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On-Road All-Terrain Vehicle (ATV) Fatalities in the United States

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Abstract

Background: The study was designed to describe the characteristics of all-terrain vehicle (ATV) rider fatalities and fatal crashes involving ATVs that occur on public roads.

Methods: Information on fatal crashes occurring on public roads during the years 2007-2011 was obtained from the Fatality Analysis Reporting System (FARS).

Results: There were 1,701 ATV rider deaths during the 5-year study period, including 1,482 drivers, 210 passengers, and 9 with unknown rider status. An additional 19 non-ATV occupants, primarily motorcyclists, died in crashes with ATVs. About half of the ATV passenger deaths were teenagers or younger, and the majority of passenger deaths were female. Ninety percent of the fatally injured drivers were 16 or older, and 90 percent were male. The crashes were most likely to occur in relatively rural states, and in rural areas within states. Only 13 percent of drivers and 6 percent of passengers killed wore helmets. Forty-three percent of the fatally injured drivers had blood alcohol concentrations (BACs) of 0.08 percent or greater. Seventy-five percent of the fatal crashes involved single ATVs; 5 percent involved multiple ATVs but no non-ATV vehicles, and 20 percent involved ATVs and non-ATVs, usually passenger vehicles. Speeding was reported by police as a contributing factor in the crash for 42 percent of ATV drivers in single-vehicle crashes and 19 percent of ATV drivers in multiple-vehicle crashes.

Practical applications: Although ATVs are designed exclusively for off-road use, many ATV occupant deaths occur on roads, despite most states having laws prohibiting many types of on-road use. Attention needs to be given to ways to reduce these deaths.

1. Introduction

All-terrain vehicles (ATVs) are gasoline or diesel-powered motorized vehicles, with oversize, low-pressure tires. Some ATVs have a straddle seat for the operator, and handlebars for steering control. Others, often called a side-by-side ATV, a recreational off-highway vehicle, or Utility Terrain Vehicle (UTV) have a bench seat or bucket seats for the driver and passengers and a car-like wheel for steering. ATVs are designed for travel off road on unpaved surfaces, and are primarily used for recreation. They also are used for some work-related purposes, for example, farming, and policing and patrolling public lands, where various terrains have to be navigated. In some rural and remote areas they serve general transportation purposes (U.S. Government Accountability Office, 2010). UTVs are a growing segment of the ATV market, but little data are available on the number of fatalities in those vehicles. ATVs were introduced in the United States at the beginning of the 1970s. Their popularity has increased markedly since that time, accompanied by concerns about the crashes and injuries that resulted, especially in regard to those younger than 16 (American Academy of Pediatrics, 2000; U.S. Government Accountability Office, 2010). The Consumer Product Safety Commission (CPSC), the federal agency responsible for regulating the safety of ATVs, conducts a yearly census of ATV rider deaths that occur on public roads, private roads, and off road. Counts are based on death certificates and a variety of other sources (CPSC, 2013). CPSC reports that it only includes straddle-type ATVs in its database and excludes UTVs. The CPSC dataset, obtained by the authors, indicates that between 1986 and 1998, ATV rider deaths averaged 227 per year but increased rapidly thereafter to more than 800 in 2007, the last year for which CPSC data are complete. Only limited exposure data are available, but CPSC estimates that there were 10.6 million ATVs in use in the United States in 2010, compared with 5.6 million in 2001 (CPSC, 2013).

ATVs are not intended for on-road use and have design features that can increase risk when operated on paved surfaces (Specialty Vehicle Institute of America, 2013; U.S. General Accountability Office, 2010). However, the majority of ATV rider deaths now occur on roads. State studies report that 57 percent of ATV rider fatalities in Iowa during 1982-2009 took place on public or private roads, and nearly two-thirds of the ATV rider fatalities in West Virginia during 2005-2007 occurred on public roads (Denning et al., 2013b; Helmkamp et al., 2008). Analysis of the CPSC data indicates that in 2007, for the

93 percent of ATV rider deaths for which location was identified, 492 (65 percent) of the 758 deaths occurred on public and private roads. Moreover, there has been a greater increase in on-road than in off-road deaths in recent years. Between 1998 and 2007, on-road deaths increased from 128 to 492 (284 percent); off-road deaths increased from 110 to 266 (155 percent).

There also has been an age shift in ATV rider deaths, with decreasing proportions of those younger than 16 involved. CPSC data indicate that the percentage of ATV rider deaths younger than 16 ranged between 23 and 28 percent during 1999-2004 but between 14 and 17 percent during 2006-2011 (2008-2011 data are preliminary) (CPSC, 2013). This trend appears related to the increasing proportions of ATV rider deaths that take place on roads. In a study based on CPSC data, there was a smaller proportion of ATV rider deaths younger than 16 in on-road compared with off-road crashes (Denning et al., 2013a).

