

Injury Prevention and Recreational All-Terrain Vehicle Use: the Impact of Helmet Use in West Virginia

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Abstract

All-terrain vehicles (ATVs) are a popular source of outdoor activity in the United States, particularly in West Virginia. During the period of time from 1999 to 2007, deaths associated with ATVs in West Virginia increased by 28%. Helmet use among bicycle and motorcycle riders has been shown to decrease morbidity and mortality following trauma. *Methods:* We performed a retrospective observational study to compare injury patterns, hospital course, and resource utilization of non-helmeted and helmeted riders involved in ATV accidents using data from the West Virginia Trauma Center System. Descriptive statistics were calculated for all study variables and comparisons were made between helmeted and non-helmeted riders. *Results:* In 2010, there were 1,059 patients aged 18 and over with traumas resulting from ATV accidents within the System. Riders involved in ATV trauma occurring on farms and streets were significantly more likely to be non-helmeted, while those using ATVs for recreational purposes were more likely to

be helmeted. Non-helmeted riders were significantly more likely to arrive to the hospital via helicopter than helmeted riders, and were less likely to be discharged home from the ED compared to helmeted riders. Non-helmeted riders sustained significantly more head, neck, soft tissue injuries, concussions, intracranial hemorrhages, facial fractures, skull fractures, and thoracic spine fractures than helmeted riders. *Discussion:* The findings of the current study support previous studies documenting that helmet use is protective against intracranial injury and other injuries of the head and neck. ATV use continues to be a significant contribution to trauma morbidity and mortality in West Virginia. *Conclusion:* Efforts that focus on increased helmet use have the potential to significantly reduce morbidity and mortality following ATV trauma. Enforcement of the current West Virginia ATV Law should be encouraged. Legislation expanding the mandatory use of safety equipment and rider training should be enacted in West Virginia..

Introduction

All-terrain vehicles (ATVs) are a popular source of both outdoor activity and functional work in the United States, particularly in West Virginia. ATVs were introduced in the 1970s and are primarily used as recreational vehicles. West Virginia has hundreds of miles of sanctioned ATV trails, most notably the Hatfield and McCoy Trail, providing a significant tourism impact to the economy. WV State tourism promotional monies help advertise

these trails on the World Wide Web. Countless additional miles of trails exist on private lands. Three-wheeled vehicles were demonstrated to be associated with significant morbidity and mortality and were removed from production in 1987. Today's ATVs are four-wheel vehicles similar to motorcycles in their method of control and riding position.

In West Virginia the death rate associated with ATV injury during the 1990s was 8 times the national average.¹ In response to these findings, legislation was passed in 2001 to improve safety measures. This law prohibited ATV operation on paved roads with a center line, unless the vehicle was traveling a distance of ≤ 10 miles and at a speed of ≤ 25 miles per hour. The statute also required helmet use and training for ATV riders aged < 18 years of age, regardless of where the ATV was ridden.^{1,2}

Injuries and fatalities continued to increase after this legislation was enacted. During the period of time from 1999 to 2007, deaths associated with ATVs in West Virginia increased by 28%.² Deaths were more likely to occur in the following groups: pediatric patients, adults with lower socioeconomic status, those with fewer years of education, and those involved in rollover accidents. Brain and spine injuries were

Objectives

All-terrain vehicles (ATVs) are a popular source of outdoor activity in the United States, particularly in West Virginia. The objective of the current study was to describe and compare the demographic variables, injury patterns, hospital course, and resource utilization of non-helmeted and helmeted riders involved in ATV accidents using data from the West Virginia Trauma Center System. We discuss impact of helmet use on injuries and emergency department and hospitalization as well as implications for helmet legislation throughout the state of West Virginia.

found to occur in 80% of fatal ATV crashes in West Virginia in 2006.²

ATV trauma results in specific injury patterns as documented previously.^{3,4} Head injuries, facial injuries, and orthopedic injuries are the most common ATV crash injuries to require medical care. It has been shown previously that children and adolescents sustain a disproportionately large percentage of injuries due to ATV use.⁵ In recent years the number of persons aged greater than 50 years sustaining ATV injuries has increased.⁶

Helmet use among bicycle and motorcycle riders has been shown to decrease morbidity and mortality following trauma. Several studies examining ATV crashes have shown helmet use among riders to be approximately 20%.^{7,8} Findings in prior studies have demonstrated helmet use is likely to decrease admission to intensive care unit, the number and severity of head injuries, and the likelihood of death. It has been estimated that helmet use for all riders might reduce the risk of death by 42% and the risk of nonfatal head injury by 64%.¹ Prior studies have examined the demographics, injury patterns, and resource utilization of ATV crash injuries; however, few have compared results between helmeted riders and non-helmeted riders.

