


Article

# Enforcement of Off-Road Vehicle Laws in Iowa

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**Abstract:** Safety laws are among the most successful means of reducing injuries, but their effectiveness is strongly influenced by the level of enforcement. To characterize enforcement of off-road vehicle (ORV) laws statewide, analyses of citations were performed using Iowa Court Information System data. From 2005–2015, 5173 individuals were charged with 5643 citations issued. Citations averaged <5/county/year, decreased dramatically over time, and varied by county when normalized to registered all-terrain vehicles (ATVs). Over 90% of operators cited were male and Caucasian. One-fifth were <18 years old. The top five violations were: operation on a highway/snowmobile trail (51%), registration/identification number not documented/displayed (19%), prohibited use in a park/preserve (5.5%), and operation with more persons than the vehicle is designed to carry (4.4%). The Department of Natural Resources issued the highest percentage of citations, followed in decreasing order by Sheriff, Police, State Patrol, and Conservation officers. Significant differences were identified when citations were compared by sex, age, race, enforcement agency, disposition (guilty vs. not guilty), and when comparing counties with or without an ORV park. These characteristics suggest limited and variable enforcement of laws statewide that may reduce their potential to prevent deaths and injuries, and that improved strategies to support ORV law enforcement are needed.

**Keywords:** all-terrain vehicle; off-road vehicle; injury prevention; enforcement; legislation

## 1. Introduction

Crashes of off-road vehicles (ORVs), specifically all-terrain vehicles (ATVs) and recreational off-highway vehicles (ROVs), are a serious public health and safety concern and a continuing source of deaths and injuries [1,2]. To address safety concerns, many states have passed ORV-related legislation. However, laws vary considerably from state to state [3], and no states have comprehensive laws that address all major risk factors. Risk factors for ORV-related crashes and injuries include younger age, being male, driving on roads, lack of helmet use, speed, riding at night, lack of training, operating under the influence of drugs or alcohol, age-inappropriate vehicle size, carrying passengers on ATVs and not wearing seat belts in ROVs [2,4–17].

Overall, traffic safety legislation has been shown to effectively decrease deaths and injuries, and enforcement appears to play an important role in achieving these goals. For example, primary and enhanced enforcement of motor vehicle seatbelt laws have resulted in increased seatbelt use and reduced traffic fatalities [18,19]. Similarly, statewide universal motorcycle helmet laws have been shown to be highly effective for increasing helmet use and decreasing brain injury [20,21]. On the other hand, youth-only helmet laws have been found to be considerably less effective [22], most likely due to the significant difficulties enforcing a law covering only a small percentage of riders.

While safety legislation has been well studied with regards to motorcycles, automobiles, and other roadway vehicles, only a few studies have focused on ORVs. Of these, some showed positive effects on riding behavior [23–25], whereas others suggested little benefit [26,27]. However, none of

these studies addressed law enforcement, and in studies with limited effects, authors speculated that the most likely reason was lack of enforcement [28]. One study provided indirect support for the hypothesis that enforcement promotes ATV safety [29]. In this publication, safer riding behaviors were observed among crash victims in environments with stronger enforcement, i.e., off-highway vehicle (OHV) parks, as compared to other off-road locations.

The objective of this study was to better understand how law enforcement officers addressed violations of ORV laws statewide. Of particular interest was determining the level of enforcement of laws that promote safer riding such as staying off public roads, no passengers, and wearing a helmet (required in state OHV parks).

## 2. Materials and Methods

### 2.1. Study Design

A retrospective secondary analysis of ATV and ROV related citations issued from 2005 to 2015 was performed using data from the Judicial Branch's Iowa Courts Information System (ICIS). The university's Institutional Review Board deemed this study exempt from federal review, as it involves secondary analysis of de-identified publicly available data.

### 2.2. Study Variables

Demographics included sex, age, and race. For comparisons, age was grouped as youth (<18 years old) or adult (18 years old or older), and race (Caucasian, African American, Hispanic, and Other) was categorized as Caucasian or Other. Those of race other than Caucasian were grouped together due to their relatively lower numbers. Citation-related variables included the season issued categorized as Winter (Dec–Feb), Spring (Mar–May), Summer (Jun–Aug), or Fall (Sep–Nov), charge type, disposition, enforcement agency, number of charges per operator, and rurality. Charge type was classified into four groups: Operator Action, Documentation and Identification, Vehicle-Related, or Location-Related violations. Disposition was either guilty or not guilty, wherein the citation was dismissed, acquitted, expunged, or not filed. The 300 arresting agencies were grouped by State Patrol/Department of Transportation (DOT), Sheriff, Police, Department of Natural Resources (DNR), and Conservation Agencies. Rurality by county was categorized as metropolitan (codes 1–3) or non-metropolitan (codes 4–9) as defined by the Rural-Urban-Continuum codes [30].

### 2.3. Statistical Analysis

SPSS (IBM Statistics Package for the Social Sciences, v22, Armonk, NY, USA) was used for descriptive (frequencies) and comparative (chi-square test) analyses of categorical variables. Significance was defined as a double-sided  $p$  value < 0.05. Logistic regression analysis was used to calculate adjusted odds ratios and 95% confidence intervals (95% CI) for categorical outcomes, after controlling for covariates.

### 2.4. Mapping Citations

Esri ArcGIS Software (v10.2, Redlands, CA, USA) was used to construct graphic depictions of citation patterns at the county level normalized per 100 registered ATVs as previously described [31]. ArcGIS selected cutoff points for the scale to optimize comparisons.

## 3. Results

### 3.1. Citation Characteristics

#### 3.1.1. Citation Types

Over the 11-year study period, there were 5643 citations issued to 5173 ORV operators (Table 1). The most common citations were location-related; almost 90% of these for operating on a highway

or snowmobile trail. The second highest proportion was related to lack or improper posting of documentation, with 60% of these for failing to have documentation of vehicle registration and another third for failing to display the vehicle’s identification number.