Studies of ATV operators killed in crashes have found evidence of low helmet use and significant alcohol involvement (Denning et al., 2013a; Denning et al. 2013b; Hall et al., 2009; Lord, Tator & Wells, 2010;). In the Denning et al. (2013a) study based on CPSC data, lower helmet use and higher alcohol use were found more often in on-road than in off-road fatalities. However, alcohol information was available only for a subset of the drivers, a limitation of other studies as well (U.S. Government Accountability Office, 2010).

Regulations and laws and their enforcement are important ways of attempting to reduce ATV crashes, especially those occurring on public roads. CPSC regulations have included a ban on the sale of three-wheeled ATVs and the requirement that manufacturers must put labels on ATVs, warning that they should not be used on paved roads, that DOT-compliant motorcycle helmets should be worn, and that ATV operators should not carry passengers (which adds to vehicle instability).

States have the authority to adopt laws governing ATV use. Based on a search of state laws, using the Lexis Research System, Appendix A provides information about when ATVs can be used on the road, who must wear helmets, and when passengers are permitted.

Most states prohibit the use of ATVs on public roads, except for specific uses. Some of the most common permitted on-road uses of ATVs are: they can cross a road to move from one trail or field to

another; can be used in work-related operations, such as utility maintenance, law enforcement, emergency services, or land surveying; and can be used when allowed by local ordinances.

Eight states require all ATV operators on public roads to wear helmets; 4 states require all ATV operators on public lands to wear helmets; 8 states have age-related helmets laws, which usually apply to riders younger than 18; and two states require some riders on public roads to wear helmets but make exceptions for riders engaged in farming. Most of these laws also pertain to passengers. Thirteen states have laws prohibiting passengers, but allow them for UTVs.

The objective of the present study was to extend findings from the limited number of prior studies that have addressed on-road ATV rider deaths. The study is based on information in the Fatality Analysis Reporting System (FARS), a census of fatal motor vehicle crashes on public roads, which has not been used in prior ATV studies. The CPSC data are limited in information about the crash events and driver actions, whereas FARS has extensive information on these factors, based on on-scene and follow-up investigations by police officers and other information. FARS, unlike CPSC, also provides information on blood alcohol concentrations (BACs) for all ATV drivers. The analyses of FARS data may suggest opportunities for intervention.

A historical look at ATV rider fatalities in FARS indicates there were 35 driver or passenger on-road fatalities in 1982, the first year they were explicitly identified. ATV rider deaths increased to more than 300 yearly beginning in 2003 and reflect the shift to older ages of fatally injured ATV riders. In 1982, 54 percent of the 35 ATV riders killed were younger than 20, compared with 19 percent of the 305 riders killed in 2011 (Insurance Institute for Highway Safety, 2013a).

The present analyses were based on fatal crashes during the years 2007-2011, the most recent year for which FARS data are currently available. The results presented in this paper are based primarily on data for straddle-type ATVs, although in some cases UTVs may have been coded as straddle-type ATVs. This provides a contemporary portrayal of ATV rider crash deaths on public roads in the United States.

2. Methods

Information on ATV rider deaths and their crashes on public roads was extracted from FARS for the 5-year 2007-2011 period. FARS is intended to identify both straddle-type ATVs and UTVs as ATVs.

It is possible that UTVs may have been coded inconsistently by state data analysts. Because many of the vehicle identification numbers (VIN) in FARS for these vehicles could not be decoded to determine make, model, and model year, it was not possible to disaggregate the different ATV types. FARS includes data on all motor vehicle crashes that occur on public traffic ways and in which a death occurred within 30 days of the crash. Information on the crash and the people involved are based on police crash reports, death certificates, coroner/medical examiner reports, and other state data sources.

All states and the District of Columbia have laws making it illegal to drive a motor vehicle on a public road with a BAC of 0.08 percent (0.08 g alcohol per 100 ml blood) or higher. Since 1982, FARS has included information on the BACs of all drivers. BACs are based on blood alcohol chemical tests or, if test results are missing, an imputed BAC value, based on crash characteristics known to be related to alcohol use (Subramanian & Utter, 2003).

For most variables, the data are presented for fatally injured drivers and passengers (state, ages, helmet use, sex, time of day, day of week, month, urban/rural, and road type). BACs are presented for fatally injured ATV drivers only. The number of fatal crashes involving ATVs are displayed for the following: the number and type of vehicles involved (e.g., one ATV, two ATVs, one ATV and one non-ATV); the first harmful event (e.g., striking a tree); crash configuration (e.g., ATV rear ended by passenger vehicle); speed limit; and the specific location of the crash (e.g., on road, on shoulder). FARS also provides driver contributing factors (e.g., speeding, not keeping in proper lane), based on police judgments, for each driver and a vehicle maneuver (e.g., turning left) for each vehicle. FARS also has a "roadway surface type" variable, which indicates if the road is paved or unpaved.

3. Results

3.1. Driver and passenger deaths and their characteristics

There were 1,701 ATV rider deaths reported in FARS during 2007-2011: 368 in 2007, 377 in 2008, 335 in 2009, 316 in 2010, and 305 in 2011. The 1,701 deaths included 1,482 drivers (87 percent), 210 passengers (12 percent), and 9 people (1 percent) for whom rider type was not known. In crashes in which rider type was known, 1,450 (87 percent) involved driver deaths only, 177 (11 percent) involved passenger deaths only, and in 32 crashes (2 percent) both drivers and passengers were killed (32 drivers, 33 passengers).