We performed a retrospective observational study to compare injury patterns, hospital course, and resource utilization of non-helmeted and helmeted riders involved in ATV accidents. Data from the WV State Trauma Registry for 2010 were compiled from the 33 acute care hospitals participating in the WV Trauma Center System.

Methods

Design and Setting

Data were extracted from the West Virginia Trauma Center System

registry, a statewide registry that compiles trauma data from 33 acute care hospitals in West Virginia. Patients are enrolled in the registry for the following reasons: the trauma team was activated during their emergency department evaluation, they are admitted or observed in the hospital for a traumatic injury, they arrive at the hospital by aero-medical transport with a traumatic injury, they have an operative procedure for a traumatic injury, or they die in the ED resulting from a traumatic injury. We analyzed the trauma registry data from the year 2010 for this retrospective cohort study. This study was approved by the West Virginia University Institutional Review Board (Protocol Number H-23530).

Selection of Cases

Cases were selected for analysis if "ATV" was included in the "Blunt Cause of Injury" field and if age was greater than 18 on the data abstraction form. Cases were

considered to be "helmeted" if "Helmet/Hard Hat" was present in the "Protective Devices" field. All other entries, including "none", "unknown", and "not applicable" were considered to be "non-helmeted." Age, sex, place of injury, mode of transportation to the ED, injury pattern and severity, ED treatment and disposition, and hospitalization course and disposition were examined and compared for helmeted and non-helmeted cases meeting the inclusion criteria.

Data Analysis

Descriptive statistics (frequencies, percentages, means and standard deviations) were calculated for all study variables. Differences between helmeted and non-helmeted patients were calculated using chi-square for categorical data and t-tests for continuous variables. Statistical significance was set to alpha <0.05 for all analyses. Data

Table 1. Demographics of ATV Traumas in 2010

	Non-Helmeted (n=861)		Helmeted (n=198)		p-value*
Age (M, SD)	37.5	(14.8)	37.1	(14.0)	0.766
Sex (n, %)					
Male	643	(74.7)	156	(78.8)	0.227
Female	218	(25.3)	42	(21.2)	0.227
Injury Severity Score (M, SD)	8.6	(8.1)	7.6	(7.8)	0.124
Location of Injury (n, %)					
Farm	54	(6.3)	2	(1.0)	0.001
Home	118	(13.7)	28	(14.1)	0.883
Recreation	319	(37.0)	93	(47.0)	0.009
Street	115	(13.4)	16	(8.1)	0.041
Other [†]	255	(29.6)	59	(29.8)	0.955
Mode of Arrival (n, %)					
Ambulance	385	(44.7)	92	(46.5)	0.646
Helicopter	68	(7.9)	6	(3.0)	0.015
Private Vehicle/Walk-in	375	(43.6)	96	(48.5)	0.211
Other [‡]	33	(3.8)	4	(2.0)	0.283

*Differences determined by t-tests or chi-square and fisher's exact test as appropriate

[†] Includes locations of "industry", "mine", "public building", "unspecified", "unknown" and "other location"

[‡] Includes "unknown", "n/a", and "other"

were analyzed using SPSS Version 19.0 (SPSS, Inc., 2011, Chicago, IL).

Results

There were 1,059 traumas enrolled with “ATV” as the “blunt cause of injury” in the WV trauma registry in 2010. This number is 5.4% of the 19,604 total traumas entered into the WV Trauma Registry for patients 18 and over for this year. Of these, 861 (81%) were non-helmeted and 198 (19%) were helmeted riders. The mean age for all cases was 37.4 years (*SD* = 14.7) and most (75%) were males. As can be seen in Table 1, there were no significant differences in helmet use by age or

sex. Riders involved in ATV trauma occurring on farms and streets were significantly more likely to be non-helmeted, while those using ATVs for recreational purposes were more likely to be helmeted. Furthermore, non-helmeted riders were significantly more likely to arrive to the hospital via helicopter than helmeted riders (Table 1).