**Table 1.** List and frequency of off-road vehicle (OHV) citations in the Iowa Courts Information System (ICIS) from 2005–2015. All citations fell under Iowa Code 321I.

Charge Type n (% of Total <sup>1</sup> )	Charge Description	n (Col%)	Related to Unsafe Riding
Operator 518 (9%)	Operate w/more persons than vehicle designed to carry	251 (48%)	Yes
	Excessive Speed	65 (13%)	Yes
	Operate in careless/reckless/negligent manner	62 (12%)	Yes
	Operate in violation of posted sign	57 (11%)	Yes
	Violation of stop signal	40 (8%)	Yes
	Operate or ride with loaded or uncased firearm	37 (7%)	Yes
	Operating while intoxicated	6 (1%)	Yes
	Helmet use <sup>2</sup>	0 (0%)	Yes
Documentation 1748 (31%)	Registration and numbering required	1055 (60%)	No
	Failure to display identification number	604 (35%)	No
	Operation by person < 18 w/o education certification <sup>2</sup>	75 (4%)	Yes
	Operation by person <12 w/o supervision <sup>2</sup>	6 (0.3%)	Yes
	Failure to file accident report	4 (0.2%)	No
	Rental violation	3 (0.2%)	No
	Violation by manufacturer, distributor, or dealer	1 (0.1%)	No
Vehicle 100 (2%)	Headlight/tail lamp/brakes required	87 (87%)	Yes
	Muffler violation	9 (9%)	No
	Lights required	4 (4%)	Yes
Location 3277 (58%)	Operation on highway or snowmobile trail	2894 (88%)	Yes
	Prohibited use in designated public areas <sup>3</sup>	313 (9.6%)	No
	Operate prohibited vehicle on designated area or trail	59 (2.3%)	No
	Operate upon an operating railroad right of way	11 (0.3%)	Yes

<sup>1</sup> Total N = 5643 citations issued to 5173 ORV operators. <sup>2</sup> Applies to off-highway vehicle parks only. <sup>3</sup> Designated public areas include parks/wildlife areas/preserves/streambeds.

Only 9% of all citations were related to operator actions apart from riding location. Almost half of these were for carrying passengers on single-rider ATVs, and many of the remaining for excessive speed or driving recklessly. Approximately 1% of citations were for operating while intoxicated and none were for failing to wear a helmet in OHV parks where they are required. Table 1 also indicates whether the laws/regulations cited were related to injury prevention. Of note, the two OHV park regulations requiring documented training and adult supervision of youth fall under the documentation and identification citation type, but also relate to ATV safety. About 30% of the citations did not involve unsafe riding practices.

### 3.1.2. Demographics of Operators Cited

Of the individuals cited, 95% were male, 97% were Caucasian, and 20% were <18 years old (Table 2). The proportion of youth issued citations increased with age, whereas the proportions decreased with age for adults.

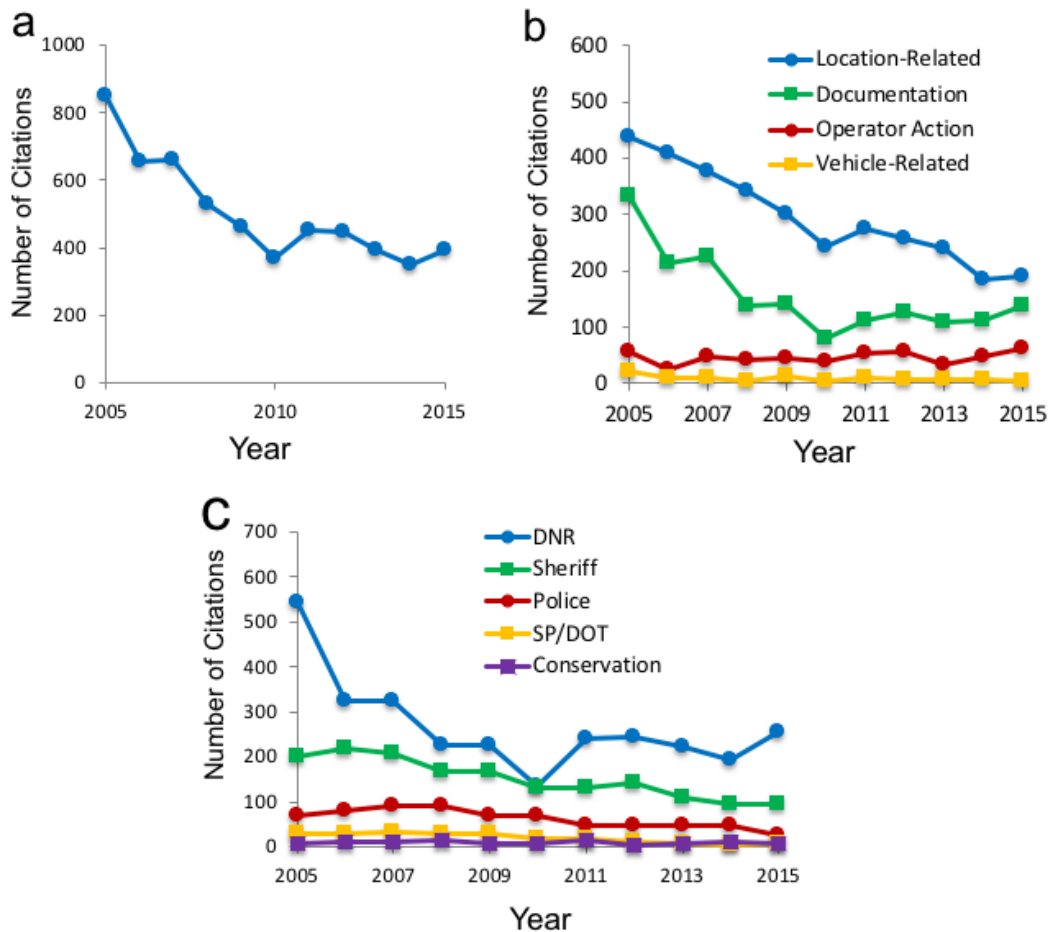
**Table 2.** Person-related characteristics of operators receiving off-road vehicle (ORV) citations in the Iowa Courts Information System (ICIS) from 2005–2015.

