were thought to be used primarily on golf courses where they were believed to be safe for use. The administration concluded that a "GC with a maximum speed that does not exceed 15 mph is a vehicle that is not primarily manufactured for use on public roads and is therefore is not a motor vehicle." For this reason, GCs (many of which now have a maximum speed of 20 mph), are not required to be fitted with the safety systems that have been commonly used in all motor vehicles since 1968. As a result, safety features such as front brakes, windshield wipers, rearview mirrors, head restraints, crash resistant bumpers, and 3-point occupant restraints are not standard issue in most GCs despite their use on public roads in many communities across the US. Moreover, the use of GCs on public roads does not require a valid MV driver's license in many states. The NHTSA has, however, designated that low-speed vehicles capable of speeds greater than 20 mph, but less than 35 mph, need to be equipped with standard MV safety systems (Seluga et al. 2005). Given this recommendation and the high rate of injury, disability, and death that results annually from GCs being used as secondary (and in some cases primary) means of transportation on public roads in retirement communities and neighborhoods like The Villages, we believe a change in policy is warranted.

In 2005, Long et al. (2005) studied the stability characteristics of GCs using the Alderson 50th percentile anthropometric "crash" dummy in a variety of real-life maneuvers on roadways. The authors concluded that the potential for ejection was significantly higher in unbelted occupants during cornering maneuvers as opposed to rollover events, even at speeds of only 11 mph. Observations made by testing the vehicles as they made a rapid turn, similar to what would occur in avoidance maneuvers, demonstrated that even hip restraint belts were ineffective at protecting the occupants. The results of these tests showed that forward and lateral accelerations during these maneuvers pulled the occupant up and over the hip restraint lap belts, ejecting the occupant into a head first dive toward the ground, even without loss of control of the vehicle. Further, they found that the speed of these ejection events was so high as to make the possibility of jumping from the vehicle virtually untenable. Our real-life data for crashes occurring in The Villages, as well as the field data of others, support these research conclusions and provide a strong argument for the use of 3-point restraints in GCs used on public roads (Passaro et al. 1996; McGwin et al. 2008; Miller et al. 2011; Sciaretta et al. 2016; Miller et al. 2016).

According to the NHTSA and the Center for Disease Control and Prevention (CDC), seat belts have saved nearly 300 000 lives in the US since 1975. Even with the availability of 3-point restraints, seat belt laws and stricter enforcement are required to effectively ensure their use and decrease GC-related fatalities (Dinh-Zarr et al. 2001; Seluga et al. 2005; Beck and West 2011). Despite state seat-belt laws, of all passenger vehicle occupants killed in 2017, 47% were not wearing seat belts. Amongst GC drivers, where there is even more of a pervasive culture of eschewing even the use of lap

belts, enforcement of installation and the use of 3-point restraints in GCs is likely to be particularly difficult. In the US, an increasing number of retirement communities are being built with GC use in mind; access to this form of transportation offers senior people a low-cost and convenient transportation to local shops, restaurants, and other activities/engagements—all of which have the potential to be beneficial to health in later life (Lane 2015). According to the International Light Transportation Vehicle Association, a trade group representing GC manufacturers, there are more than 350 cities and counties in the US where GCs are used on roads for transportation (American National Standards Institute (ANSI) 2020). Annually, Americans drive more than 65 million miles on roadways by GCs, with 45% of drivers being 65 years of age and older (Poncy et al. 2011). As such, it is important that policies be instituted to minimize risk and facilitate safe use. Given that the average price of aftermarket seatbelt installation in a GC is $90–$160, the use of a 3-point restraint is not cost-prohibitive, especially when factored against the typical cost of a new GC ($6,000 to $10,000). Considering the potential for reduction in injury, disability, and death if a 3-point restraint is installed as part of the required safety features in an original GC build, this cost is likely to be even less, further strengthening the cost/benefit argument.

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