As can be seen in Table 2, significantly fewer non-helmeted riders (33.1%) were discharged home from the ED compared to helmeted riders (44.9%, *p* = 0.002). There were no significant differences between helmeted and non-

helmeted riders in terms of hospital disposition to home, however.

When patterns of injury were compared, significant differences were found between the proportion of helmeted and non-helmeted riders for various injuries. Specifically, when compared to helmeted riders, non-helmeted riders sustained significantly more head and neck soft tissue injuries (STI; 81% vs. 56%), concussions (60% vs. 38%), intra-cranial hemorrhages (22% vs. 6%), facial fractures (21% vs. 12%), skull fractures (19% vs. 9%), and thoracic spine fractures (11% vs. 5%). Helmeted riders sustained significantly more STIs to the trunk (66% vs. 39%), upper arm (31% vs. 22%) and lower leg (17% vs. 11%), as well as significantly more forearm and foot fractures (15% vs. 10% and 0.2% vs. 2.0%, respectively) than non-helmeted riders.

Table 2. Emergency Department and Hospital Dispositions for Non-Helmeted and Helmeted Cases

	Non-Helmeted (n=861)		Helmeted (n=198)		p-value
	n	%	n	%	
ED Disposition					
Home	285	(33.1)	89	(44.9)	0.002
Floor†	297	(34.5)	58	(29.3)	0.162
ICU	138	(16.0)	22	(11.1)	0.082
OR	43	(5.0)	9	(4.5)	0.769
Transfer	11	(1.3)	3	(1.5)	0.734
Stepdown	36	(4.2)	9	(4.8)	0.850
Other‡	51	(5.9)	7	(3.5)	0.180
Death	0	--	1	(0.5)	0.187
Hospital Disposition					
Home§	795	(92.3)	187	(94.4)	0.306
Inpatient Facility	19	(2.2)	4	(2.0)	1.000
Rehab Facility	15	(1.7)	3	(1.5)	1.000
Skilled Nursing Facility	7	(0.8)	0	--	0.360
Residential Institution	2	(0.2)	0	--	1.000
Morgue	5	(0.6)	1	(0.5)	1.000
Other¶	18	(2.1)	3	(1.5)	0.781
Discharge Status					
Dead	5	(0.6)	1	(0.5)	1.000

*Differences determined by t-tests

† Includes dispositions of “floor”, “observation” and “telemetry”

‡ Includes dispositions of “unknown”, “AMA”, “n/a”, and “other”

§ Includes dispositions of “home, no assistance” and home, health care”

|| Includes dispositions of “acute care hospital” and “ICF”

¶ Includes dispositions of “unable to complete treatment”, “n/a”, and “other”

Discussion

The results of this study reveal several differences in location of injury and resource utilization after ATV trauma. Specifically, non-helmeted riders were more likely to be injured on farms and streets and were more likely to be transported to the hospital via helicopter than helmeted riders. Significantly more riders who were riding ATVs for recreational purposes were wearing helmets, suggesting that educational efforts should be expanded to promote wearing helmets on farms and for transportation as well as during recreational activities. Furthermore, as nearly half of helmeted riders (44.9%) were discharged from the ED compared with 33.1% of non-helmeted riders, wearing a helmet was associated with a greater likelihood of discharge from the ED as opposed to hospital admission. There were no significant differences in the number of deaths between helmeted versus non-

Table 3. Injury Patterns of Helmeted and Non-Helmeted ATV Riders Involved in Trauma