ATV rider fatalities occurred in every state during 2007-2011 except the District of Columbia and New Hampshire. The most deaths occurred in Kentucky (122), Pennsylvania (97), West Virginia (96), and Texas (95). Table 1 shows the numbers of ATV rider deaths and death rates per population for all the states and the District of Columbia. ATV rider death rates were generally higher in states that were rural and less populous. The top ten states based on death rates were West Virginia (104.9 per 10 million), Wyoming (69.6), Kentucky (56.7), Montana (47.1), Idaho (36.3), Vermont (35.3), Arkansas (34.6), Mississippi (31.9), North Dakota (30.4), and Alaska (28.6). Seven of these states were among the 10 states with the highest percentages of the population living in rural areas in 2010 (U.S. Bureau of the Census, 2010).

Age distributions of fatally injured ATV riders are presented in Table 2. Ninety percent of the drivers were 16 or older. Almost half of the passengers were either teenagers (19 percent) or younger (28 percent).

Overall, 84 percent of fatally injured ATV riders were male. However, the majority of passenger deaths (55 percent) were female, whereas 90 percent of the driver deaths were male. Males 16 and older constituted 82 percent of all drivers killed.

ATV rider deaths were most likely to occur in June, July, and August. Almost half of the deaths occurred on Saturdays (28 percent) and Sundays (22 percent), and about half (49 percent) took place between 3 p.m. and 9 p.m. Twenty-eight percent occurred during the nighttime hours 9 p.m. to 6 a.m.

Table 3 provides information on the road type and land use (rural or urban) for ATV rider fatalities. Eighty-six percent occurred on rural roads, and 76 percent occurred on minor roads. Sixty-five percent took place on minor roads in rural areas.

Information on helmet use was missing for 3 percent of the fatally injured drivers and 3 percent of the fatally injured passengers. For fatally injured riders with known helmet information, few were reported to have used them. The rate of helmet use was 12 percent overall, 13 percent for drivers, and 6 percent for passengers.

Table 4 presents BAC distributions for fatally injured drivers by age group. Overall 43 percent of fatally injured drivers had BACs at or above 0.08 percent. BACs of 0.08 percent or higher were most

prominent at ages 30-39 (62 percent) and 40-49 (67 percent). Thirty percent of all fatally injured drivers had very high BACs of 0.15 percent or more.

3.2. Characteristics of the crashes

Table 5 provides the distribution of fatal ATV crashes by the number of ATVs and non-ATV vehicles involved. In all, there were 1,675 fatal crashes involving ATVs during 2007-2011. Three-quarters of the crashes involved one ATV only. One in five involved collisions between ATVs and non-ATVs, generally cars, SUVs, or pickups. In most instances, these crashes involved a single ATV and a single non-ATV vehicle. Although these crashes usually involved the death of an ATV rider, 19 of these deaths were not ATV riders, including 15 motorcyclists, 3 car occupants, and 1 "other." Five percent of the crashes involved ATVs colliding with each other and no other vehicles.

In 47 percent of the 1,260 crashes involving a single ATV and no other vehicles, the first harmful event was the ATV striking something, most often trees (20 percent) but also ditches, embankments, utility poles, fences, or a variety of other fixed objects. In 31 percent of the crashes, the ATV rolled/overturned as the first harmful event. However, FARS also indicates if a rollover occurred at any point during the crash sequence of a vehicle, and in total, 56 percent of the fatal single-vehicle ATV crashes involved rollover. Separately, in 5 percent of the crashes, it was reported that the operator fell off the vehicle.

Rollover also occurred in the crashes in which ATVs collided with other vehicles. Of the 523 ATVs involved in multiple-vehicle fatal crashes, 25 percent were said to have overturned.

There were 245 fatal crashes involving one ATV and one passenger vehicle, and in 212 crashes the impact points for the two colliding vehicles were known. Of these 212 crashes, 91 (43 percent) were front-to-side, 74 (35 percent) were front-to-front, and 41 (19 percent) were front-to-rear. Of the front-to-side crashes, 64 percent involved a passenger vehicle colliding into the side of an ATV; 36 percent involved an ATV colliding into the side of a passenger vehicle. Most (80 percent) of the rear-end crashes involved a passenger vehicle rear-ending an ATV.

Speed limits were unknown for 15 percent of the fatal ATV crashes. Where known, the limits were 10-35 mph at 43 percent of the crash locations, 40-50 mph at 17 percent of the locations, and 55 mph or greater at 41 percent of the locations.

Table 6 indicates the part of the roadway on which the fatal crashes occurred. The codes are based on the location of the first harmful event, so that if, for example, an ATV went off the road and hit a tree, the location would be coded as off-roadway. The most frequent crash location was on the road itself (47 percent). At least 40 percent occurred in locations immediately alongside the road, such as the shoulder, parking lane, or median. Among crashes occurring on-road, the surface was paved in 74 percent of the cases.