Sex n (Col%) <sup>1</sup>	Race n (Col%) <sup>1</sup>	Youth (years old) n (Col% all ages) <sup>1</sup>	Adult (years old) n (Col% all ages) <sup>1</sup>
Male 4437 (95%)	Caucasian 4102 (97%)	6–11 7 (0.1%)	18–22 1459 (29%)
	AA/Black 45 (1.1%)	12–15 406 (8%)	23–39 1875 (37%)
Female 231 (5%)	Hispanic 55 (1.3%)	16–17 610 (12%)	40–59 705 (14%)
	Other 20 (0.5%)		≥60 63 (1.2%)

<sup>1</sup> Column total may not equal total number of operators receiving citations (N = 5173) due to missing data. Abbreviations: AA, African American.

### 3.1.3. Changes in Citations over Time

The number of citations as a function of time decreased from a high in 2005 of 848 until 2010, and averaged ~400 citations per year after that (Figure 1a). For citation type, decreases were seen for both location and documentation-related charges, whereas operator actions and vehicle-related charges were lower in number and remained steady over time (Figure 1b). Consistent with the magnitude of the overall changes, citations for the most common violation (operation on roadways/snowmobile trails) decreased almost 70% (438 to 135) from 2005–2015.



**Figure 1.** Graphs of citations issued over time. Number of ORV-related citations over time: (a) All citations, (b) by citation type, and (c) by enforcement agency. Abbreviations: DNR, Department of Natural Resources; SP/DOT, State Patrol/Department of Transportation.

Figure 1c shows changes in the number of citations issued over time by each enforcement agency. The DNR issued the highest percentage of citations and showed a precipitous drop from 2005 (544 citations) to 2006 (323 citations), varying considerably after that with an overall decrease of 53%. Sheriffs’ officers issued the next highest number of citations followed by police officers. Citations from sheriffs’ officers, police, and state patrol decreased more gradually, with net decreases of 52%, 65% and 72%, respectively. Citations by conservation agencies were  $\leq 13$  per year and remained relatively constant.

### 3.2. Comparative Analysis

More citations were issued in the spring and summer months, and 71% were given from Friday through Sunday (Table 3). The DNR issued over half of all citations, and the most common were location related, predominately for riding on the roadway. Four percent of charges were for carrying a

passenger. Scheduled violations that required the individual to appear in court were about 98% of charges (data not shown). Nine percent of citations were disposed of with no guilty charges, 7% of operators were charged with more than one offense (362 of 5173), and sixty-five percent of citations (3359 of 5173) were issued in non-metropolitan areas.

**Table 3.** Citation-related characteristics and demographic comparisons for off-road vehicle (ORV) citations in the Iowa Courts Information System (ICIS) from 2005–2015.

Variable	All n (Col%) <sup>1</sup>	Sex		p Value	Age (Years Old)		p Value
		Male n (Col%) <sup>1</sup>	Female n (Col%) <sup>1</sup>		<18 n (Col%) <sup>1</sup>	≥18 n (Col%) <sup>1</sup>	
Season							
Winter	826 (16%)	744 (17%)	21 (9%)	0.006	155 (14%)	741 (17%)	0.002
Spring	1451 (28%)	1264 (28%)	84 (36%)		288 (25%)	1275 (29%)	
Summer	1870 (36%)	1569 (35%)	82 (35%)		445 (39%)	1581 (35%)	
Fall	1026 (20%)	860 (19%)	44 (19%)		248 (22%)	867 (19%)	
Day of Week							
Mon-Thurs	1516 (29%)	1323 (30%)	72 (31%)	0.66	381 (37%)	1124 (27%)	<0.001
Fri-Sun	3655 (71%)	3112 (70%)	159 (69%)		642 (63%)	2977 (73%)	
Agency							
DNR	2778 (54%)	2363 (53%)	118 (51%)	0.39	417 (41%)	2326 (57%)	<0.001
Sheriff	1505 (29%)	1279 (29%)	79 (34%)		432 (43%)	1064 (26%)	
Police	601 (12%)	543 (12%)	22 (10%)		118 (12%)	482 (12%)	
SP/DOT	195 (4%)	178 (4%)	8 (3%)		29 (3%)	156 (4%)	
Conservation	91 (2%)	78 (2%)	3 (1%)		17 (2%)	71 (2%)	
Charge Type							
Operator	518 (9%)	430 (9%)	33 (13%)	0.022	75 (7%)	439 (10%)	<0.001
Documentation	1748 (31%)	1499 (31%)	67 (26%)		307 (27%)	1423 (32%)	
Vehicle	100 (2%)	97 (2%)	1 (0.4%)		20 (2%)	80 (1.8%)	
Location	3277 (58%)	2816 (58%)	154 (60%)		734 (65%)	2522 (56%)	
Charge Type							
Roadway	2894 (51%)	2377 (54%)	127 (55%)	0.69	699 (62%)	2178 (49%)	<0.001
Other	2749 (49%)	2060 (46%)	104 (45%)		437 (38%)	2286 (64%)	
Charge Type							
Passenger	249 (4%)	197 (4%)	22 (9%)	0.001	33 (3%)	215 (5%)	0.005
Other	5394 (96%)	4645 (96%)	233 (91%)		1103 (97%)	4249 (95%)	
Guilty Disposition							
None	481 (9%)	426 (10%)	23 (10%)	0.82	93 (8%)	543 (12%)	<0.001
One or More	4692 (91%)	4011 (90%)	208 (90%)		1043 (92%)	3921 (88%)	

Abbreviations: DNR, Department of Natural Resources; SP/DOT, State Patrol/Department of Transportation.