	Non-Helmeted (n = 861)		Helmeted (n = 198)		p-value*
Diagnosis (n, %)					
Head and neck STI [†]	700	(81.3)	111	(56.1)	<0.001
Concussion [‡]	513	(59.6)	76	(38.4)	<0.001
Trunk STI	336	(39.0)	131	(66.2)	<0.001
Upper leg STI	211	(24.5)	55	(27.8)	0.339
Intra-cranial hemorrhage [§]	188	(21.8)	11	(5.6)	<0.001
Facial fracture	182	(21.1)	23	(11.6)	0.002
Upper arm STI	178	(20.7)	42	(21.1)	0.867
Skull fracture	161	(18.7)	17	(8.6)	0.001
Intra-thoracic injury	147	(17.1)	32	(16.2)	0.757
Rib/Sternum fracture	143	(16.1)	43	(21.7)	0.089
Upper arm fracture	134	(15.6)	42	(21.2)	0.054
Forearm STI	112	(13.1)	41	(20.7)	0.006
Lower leg fracture	105	(12.2)	21	(10.6)	0.533
Lower leg STI	97	(11.3)	33	(16.7)	0.037
T spine fracture	94	(10.9)	10	(5.1)	0.012
Lumbar fracture	89	(10.3)	13	(6.6)	0.105
Intra-abdominal injury [¶]	88	(10.2)	23	(11.6)	0.563
Forearm fracture	84	(9.8)	29	(14.7)	0.044
Hand STI	68	(7.9)	23	(11.6)	0.092
Pelvis fracture	63	(7.3)	14	(7.1)	0.905
C spine fracture	48	(5.6)	14	(7.1)	0.419
Hand fracture	45	(5.2)	13	(6.6)	0.455
Femur fracture	33	(3.8)	6	(3.0)	0.589
Foot STI	18	(2.1)	6	(3.0)	0.423
Foot fracture	2	(0.2)	4	(2.0)	0.013

*Differences determined by t-tests

[†] Soft tissue injury (STI) includes: lacerations, contusions, abrasions, hematomas and tissue avulsions to the body area. STI excludes fracture to the body area.

[‡] Includes: loss of consciousness and concussion

[§] Includes: subdural hemorrhage, subarachnoid hemorrhage, intra-parenchymal hemorrhage, epidural hematoma and cerebral contusion

^{||} Includes: pneumothorax, hemothorax, myocardial contusion

[¶] Includes: liver laceration, bowel injury, aortic injury

***Total percentages will exceed 100% due to multiple diagnoses per patient

helmeted riders; however there were only 5 helmeted deaths and 2 non-helmeted deaths recorded in the database during this time period. This is fewer than predicted by

studies of death certificates, showing 27-46 deaths annually from ATV-related trauma.² This may reflect the fact that many ATV riders die outside of the hospital setting. ATV riders

pronounced dead at the scene are not included in the Registry and as a result not included in this study. Further study is needed in this area.

It is well documented that helmet use in bicycle riding, motorcycle riding, and ATV use is protective against intracranial injury and other injuries of the head and neck. The findings of this study were reflective of this as well. Specifically, 22% of non-helmeted riders sustained intracranial injuries, whereas only 6% of helmeted riders sustained this type of injury. Non-helmeted riders were also more likely to have facial fractures and skull fractures. These injuries are associated with decreased independence and increased disability which is reflected in the fact that significantly fewer non-helmeted riders were discharged to home after hospitalization.

Limitations

Our data are limited to ATV trauma evaluated in the ED or hospital setting. Comparison of death rate to prior studies is not possible due to lack of data relating to out of hospital deaths. Another limitation is that the data were collected from hospitals participating in the State Trauma Registry, which only represent 33 of the 52 acute care hospitals in the state. Higher acuity patients initially seen at a nonparticipating hospital were likely transferred to higher level of care facilities. The transferred patients were likely captured in the data. However, minimally injured patients, who were seen and discharged home from a non-participating hospital, would not be captured. This would have increased the number of lower severity injuries within the data sets.

Conclusion

Recreational ATV use has become a significant part of the tourism sector of the West Virginia economy.