Fifty-one percent of the fatal crashes with the first harmful event occurring on the roadway involved collisions of ATVs with at least one other vehicle. These types of multiple-vehicle collisions occurred in less than 1 percent of the crashes for which the first harmful event occurred off the roadway.

3.3. Driver actions

There were 1,772 ATV drivers in the 1,675 fatal crashes. In terms of driver actions, 56 percent were said to be going straight, 27 percent negotiating a curve, 4 percent turning left, 2 percent turning right, and all other actions were performed by less than 2 percent of drivers.

The most frequently cited driver contributing factor for the 1,260 ATV operators in single-vehicle crashes was going too fast for conditions or exceeding the speed limit (42 percent). Eighteen percent were reported not to be in the proper lane, 10 percent were operating the vehicle in a careless or erratic manner, and 5 percent were overcorrecting. For all ATV drivers in multiple-vehicle crashes, 19 percent were reported to be speeding or going too fast for conditions, 19 percent failed to yield the right of way, 11 percent did not keep in the proper lane, and 9 percent disobeyed a traffic signal. For all ATV drivers combined, 6 percent were reported by the police to be operating a vehicle on a prohibited roadway.

4. Discussion

ATV rider fatalities on public roads have increased substantially since 1982, reflecting in part an increase in exposure. During this period, ATVs with greater horsepower have become increasingly available, according to sales data and CPSC data. However, because many of the ATV VINs in FARS could not be decoded, it was not possible to examine the role of engine size or horsepower. (Among ATVs with decodable VINs, 94 percent were straddle-type.) It has been noted that the increasing numbers and proportions of ATV rider fatalities on public roads may be due to the proliferation of ATVs

capable of roadway speeds (Denning et al., 2013a). This is speculative, although the high proportions of ATV operators reported to be speeding is suggestive in this regard.

However, the upward trend in ATV rider fatalities on public roads has halted, at least temporarily. During the 5-year period 2007-2011 included in the present study, ATV rider fatalities in FARS peaked in 2008, and then declined by 19 percent from 2008 to 2011. Recent declines in ATV rider non-fatal injuries have also been reported (Shults et al., 2013). Overall motor vehicle deaths have also declined substantially in recent years, dropping by 22 percent since 2007. This trend is thought to be due largely to the severe economic decline that occurred beginning in 2008 (Longthorne et al., 2010; Sivak, 2008), which also may have affected ATV rider fatalities. According to industry reports, sales of straddle-type ATVs fell from 752,000 units in 2007 to 289,000 units in 2012. In contrast, sales of UTVs increased nearly 23 percent from 2007 to 2012, to 166,449 units (Republican American, 2013). CPSC reports that when UTVs were first offered in 1998, fewer than 2,000 were sold (74 FR 55496).

FARS includes crashes on public roads in which one or more deaths occur within 30 days, whereas CPSC counts include deaths that occur on both private and public roads and deaths that occur beyond 30 days. According to the U.S. Bureau of the Census (2012), 6 percent of motor vehicle crash deaths in 2009 occurred between 30 days and 1 year of the crash. CPSC data indicate that in 2007 (the last year for which complete CPSC data are available), 492 ATV rider deaths occurred on roads: 375 on public roads, 51 on private roads, and 66 on roads of unknown type. Assuming that deaths on roads of unknown type are split according to the proportions occurring on public versus private roads in known cases, and subtracting estimated crash deaths occurring beyond 30 days, the CPSC adjusted number of deaths on public roads within 30 days in 2007 would be roughly 408, compared with 368 based on FARS. The CPSC count does not include any of the 61 deaths in 2007 where it was not known whether the deaths occurred on or off road, and some of these may have occurred on public roads. One possible reason for the discrepancy between FARS and CPSC is that FARS may miss some deaths, presumably those occurring in single-vehicle ATV crashes. It is also possible that some ATVs are not classified as ATVs in FARS. Another possibility is that CPSC misclassifies some roads as public, or misclassifies some off-road locations as roads.

ATV crashes are primarily a rural phenomenon (Killingsworth et al., 2005; Rodgers, 2008). ATV exposure is known to be high in rural areas, per capita fatality rates were highest in rural states, and fatal crashes most commonly occurred in rural areas within states. West Virginia, the third most rural state in the United States, stands out as having by far the highest per capita on-road ATV rider fatality rate.

ATV rider fatalities primarily occur in single ATV events, mostly involving collisions with fixed objects such as trees, or rollovers, and often excessive speed, according to the judgment of investigating officers. Overall, about half of the first harmful collision events took place on roads rather than alongside them, including all of the collisions of ATVs and passenger vehicles, which primarily involved front-to-side impacts or head-on collisions.

In addressing ATV crashes and injuries, major attention has been and continues to be given to those younger than 16 (Blecker et al., 2012; Bowman & Aitken, 2010; Helmkamp, 2000; Rodgers, 1993; Shults et al., 2013). In the present study, those younger than 16 were often involved as passengers, but ATV driver deaths on public roads are mostly adults, particularly males. Nine out of 10 drivers killed were 16 or older; more than 8 out of 10 were males of these ages.