<sup>1</sup> Column total may not equal total number of operators in each category due to missing data.

### 3.2.1. Demographic Comparisons

A higher proportion of males than females were cited in the winter months (Table 3). Citations related to operator actions were more common among females than males, a finding primarily due to the difference in passenger-related charges ( $p = 0.001$ ). Adult operators had a higher proportion of citations issued in the winter and spring as compared to youth (46% vs. 39%,  $p = 0.002$ ). Relative to adults, younger operators had a higher proportion of citations issued on weekdays, by sheriff's departments, and related to location,  $p < 0.001$  in each case. The percentage of youth found guilty of their charges was also higher than for adults (92% vs. 88%,  $p < 0.001$ ).

In data not shown, citations related to operator actions were less common among Caucasians than among other races (9% vs. 17%),  $p = 0.012$ . This was due, at least in part, to a lower proportion of passenger-related charges issued to Caucasians (4% vs. 9%),  $p = 0.013$ . Also relative to other races, Caucasians had a higher proportion of roadway-related citations (53% vs. 43%),  $p = 0.034$ . Whereas half of citations to non-Caucasians were issued in metropolitan areas, this was only 36% for Caucasian operators. No other differences related to issued citations were observed by sex, age, or race.

### 3.2.2. Comparisons by Enforcement Agency

All citation-related characteristics were different by enforcement agency, overall p values for all comparisons was  $p < 0.0001$  (Table 4). Briefly, the highest proportion of citations issued by all agencies was in the summer, but the pattern for other seasons varied. The DNR and Conservation agencies more commonly issued citations on weekends as compared to other agencies. A higher proportion of documentation-related citations were issued by the DNR, whereas location-related citations were more common for all other agencies. The DNR had a lower proportion of operators cited for multiple charges, and along with conservation agencies, a lower proportion of those cited who were found not guilty. The DNR had the highest proportion of citations issued in metropolitan areas.

**Table 4.** Comparisons by enforcement agency and by county presence of an off-highway vehicle (OHV) park for off-road vehicle (ORV) citations in the Iowa Courts Information System (ICIS) from 2005–2015.

Variable	Enforcement Agency				
	DNR n (Col%) <sup>1</sup>	Sherriff n (Col%) <sup>1</sup>	Police n (Col%) <sup>1</sup>	SP/DOT n (Col%) <sup>1</sup>	Conservation n (Col%) <sup>1</sup>
Season					
Winter	515 (19%)	162 (11%)	126 (21%)	21 (11%)	2 (2%)
Spring	722 (26%)	467 (31%)	179 (30%)	56 (29%)	24 (26%)
Summer	955 (34%)	601 (40%)	201 (33%)	71 (36%)	42 (46%)
Fall	586 (21%)	275 (18%)	95 (16%)	47 (24%)	23 (25%)
Day of Week					
Mon-Thurs	533 (19%)	616 (41%)	269 (45%)	78 (40%)	19 (21%)
Fri-Sun	2244(81%)	888 (59%)	332 (55%)	117 (60%)	72 (79%)
Charge Type					
Operator	344 (12%)	106 (6%)	44 (6%)	20 (9%)	4 (4%)
Documentation	1416 (48%)	172 (10%)	120 (17%)	24 (11%)	16 (16%)
Vehicle	14 (0.5%)	42 (3%)	34 (5%)	10 (5%)	0 (0%)
Location	1183 (40%)	1357 (81%)	492 (71%)	166 (75%)	79 (80%)
Charge Type					
Roadway	870 (31%)	1226 (81%)	444 (74%)	154 (79%)	49 (54%)
Other	1908 (69%)	279 (19%)	157 (26%)	41 (21%)	42 (46%)
Charge Type					
Passenger	166 (6%)	23 (2%)	8 (1%)	11 (6%)	0 (0%)
Other	2612 (94%)	1482 (98%)	593 (99%)	184 (94%)	91 (100%)
Number of Charges					
One	2635 (95%)	1379 (92%)	534 (89%)	176 (90%)	84 (92%)
More than one	143 (5%)	126 (8%)	67 (11%)	19 (10%)	7 (8%)
Guilty Disposition					
None	152 (5%)	181 (12%)	122 (20%)	20 (10%)	4 (4%)
One or More	2626 (95%)	1324 (88%)	479 (80%)	175 (90%)	87 (96%)
Rurality					
Metropolitan	1058 (38%)	465 (31%)	198 (33%)	61 (31%)	31 (34%)
Non-metropolitan	1720 (62%)	1040 (69%)	403 (67%)	134 (69%)	60 (66%)

Abbreviations: SP/DOT, State Patrol/Department of Transportation; DNR, Department of Natural Resources.

<sup>1</sup> Column total may not equal total number for each agency due to missing data.

### 3.2.3. Comparing Counties with and without an ORV Park

Thirty percent (1563 of 5173) of cited operators received their citation in the eight Iowa counties with OHV parks. Consistent with its primary role in enforcing park regulations, the DNR issued 83% (1294 of 1563) of all citations in these counties. Additional comparisons with the 91 counties without parks showed multiple differences (Table 5).



**Table 5.** Comparisons for counties with and without an off-highway vehicle (OHV) park for off-road vehicle (ORV) citations in the Iowa Courts Information System (ICIS) from 2005–2015.