Figure 1.*Call to Action: Physician Interventions to Reduce ATV-Related Injuries*

- **Educate yourself on current guidelines for protective equipment use and rider training**
- **Provide anticipatory guidance to your patients regarding proper use of protective equipment and the need for rider training and certification**
- **Provide this information in your waiting room and on your practice's website**
- **Provide written information to your at risk patients with their aftercare instructions**
- **Support community based campaigns to expand ATV safety awareness and rider training and certification**
- **Support legislative initiatives to expand mandatory helmet use and mandatory rider training**

In addition, recreational ATV use continues to be a significant contribution to trauma morbidity and mortality in West Virginia. Legislative efforts have focused on helmet use for pediatric riders and limiting use to smaller or rural roadways. Despite legislation enacted in 2001, the rate of morbidity and mortality has continued to increase. Our study examined adult ATV riders. In this population helmet use was very low (19%). Non-helmeted riders that sustained ATV-related trauma utilized more healthcare resources and experienced increased numbers of severe head and neck injuries. Non-helmet use was also associated with increased likelihood of hospital admission. Helmet use is an active form of injury prevention. Efforts that focus on increased helmet use have the potential to significantly reduce morbidity and mortality following ATV trauma. However, for a helmet to be effective it must be worn every time the ATV is ridden. Enforcement of the current West Virginia ATV Law should be encouraged and consideration given to expanding

the scope of the legislation. Based on the data in this study we recommend mandating helmet use on all WV lands for riders of all ages.

ATV safety is a complex issue. Several factors contribute to the growing number of injuries. The ATV industry continues to develop larger, more powerful machines. Helmet legislation is difficult to enforce and limited in scope at this time in West Virginia. Overall, there is a low rate of safety training prior to operation of these machines and an infrequent use of protective gear.

Several studies have shown promise for improving ATV safety. Legislative efforts that focus on safety training and improved awareness of existing laws have been demonstrated to be effective. Campaigns that involve community groups developing and implementing safety training and awareness have had significant impact on these communities. Surveys have shown that patients would be appreciative of safety information provided by primary care physicians at regular health care appointments. Studies have demonstrated that

health care providers can improve safety awareness and impact the behaviors of their patients. Anticipatory guidance has been shown to be most effective when used to develop preventive behaviors. Data demonstrates that the pediatric population is much safer on ATVs when the guidelines for ATV use, developed by the American Academy of Physicians, are followed; however many doctors that practice anticipatory guidance are not aware of these guidelines.

Physicians have a responsibility to contribute to the safety of the patients and communities which they serve. Recreational ATV use is an area where much work is yet to be done to improve safety. Figure 1 summarizes interventions West Virginia physicians should implement to prevent ATV injuries.

Physicians should support legislative efforts to require helmet use and training for all riders in all venues in West Virginia. Physicians should support administrative and legislative efforts designed to implement safety training programs for ATV riders as well as support efforts to implement awareness of current laws and guidelines for ATV use. The American Academy Pediatrics has developed guidelines specific to pediatric use. Physicians who see children and adolescents in their practice should be aware of these guidelines and discuss them with their patients. There are currently no guidelines developed by physicians for adult riders. This is an area that has promise for improved safety. All patients should be encouraged to use helmets and other protective equipment when riding an ATV. Community awareness programs including poster contests, movie trailers, school training videos, and ATV safety rodeos have improved community safety. Physicians

can promote and contribute to these activities in many ways.

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CME POST-TEST

40. According to the 2001 ATV Safety Legislation passed in West Virginia, when riding an ATV you may travel no more than ___ miles and must keep your speed below ___ miles per hour on a paved road with a center line.
- a. 1, 5
 - b. 2, 10
 - c. 10, 20
 - d. 10, 25
 - e. 35, 50
41. Which of the following statements is supported by the data obtained in this study?
- a. Females were involved in the majority of ATV-related trauma.
 - b. Females involved in ATV accidents were more likely to be helmeted compared to males.
 - c. Non-helmeted ATV trauma victims were more likely to be transported to the hospital by helicopter.
 - d. Approximately 80% of all ATV trauma victims in this study were helmeted.
 - e. Helmeted riders sustained significantly fewer soft tissue injuries to the trunk and upper arm than non-helmeted riders.
42. Which of the following is true regarding helmet use in the setting of ATV trauma in this study?
- a. There was a significant difference in the number of deaths between helmeted vs. non-helmeted riders.
 - b. Hospital length of stay and ICU length of stay were similar between helmeted and non-helmeted ATV riders.
 - c. The need for admission to the hospital was not affected by helmet usage.
 - d. Significantly more non-helmeted riders were discharged to home after hospitalization compared to helmeted riders.
 - e. Helmet use does not affect the incidence of traumatic intracranial hemorrhage.

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