As in other ATV studies, alcohol use and low helmet use were prominent. Only about 1 in 10 fatally injured ATV riders were wearing helmets, and 43 percent of the drivers were at or beyond BACs of 0.08 percent. This exceeds the percentage of fatally injured passenger vehicle drivers (33 percent in 2011), or motorcyclists (30 percent) with BACs of 0.08 percent or higher in 2011 (Insurance Institute for Highway Safety, 2013b). If drivers 20 and older are examined, more than half (53 percent) had illegal BACs, and 37 percent had BACs that were 0.15 percent or higher. Reducing alcohol-impaired driving among ATV drivers is a logical target in attempting to reduce deaths associated with ATV use, but it is not clear how this can be accomplished. ATV drivers on public roads already are subject to the same driving-while-impaired laws that apply to other motor vehicle operators.

There are several potential approaches for reducing or mitigating ATV crashes and injuries. Rider education and training programs are in wide use, but their effectiveness has never been formally established. Training programs involving automobile or motorcycle use have not been shown to reduce crashes (Christie, 2001; Kardamanidisk et al., 2010), and education through pamphlets, warning labels,

or public service announcements, typically does not result in behavior change (National Cooperative Highway Research Program, 2007).

Absence of laws, weaknesses in those that exist, and enforcement challenges hamper law-based approaches to protecting ATV riders. Some states do not have laws addressing any of the three activities warned against on ATV labels — on-road use, helmets, and passenger presence. State laws prohibiting on-road use have many exceptions, and it is not clear how well these laws are understood by ATV operators and the police. In this context it is notable that only 6 percent of ATV drivers in fatal crashes on public roads were reported by the police to be on roads on which they were prohibited. It is unknown to what extent this information is accurate. Many states allow ATVs to cross public roads, and it may be difficult to determine whether the drivers were, in fact, violating the law. The majority of laws requiring helmet use by ATV operators apply only to young people. The majority of state motorcycle helmet use laws also apply only to young people. Age-specific helmet use laws have been found to be ineffective in increasing helmet use or reducing death rates in younger or older populations (Houston & Richardson, 2007, 2008; Kyrychenko & McCartt, 2006; U.S. Government Accounting Office, 1991; Weiss et al., 2010).

There is limited information on law compliance among ATV operators. The amount of enforcement of the laws, which is key to their success, is also largely unknown. There are manpower challenges in enforcing ATV laws in rural areas, and exceptions to the laws can make it difficult to know if a violation has occurred or not. For example, West Virginia's law in regard to on-road travel allows travel on the side of the road not to exceed 10 miles.

There does appear to be some public support for legislation. A telephone survey of registered voters in Ohio found that 78 percent were in favor of helmet use laws for ATV riders, and 81 percent favored passenger restrictions (Stolz et al., 2009). A statewide survey in West Virginia found that 77 percent supported a ban on using ATVs on public roads (Helmkamp et al., 2008). However, there is little information regarding the views of ATV operators about such laws. Focus groups of ATV riders have indicated that the discomfort and inconvenience of helmets and the perceived lack of need for them discourage their use (Adams et al., 2013).

Because the majority of ATV rider deaths now occur in on-road crashes and frequently involve rollover, it may be appropriate to involve the National Highway Traffic Safety Administration (NHTSA) in

ATV safety. NHTSA is the federal agency that regulates the safety of motor vehicles used on public roads and has expertise on improving vehicle stability and reducing injuries in rollover crashes.

The University of New South Wales is developing a test procedure and performance requirements for evaluating the rollover stability and crashworthiness of ATVs (Rechnitzer et al., 2013). This may be useful in evaluating the safety of ATVs in the United States.

In summary, the current situation is that vehicles designed exclusively for off-road use are involved in more on-road than off-road fatal crashes, despite laws in most states prohibiting many types of on-road use. At least two-thirds of the crashes take place on paved roads, which increase ATV crash risk. ATV riders comprise only 1 percent of all motor vehicle crash deaths on public roads, but their presence on the roads endangers them and others. There may be remedies for reducing on-road ATV crashes, primarily through appropriate legislation, but they have yet to be identified or implemented adequately.

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References

Adams, L. E., Aitkin, M. E., Mullins, S. H., Miller, B. K., & Graham, J. (2013). Barriers and facilitators to all-terrain vehicle helmet use. *Journal of Trauma and Acute Care Surgery*, 75, S296-S300.

American Academy of Pediatrics. (2000). All-terrain vehicle injury prevention: two-, three-, and four-wheeled unlicensed motor vehicles. *Pediatrics*, 105, 1352.

Blecker, N., Rhee, P., Judkins, D. G., Wynne, J. L., Friese, R. S., Kulvatunyou, N., Latifi, R., & O'Keefe, T. (2012). Pediatric all-terrain vehicle trauma; the epidemic continues unabated. *Pediatric Emergency Care*, 28, 443-447.