Variable	Does County Have OHV Park?		p Value
	Park n (Col%) <sup>1</sup>	No Park n (Col%) <sup>1</sup>	
Season			
Winter	156 (10%)	670 (19%)	
Spring	432 (28%)	1019 (28%)	<0.001
Summer	743 (48%)	1127 (31%)	
Fall	232 (15%)	794 (15%)	
Day of Week			
Mon-Thurs	367 (23%)	1149 (32%)	<0.001
Fri-Sun	1196 (77%)	2459 (68%)	
Charge Type			
Operator	207 (13%)	311 (8%)	
Documentation	955 (58%)	793 (20%)	<0.001
Vehicle	15 (1%)	85 (2%)	
Location	466 (28%)	2811 (70%)	
Charge Type			
Roadway	388 (25%)	2357 (65%)	<0.001
Other	1175 (75%)	1253 (35%)	
Charge Type			
Passenger	101 (6%)	107 (3%)	<0.001
Other	1462 (94%)	3503 (97%)	
Number of Charges			
One	1497 (96%)	3314 (92%)	<0.001
More than one	66 (4%)	296 (8%)	
Guilty Disposition			
None	152 (9%)	484 (12%)	0.002
One or More	1491 (91%)	3516 (88%)	
<b>Metropolitan</b>			
Yes	764 (47%)	1235 (31%)	<0.001
No	879 (53%)	2765 (69%)	

<sup>1</sup> Column total may not equal total number for each agency due to missing data.

Counties with parks had a higher proportion of citations in the summer and on weekends as compared to other times. OHV park counties also had more than twice the proportion of operator action-related charges, including carrying passengers, than counties without parks. Citations for roadway riding were much less common in counties with parks than in those without. A higher proportion of citations issued in OHV park counties were characterized as metropolitan, as many OHV parks are near cities. Both number of charges and guilty disposition were significantly different between counties with and without parks, but the proportional differences were relatively small.

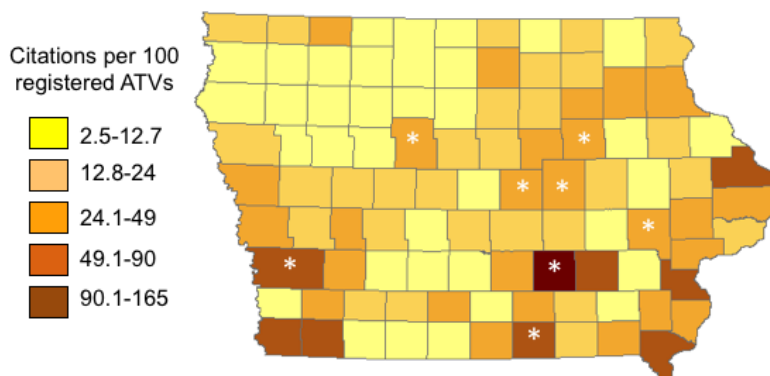
### 3.3. Geographic Distribution

The statewide pattern of citations issued was also determined. To do this, the total number of citations per county over the study period were normalized to the number of registered ATVs (citations/100 ATVs) and mapped using ArcGIS (Figure 2). Significant variability by county as a function of registered ATVs was observed.

### 3.4. Logistic Regression Analysis

Citations issued on weekdays were 31% less likely to result in a disposition of guilty, whereas youth were more than twice as likely to be found guilty as compared to adults (Table 6). All agencies

were less likely than DNR and Conservation officers to issue citations with guilty dispositions. Both documentation and location-related charges were more likely to result in a finding of guilty than vehicle-related charges. Citations in metropolitan counties were 20% less likely than non-metropolitan counties to have a guilty disposition. Charge dispositions did not differ due to season, sex, or race.



**Figure 2.** Mapping of citations by county. The total number of citations per county from 2005–2015 were calculated. Values were normalized per 100 registered ATVs and mapped using ArcGIS. Asterisk indicates a county with an off-road vehicle (ORV) park.

**Table 6.** Binary logistic regression analysis of citation data from the Iowa Courts Information System (ICIS) from 2005–2015. Both models included 4594 cases for which there were no missing values for any of the covariables.

Covariables	Charge Disposition (Guilty vs. Not Guilty)		Counties with OHV Parks vs. Those Without	
	aOR	95% CI	aOR	95% CI
Season				
Winter	1.18	0.86–1.63	0.58	0.44–0.76
Spring	1.08	0.82–1.42	1.56	1.24–1.97
Summer	1.15	0.88–1.50	2.42	1.94–3.01
Fall	1.0 (ref)		1.0 (ref)	
Day of Week				
Mon-Thu	0.69	0.57–0.84	1.1	0.93–1.32
Fri-Sun	1.0 (ref)		1.0 (ref)	
Sex				
Male	1.02	0.67–1.55	2.02	1.37–2.97
Female	1.0 (ref)		1.0 (ref)	
Age (Years Old)				
<18	2.36	1.80–3.11	0.83	0.68–1.02
≥18	1.0 (ref)		1.0 (ref)	
Race				
Caucasian	0.65	0.35–1.22	0.43	0.28–0.65
Other	1.0 (ref)		1.0 (ref)	
Enforcement Agency				
Sheriff	0.29	0.22–0.37	0.24	0.19–0.30
Police	0.19	0.14–0.25	0.33	0.25–0.42
SP/DOT	52	0.31–0.90	0.16	0.09–0.29
DNR/Conservation	1.0 (ref)		1.0 (ref)	
Charge Type				
Operator	1.61	0.93–2.79	1.83	0.96–3.56
Documentation	1.81	1.09–3.00	3.63	1.97–6.68
Location	2.71	1.69–4.35	0.75	0.41–1.37
Vehicle	1.0 (ref)		1.0 (ref)	
Metropolitan				
Yes	0.8	0.66–0.98	2.3	1.97–2.69
No	1.0 (ref)		1.0 (ref)	

Abbreviations: Department of Natural Resources, DNR; off-highway vehicle, OHV; State Patrol/Department of Transportation, SP/DOT.



Citations in counties with OHV parks were more likely to be issued in spring and summer than in fall as compared to counties without parks, and twice more likely to involve males than females. Counties with parks involved citations that were 57% less likely to be issued to Caucasians than to other races, and less likely to involve enforcement agencies other than the DNR and Conservations agencies. Counties with parks were also characterized as being over 3.6 times more likely than counties without parks to have issued documentation-related citations, and twice as likely to be designated as a metropolitan county. Citation characteristics for counties with and without OHV parks did not differ due to day of the week or offender age.

## 4. Discussion

### 4.1. Iowa ORV Law Enforcement

Independent risk factors that increase the likelihood of ORV-related deaths and injuries include roadway riding [9,11,12], being male and/or <16 years of age [13,14,32], youth operating adult-size ATVs [10], carrying passengers on ATVs designed for a single rider [9–11,33], alcohol [34–36], and lack of helmet use by ATV riders [34,37–39]. Safety laws are designed to reduce crashes and injuries by focusing on risk factors, and Iowa's ORV laws and OHV park regulations do address some of these issues. However, our study suggests limited statewide enforcement of existing ORV laws/regulations and found that overall, the number of citations decreased dramatically over the study period. In fact, citations dropped from an overall average of 8.6 citations per county in 2004 to only 4.0 citations per county in 2015. The number of citations per county as a function of registered ATVs also varied significantly, suggesting county-dependent differences in enforcement levels.

### 4.2. Riding on Public Roads

Roadway riding is among the most significant risk factors for serious injury and death [9–12]. This is because ATVs and ROVs are specifically designed for off-road use only. Features including a relatively high center of gravity, low-pressure off-road tires, and a locked rear differential or solid rear axle can increase the risk of losing control and/or having a rollover on roadways [9–12]. Iowa state law prohibits riding on public roadways unless using the vehicle under specified conditions for occupational purposes.

We found that around 50% of all citations were given for riding on public roads, but the number of charges were never more than 4 citations/county/year and decreased 70% over time. The observations that more than half of all fatalities and approximately one-third of injuries involving ATVs have occurred on Iowa's roads [9,11], along with survey studies of Iowa ATV riders [40,41], support the hypothesis that riding on roads is common across the state. Thus, lack of roadway riding is unlikely to fully account for the small number of citations. We can only speculate about the reasons for the observed decrease in citations related to roadway use. One contributor may be the fact that since 2011, a number of Iowa counties have passed ordinances opening at least some of their public roads to ORV transportation and recreational use.

### 4.3. Carrying Passengers

Passengers or operators with passengers are a significant proportion of crash victims, and roadway ATV-related fatalities are more likely to involve passengers than fatalities occurring off-road [9–12,42]. Almost all ATVs are designed for an operator only and passengers are an independent risk factor for ATV-related crashes and injuries [9,11,32]. Iowa statute prohibits multiple riders on single-person ATVs, and this applies to both public and private lands. Counties and cities cannot override this prohibition.

Passenger-related citations ranged from 14 to 30 per year for the entire state. Of note, a study of over 4500 Iowa school-aged children (11–16 years old) found that of the approximately 80% that reported having been on an ATV, 91% had ridden with or as a passenger [40]. Similarly, survey studies of attendees at the Iowa-Illinois Farm Progress Show found that more than 80% of respondents had

ridden with or as a passenger on an ATV [41]. These data suggest that riding with passengers is common in the state, and that again, lack of this riding behavior is unlikely to explain the small number of citations.

#### 4.4. Alcohol

Another major risk factor for crashes and injuries is alcohol intoxication, and state law prohibits operating ORVs while under the influence of alcohol or drugs. A previous study using national data showed alcohol use by 39% of fatality victims, and a study using Iowa data found over 30% of non-fatal crashes involved alcohol use [11]. These and other studies suggest alcohol use is common among ATV riders, yet <1% of citations were given for operating an ORV while intoxicated. It is currently unclear why this discrepancy exists, and further study will be needed to address this very significant question.

#### 4.5. Helmet Use

Head injuries are among the leading causes of death and disability from ATV crashes [43], and helmets have been shown to significantly reduce the likelihood of these injuries [9,12]. There are no general helmet laws in Iowa for ORVs or other vehicles. Iowa is one of only three states where this is true. However, Iowa's OHV parks do require helmets for all park riders. Despite this, no citations were given for lack of helmet use by the DNR, the agency that primarily enforces park regulations.

#### 4.6. ORV Laws and Injury Prevention

The most effective means of injury prevention are evidence-based safety laws and their enforcement. For ORVs, injury prevention laws are often limited and vary by state [3]. Advocacy for more laws is critically needed. In Iowa, some of the key ORV laws needed are those requiring specific training and licensing, seat belt (ROV) and helmet use, an evidenced-based minimum age for vehicle operation, and laws prohibiting youth operation of adult-size ATVs. Repeal of ordinances expanding roadway access would also be essential.

However, both existing and future laws will have limited effectiveness in injury prevention if enforcement is lacking. We can only speculate as to why there were relatively few ORV citations issued in the state over 11 years, why citation rates varied considerable by county, and why the total number decreased over time. Possible contributors to all of these may include limited knowledge about existing ORV laws among riders and among officers in some agencies. Another known challenge is the inability of enforcement officers in roadway vehicles to stop ORVs when their operators choose to flee by going off the road. Enforcement agencies often have policies that discourage vehicle chases, which could increase the risk of an ORV crash.

Reduced resources may also be contributing to less enforcement. In 2005, the jurisdiction of DNR officers became more limited, and this may explain at least in part the marked decrease in citations from 2005 to 2006. We have recently learned that state budget cuts will mean no part-time summer DNR officers, which will likely further reduce enforcement of OHV park regulations. These parks were previously an example of how effective enforcement can positively impact safety behavior [29]. In the context of limited resources, officers' attitudes about the priority of enforcing ORV laws may also be important and remain unknown.

ORV safety education efforts are ongoing in many states and other countries but need to be expanded to legislators and enforcement officers. This education needs to include information on why laws and their enforcement are essential for injury prevention. Additionally, advocacy groups need to partner with other stakeholders to identify more effective strategies and more resources for enforcing ORV laws. Finally, additional studies are needed regarding enforcement of ORV laws, as are expanded efforts for standardizing these laws across states to optimize their impact.