Bowman, S. M., & Aitken, M.E. (2010). Still unsafe, still in use: ongoing epidemic of all-terrain vehicle injury hospitalizations among children. *Journal of Trauma Injury, Infection, and Critical Care*, 69, 1344-1349.

Christie, R. (2001). *The effectiveness of driver training as a road safety measure: a review of the literature*. Victoria, Australia: Royal Automobile Club of Victoria Ltd.

Consumer Product Safety Commission. (2013). *Annual report of ATV-related deaths and injuries*. Bethesda MD.

- Denning, G. M., Harland, K. K., Ellis, D. G., & Jennissen, C.A. (2013a). More fatal all-terrain vehicle crashes occur on the roadway than off: increased risk-taking characterizes roadway fatalities. *Injury Prevention*, 19, 205-256.
- Denning, G. M., Jennisen, C. A., Hartland, K. K., Ellis, D. G., & Buresh, C. T. (2013b). All-terrain vehicles (ATVs) on the road: a serious traffic safety and public health concern. *Traffic Injury Prevention*, 14, 78-85.
- Hall, A. J., Bixler, D., Helmkamp, J. C., Kraner, J. C., & Kaplan, J. A. (2009). Fatal all-terrain vehicle crashes; injury types and alcohol use. *American Journal Preventive Medicine*, 36, 311-316.
- Helmkamp, J. C. (2000). Adolescent all-terrain vehicle deaths in West Virginia, 1990-1998. *West Virginia Medical Journal*, 96, 361-363.
- Helmkamp, J. C., Ramsey, W. D., Hass, S. M., & Holmes, M. (2008). *All-terrain vehicle (ATV) deaths and injuries in West Virginia: a summary of surveillance and data sources*. Charleston WV: Criminal Justice Statistical Analysis Center, Division of Criminal Justice Services, Department of Military Affairs and Public Safety. Available: www.wvdcjs.com/statsanalysis
- Houston, D. J., & Richardson, Jr. L. E. (2007). Motorcycle safety and the repeal of universal helmet laws. *American Journal of Public Health*, 97, 2063-2069.
- Houston, D. J., & Richardson, Jr. L. E. (2008). Motorcycle fatality rates and mandatory helmet use laws. *Accident Analysis & Prevention*, 40, 200-208.
- Insurance Institute for Highway Safety. (2013a). *2011 Motorcycles and ATVs fact sheet*. Arlington, VA.
- Insurance Institute for Highway Safety. (2013b). *2011 Alcohol fact sheet*. Arlington, VA.
- Kardamanidisk, K., Martiniuk, A., Ivers, R. Q., Stevenson, M. R., & Thistlethwaite, K. (2010). *Motorcycle rider training for the prevention of road crashes (review)*. Cochrane Database of Systematic Reviews, Issue 10, Article no. CD005240. Oxfordshire, England: The Cochrane Collaboration.
- Killingsworth, J. B., Tilford, J. M., Parker, J. G., Graham, J. J., Dick, R. M., Aitken, M. E. (2005). National hospitalization impact of pediatric all-terrain vehicle injuries. *Pediatrics*, 115, 316-321.
- Kyrychenko, S. Y., & McCartt, A. T. (2006). Florida's weakened motorcycle helmet law: effects on death rates in motorcycle crashes. *Traffic Injury Prevention*, 7, 55-60.
- Longthorne, A., Subramanian, R., & Chen, C.-L. (2010). An analysis of the significant decline in motor vehicle traffic fatalities in 2008. Report no. DOT HS-811-346. Washington, DC: U.S. Department of Transportation.
- Lord, S., Tator, C. H., & Wells, S. (2010). Examining Ontario deaths due to all-terrain vehicles, and targets for prevention. *Canadian Journal of Neurological Science*, 37, 343-349.
- National Cooperative Highway Research Program. (2007). Public information and education in the promotion of highway safety. *Research Results Digest* 322. Washington DC: Transportation Research Board.
- Rechnitzer, G., Grzebieta, R. H., McIntosh, A. S., & Simmons, K. (2013). Reducing all terrain vehicle injuries (ATVs) and deaths — a way ahead. Proceedings of 23rd International Technical Conference on the Enhanced Safety of Vehicles (CD-ROM). Washington, DC: National Highway Traffic Safety Administration.

- Republican American. (2013). *Side-by-sides drive like a car, act like a bike*. Rep-Am.com, Jun 17. Available: www.rep-am.com/articles/2013/06/17/lifestyle/travel/TB117.
- Rodgers, G. B. (1993). All-terrain vehicle injury risk and the effects of regulation. *Accident Analysis & Prevention*, 25, 335-346.
- Rodgers, G. B. (2008). Factors associated with the all-terrain vehicle mortality rate in the U.S.: an analysis of state-level data. *Accident Analysis & Prevention*, 40, 725-732.
- Shults, R. A., West, B. A., Rudd, R. A., & Helmkamp, J. C. (2013). All-terrain vehicle-related nonfatal injuries among young rider in the United States, 2001-2010. *Pediatrics*, 132, 282-289.
- Sivak, M. (2008). *Is the U.S. on the path to the lowest motor vehicle fatalities in decades?* Report no. UMTRI-2008-39. Ann Arbor: University of Michigan Transport Research Institute.
- Specialty Vehicle Institute of America. (2013). *Position in opposition to on-road operation of ATVs*. Arlington VA.
- Stolz, U., McKenzie, L. A., Mehan, T. J., & Smith, G. A. (2009). Assessing public opinion regarding potential ATV-related policies. *Journal of Safety Research*, 40, 149-155.
- Subramanian, R., & Utter, D. (2003). *Multiple imputation of missing blood alcohol concentration (BAC) values in FARS*. Paper presented at the Federal Committee on Statistical Methodology Conference. November 17-19. Arlington VA.
- U.S. Bureau of the Census. (2010). *Urban and rural population by state, 2010*. Washington, DC. Available: <http://www.census.gov/geo/www/ua/2010urbanruralclass.html>
- U.S. Bureau of the Census. (2012). *Statistical abstract of the United States*. Washington, DC.
- U.S. Government Accountability Office. (2010). *All-terrain vehicles: how they are used, crashes, and sales of adult-sized vehicles for children's use*. Publication no. GAO-10-418. Washington, DC.
- U.S. Government Accounting Office. (1991). *Highway safety: motorcycle helmet laws save lives and reduce costs to society*. Washington, DC.
- Weiss, H., Agimi, Y., & Steiner, C. (2010). Youth motorcycle related brain injury by state helmet law. *Pediatrics*, 126, 1149-1155.

Table 1. ATV rider deaths on public roads and rate of deaths per 10 million people by state during 2007-2011 by state

State	ATV rider deaths	Rate of deaths per 10 million people
Alabama	55	23.3
Alaska	10	28.6
Arizona	52	16.1
Arkansas	50	34.6
California	79	4.3
Colorado	2	0.8
Connecticut	5	2.8
Delaware	2	4.5
District of Columbia	0	0.0
Florida	74	8.0
Georgia	62	12.8
Hawaii	4	6.1
Idaho	28	36.3
Illinois	39	6.1
Indiana	12	3.7
Iowa	26	17.2
Kansas	19	13.5
Kentucky	122	56.7
Louisiana	40	17.9
Maine	16	24.2
Maryland	9	3.2
Massachusetts	2	0.6
Michigan	52	10.4
Minnesota	38	14.4
Mississippi	47	31.9
Missouri	69	23.2
Montana	23	47.1
Nebraska	17	18.8
Nevada	4	3.0
New Hampshire	0	0.0
New Jersey	13	3.0
New Mexico	13	12.9
New York	58	6.0
North Carolina	29	6.2
North Dakota	10	30.4
Ohio	65	11.3
Oklahoma	33	17.8
Oregon	19	10.0
Pennsylvania	97	15.4
Rhode Island	1	1.9
South Carolina	8	3.5
South Dakota	5	12.3
Tennessee	67	21.3
Texas	95	7.7
Utah	20	14.5
Vermont	11	35.3
Virginia	17	4.3
Washington	24	7.2
West Virginia	96	104.9
Wisconsin	43	15.2
Wyoming	19	69.6
Total	1,701	11.2

Table 2. Age distribution of fatally injured ATV riders on public roads during 2007-2011

Age (years)	Drivers	Passengers	Total
	(N=1,482) Percent	(N=210) Percent	(N=1,701)* Percent
<13	3.2	17.1	4.9
13-15	6.7	11.4	7.3
16-19	11.1	18.6	12.1
20-29	25.9	22.4	25.6
30-39	17.4	9.5	16.5
40-49	16.5	15.2	16.3
50+	19.2	5.7	17.4

*Includes unknown driver/passenger status

Table 3. Percentage distributions of fatally injured ATV riders on public roads during 2007-2011 by road type and land use

Road type	Land Use			Total (N=1,701)
	Urban	Rural	Unknown	
Interstate	0	0.1	0	0.1
Non-interstate major road	2.4	18.9	0	21.3
Minor road	10.9	64.7	0	75.6
Unknown roads	0.1	2.5	0.5	3.1
Total	13.3	86.1	0.5	100

Table 4. Percentage distribution of blood alcohol concentrations (BACs) of fatally injured ATV drivers on public roads during 2007-2011, by driver age

Driver age (years)	Number of driver deaths	Percent of drivers with BACs \geq 0.08%	Percent of drivers with BACs \geq 0.15%
<13	47	<1	0
13-15	99	4.5	1.8
16-19	165	13.9	7.0
20-29	384	48.6	32.5
30-39	258	62.5	42.3
40-49	245	66.6	48.3
50+	284	37.0	29.3
Total	1482	43.4	30.3

Table 5. Percentage distribution of fatal ATV crashes on public roads during 2007-2011 by number of ATVs and non-ATVs involved

Number of ATVs and non-ATVs	N=1,675
Single ATV	75.2
Two ATVs	5.2
Three ATVs	0.1
One ATV and one non-ATV	18.7
One ATV and multiple non-ATVs	0.5
Multiple ATVs and One or more non-ATVs	0.3