#### 4.7. Limitations

The current study is limited by its retrospective nature. Furthermore, the data analyzes enforcement and legislation specific to the state of Iowa and may not be generalizable to other jurisdictions. The source of data only covered physical citations that were recorded by police officers and did not include warnings. Therefore, the data are likely an underrepresentation of the actual number of individuals who were stopped for engaging in unsafe riding behaviors, as well as the extent to which the laws were being enforced. Although mapping data were normalized to registered ATVs, we cannot rule out the possibility that the variability observed between counties was due, at least in part, to riding extent (riding hours/ATV), ratio of registered versus unregistered ATVs, and/or the extent to which illegal riding behaviors occurred. However, there was an approximate 100-fold variation in citation rates, and it seems unlikely that that level of variability was exclusively due to differences in ORV operator riding behaviors or registered versus unregistered ATVs.

#### 5. Conclusions

This study shows relatively limited enforcement of ORV laws and regulations in the state, with less than five citations per county per year issued during the study period. Data also demonstrated a significant decrease in citations issued over time and suggest there may be differences in the level of enforcement by county. We hypothesize that these characteristics may be reducing the effectiveness of existing laws and their potential to prevent deaths and injuries. Further study is needed to determine law enforcement officer's attitudes regarding the importance ORV law enforcement, and the barriers they encounter in successfully enforcing ORV laws. Our findings suggest a need for further education about laws and their enforcement, and for better enforcement-based strategies for ORV injury prevention.

**Author Contributions:** E.S.Q. was primarily responsible for organizing the data, performing initial analysis, and creating the first draft of tables, figures, and the manuscript. G.M.D. helped with data analysis and significantly contributed to data interpretation as well as creation of the final tables, figures and manuscript for submission. C.A.J. was primarily responsible for the final study design and significantly contributed to data interpretation and creation of the completed manuscript for submission.

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#### References

1. U.S. Consumer Product Safety Commission 2016 Annual Report of ATV-Related Deaths and Injuries. Available online: [https://www.cpsc.gov/s3fs-public/atv\\_annual\\_Report\\_2016\\_0.pdf?ntwycn8wu3ITrXLnLC49kn\\_lxxDASq5e](https://www.cpsc.gov/s3fs-public/atv_annual_Report_2016_0.pdf?ntwycn8wu3ITrXLnLC49kn_lxxDASq5e) (accessed on 13 February 2019).
2. Denning, G.; Jennissen, C. Pediatric and adolescent injury in all-terrain vehicles. Special Issue: Epidemiology of youth injury in adventure and extreme sports. *Res. Sports Med.* **2018**, *26*, 38–56. [CrossRef] [PubMed]
3. National Conferences of State Legislatures All-Terrain Vehicle (ATV) Safety Laws by State. Available online: <http://www.ncsl.org/research/transportation/all-terrain-vehicle-safety-laws-by-state.aspx#ma> (accessed on 13 February 2019).
4. U.S. Consumer Product Safety Commission Notice of Proposed Rulemaking. 16 CFR Part 1422. Safety standard for recreational off-highway vehicles (ROVs). *Federal Register*. **2014**, *79*, 68964–69031. Available online: <http://www.cpsc.gov/Global/Newsroom/FOIA/CommissionBriefingPackages/2014/SafetyStandardforRecreationalOff-HighwayVehicles-ProposedRule.pdf> (accessed on 28 October 2015).
5. Aitken, M.E.; Graham, C.J.; Killingsworth, J.B.; Mullins, S.H.; Parnell, D.N.; Dick, R.M. All-terrain vehicle injury in children: Strategies for prevention. *Inj. Prev.* **2004**, *10*, 303–307. [CrossRef]
6. Consumer Federation of America All-Terrain Vehicle (ATV) Safety Crisis: America's Children at Risk. 2002. Available online: <http://consumerfed.org/wp-content/uploads/2010/08/atv-safety-crisis-2003-final-all.pdf> (accessed on 1 October 2017).