Table 6. Percentage distribution of fatal ATV crash locations during 2007-2011 in relation to trafficway, U.S. 2007-2011

Relationship to trafficway	N=1,675
On road	46.5
Off-road – Roadside, shoulder, parking lane/zone, median	40.3
Off road – Location other/unknown	13.2

Appendix A. Summary of state ATV laws

State	When permitted on public roads	Helmet requirement	Passenger restriction
Alabama	—	—	—
Alaska	d, j, k, q	—	—
Arizona	k	age 17 and younger	—
Arkansas	a, b, c, d, f, m, o	—	—
California	e	all riders on public lands	no passengers, unless ATV specifically designed for them
Colorado	a, d, g, h, j, k, l, m	—	—
Connecticut	d	—	—
Delaware	h, n	all riders of 3-wheel ATVs	—
Florida	k, o, w	age 15 and younger	no passengers, unless ATV specifically designed for them
Georgia	k	—	—
Hawaii	—	—	—
Idaho	a, d, k, l	age 17 and younger	—
Illinois	a, d, k, v	—	—
Indiana	d, h, q, r, s	—	—
Iowa	a, k, m, q, t, u	—	no passengers, unless ATV specifically designed for them
Kansas	k, m, v	—	—
Kentucky	a, d, k, m, v	age 15 and younger	—
Louisiana	a, d, q, v	—	—
Maine	d, g, h, j, k, o, q, v	age 17 and younger	—
Maryland	a, o	all riders on public lands	—
Massachusetts	a, d, h, j	all riders	—
Michigan	a, c, d, g, h, k, q, v	all riders	no passengers, unless ATV specifically designed for them
Minnesota	a, d, g, j, m, q, v	age 17 and younger	drivers 18 and older are limited to one passenger unless ATV specifically designed for passengers; drivers 17 and younger may carry only a parent or guardian
Mississippi	not permitted	age 15 and younger on public lands	—
Missouri	a, f, i, k, o, v	age 17 and younger	no passengers, unless ATV specifically designed for them
Montana	k	—	—
Nebraska	a, d, h, k, m, v	—	—

State	When permitted on public roads	Helmet requirement	Passenger restriction
Nevada	c, d, j, k, x	all riders	—
New Hampshire	c, d, j, q, x	age 17 and younger	age 17 and younger may not have passengers
New Jersey	d, x	all riders	—
New Mexico	d	age 17 and younger	age 17 and younger may not have passengers
New York	d, k, v	all riders	no passengers, unless ATV specifically designed for them
North Carolina	a, b, d, i, o	all riders	no passengers, unless ATV specifically designed for them
North Dakota	d, j	age 17 and younger	no passengers, unless ATV specifically designed for them
Ohio	c, d, j, k, q, v, x	all riders on public lands	no passengers unless ATV specifically designed for them
Oklahoma	d, k, v	age 17 and younger on public lands	no passengers, unless ATV specifically designed for them
Oregon	a, d, j, x	age 17 and younger on public lands	—
Pennsylvania	d, g, j, k	all riders	—
Rhode Island	d, j, v	all riders	—
South Carolina	—	age 14 and younger	age 15 and younger may not have passengers
South Dakota	d, j, m, q, t, w, x	—	no passengers, unless ATV specifically designed for them
Tennessee	a, c, d, k, n, o, u	age 17 and younger on public lands	—
Texas	a, d, m, o, v	all riders on public lands	no passengers unless ATV specifically designed for them
Utah	d, j, k, x	age 17 and younger	—
Vermont	a, d, k	—	—
Virginia	a, c, d, k, o, u, v	all riders except those engaged in farming	no passengers unless ATV specifically designed for them
Washington	k	all riders except those engaged in farming	—
West Virginia	a, c, d, h, j, k, m, t, v	17 and younger	limit of one passenger, unless ATV specifically designed for passengers; passengers 18 and younger may only ride with intermediate license holders or licensed drivers 18 and older
Wisconsin	a, b, d, g, h, i, k, m, q, t, v	17 and younger	no passengers unless specifically designed

State	When permitted on public roads	Helmet requirement	Passenger restriction
Wyoming	a, d, k, l	—	—
District of Columbia	not permitted	—	—

^aagricultural purposes

^bhunting operations

^cfield to field or trail to trail travel

^dcrossing road

^efire trails, logging and service roads that are on public lands, regardless of their surface composition

^fhandicapped persons

^gcrossing bridge or culvert

^hspecial events lawfully conducted and of specified duration

ⁱATV operated by governmental entity

^jemergency conditions

^klocal ordinance or specifically authorized by state

^lU.S. government authorization on federal lands

^mutility and maintenance workers

ⁿmay be pushed across or adjacent to roadway

^olaw enforcement

^proad specially designed for ATV use

^qroad shoulder or right-of-way

^rcountry roads by local ordinance

^spermission granted by law enforcement

^tsurveying purposes

^uemergency services

^vapproved riding is restricted to daylight hours

^wgravel, dirt or loose surface road

^xloading or unloading