7. GAO All-Terrain Vehicles: How They Are Used, Crashes, and Sales of Adult-Sized Vehicles for Children's Use. 2010 Report to Congressional Committees (GAO-10-418); 2010. Available online: <http://www.gao.gov/new.items/d10418.pdf> (accessed on 28 June 2017).
8. Campbell, B.T.; Kelliher, K.M.; Borrup, K.; Corsi, J.; Saleheen, H.; Bourque, M.D.; Lapidus, G. All-terrain vehicle riding among youth: How do they fair? *J. Pediatr. Surg.* **2010**, *45*, 925–929. [[CrossRef](#)] [[PubMed](#)]
9. Denning, G.; Harland, K.; Ellis, D.; Jennissen, C. More fatal all-terrain vehicle crashes occur on the roadway than off: Increased risk-taking characterises roadway fatalities. *Inj. Prev.* **2013**, *19*, 250–256. [[CrossRef](#)] [[PubMed](#)]
10. Denning, G.; Harland, K.; Jennissen, C. Age-Based Risk Factors for Pediatric ATV-Related Fatalities. *Pediatrics* **2014**, *134*, 1094–1102. [[CrossRef](#)]
11. Denning, G.; Jennissen, C.; Harland, K.; Ellis, D.; Buresh, C. All-terrain vehicles (ATVs) on the road: A serious traffic safety and public health concern. *Traffic Inj. Prev.* **2013**, *14*, 78–85. [[CrossRef](#)] [[PubMed](#)]
12. Denning, G.M.; Jennissen, C.A. All-terrain vehicle fatalities on paved roads, unpaved roads, and off-road: Evidence for informed roadway safety warnings and legislation. *Traffic Inj. Prev.* **2016**, *17*, 406–412. [[CrossRef](#)]
13. Rodgers, G.B. Factors associated with the all-terrain vehicle mortality rate in the United States: An analysis of state-level data. *Accid. Anal. Prev.* **2008**, *40*, 725–732. [[CrossRef](#)]
14. Rodgers, G.B.; Adler, P. Risk factors for all-terrain vehicle injuries: A national case-control study. *Am. J. Epidemiol.* **2001**, *153*, 1112–1118. [[CrossRef](#)] [[PubMed](#)]
15. Shulruf, B.; Balemi, A. Risk and preventive factors for fatalities in all-terrain vehicle accidents in New Zealand. *Accid. Anal. Prev.* **2010**, *42*, 612–618. [[CrossRef](#)] [[PubMed](#)]
16. Hafner, J.W.; Hough, S.M.; Getz, M.A.; Whitehurst, Y.; Pearl, R.H. All-terrain vehicle safety and use patterns in central Illinois youth. *J. Rural Health* **2010**, *26*, 67–72. [[CrossRef](#)] [[PubMed](#)]
17. Burgus, S.K.; Madsen, M.D.; Sanderson, W.T.; Rautiainen, R.H. Youths operating all-terrain vehicles—Implications for safety education. *J. Agromed.* **2009**, *14*, 97–104. [[CrossRef](#)] [[PubMed](#)]
18. Shults, R.A.; Beck, L.F. Self-reported seatbelt use, United States, 2002–2010: Does prevalence vary by state and type of seatbelt law? *J. Saf. Res.* **2012**, *43*, 417–420. [[CrossRef](#)]
19. Carpenter, C.S.; Stehr, M. The effects of mandatory seatbelt laws on seatbelt use, motor vehicle fatalities, and crash-related injuries among youths. *J. Health Econ.* **2008**, *27*, 642–662. [[CrossRef](#)]
20. Olsen, C.S.; Thomas, A.M.; Singleton, M.; Gaichas, A.M.; Smith, T.J.; Smith, G.A.; Peng, J.; Bauer, M.J.; Qu, M.; Yeager, D.; Kerns, T.; Burch, C.; Cook, L.J. Motorcycle helmet effectiveness in reducing head, face and brain injuries by state and helmet law. *Inj. Epidemiol.* **2016**, *3*, 8. [[CrossRef](#)] [[PubMed](#)]
21. Araujo, M.; Illanes, E.; Chapman, E.; Rodrigues, E. Effectiveness of interventions to prevent motorcycle injuries: Systematic review of the literature. *Int. J. Inj. Contr. Saf. Promot.* **2017**, *24*, 406–422. [[CrossRef](#)]
22. Brooks, E.; Naud, S.; Shapiro, S. Are youth-only motorcycle helmet laws better than none at all? *Am. J. Forensic Med. Pathol.* **2010**, *31*, 125–129. [[CrossRef](#)]
23. Keenan, H.T.; Bratton, S.L. All-terrain vehicle legislation for children: A comparison of a state with and a state without a helmet law. *Pediatrics* **2004**, *113*, e330–e334. [[CrossRef](#)]
24. Beidler, S.K.; Kromhout-Schiro, S.; Douillet, C.D.; Riesenman, P.J.; Rich, P.B. North Carolina all-terrain vehicle (ATV) safety legislation: An assessment of the short-term impact on ATV-related morbidity and mortality. *N. C. Med. J.* **2009**, *70*, 503–506.
25. Flaherty, M.R.; Raybould, T.; Kelleher, C.M.; Seethala, R.; Lee, J.; Kaafarani, H.M.A.; Masiakos, P.T. Age Legislation and Off-Road Vehicle Injuries in Children. *Pediatrics* **2017**, *140*, e20171164. [[CrossRef](#)]
26. McBride, A.S.; Cline, D.M.; Neiberg, R.H.; Westmoreland, K.D. Pediatric all-terrain vehicle injuries: Does legislation make a dent? *Pediatr. Emerg. Care* **2011**, *27*, 97–101. [[CrossRef](#)]
27. Winfield, R.D.; Mazingo, D.W.; Armstrong, J.H.; Hollenbeck, J.I.; Richards, W.T.; Martin, L.C.; Beierle, E.A.; Lottenberg, L. All-terrain vehicle safety in Florida: Is legislation really the answer? *Am. Surg.* **2010**, *76*, 149–153.
28. Helmkamp, J.C.; Aitken, M.E.; Graham, J.; Campbell, C.R. State-specific ATV-related fatality rates: An update in the new millennium. *Public Health Rep.* **2012**, *127*, 364–374. [[CrossRef](#)] [[PubMed](#)]
29. Denning, G.; Jennissen, C.; Harland, K.; Ellis, D.; Buresh, C. Off-highway vehicle parks: Combining environment, knowledge, and enforcement for all-terrain vehicle injury prevention. *Accid. Anal. Prev.* **2013**, *52*, 64–70. [[CrossRef](#)] [[PubMed](#)]

30. United States Department of Agriculture Economic Research Service Rural-Urban Continuum Codes. Available online: <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/> (accessed on 29 November 2018).
31. Qin, E.S.; Jennissen, C.A.; Wadman, C.A.; Denning, G.M. Using Geospatial Mapping to Determine the Impact of All-Terrain Vehicle Crashes on Both Rural and Urban Communities. *West J. Emerg. Med.* **2017**, *18*, 913–922. [[CrossRef](#)]
32. Levenson, M. All-Terrain Vehicle 2001 Injury and Exposure Studies. Consumer Product Safety Commission Report. Available online: <https://www.cpsc.gov/s3fs-public/pdfs/atvex2001.pdf> (accessed on 13 February 2019).
33. Jennissen, C.; Harland, K.; Wetjen, K.; Denning, G. The Effect of Passengers on All-Terrain Vehicle Crash Mechanisms and Injuries. *Safety* **2016**, *2*, 1. [[CrossRef](#)]
34. Bethea, A.; Samanta, D.; Willis, J.A.; Lucente, F.C.; Chumbe, J.T. Substance exposure and helmet use in all-terrain vehicle accidents: Nine years of experience at a level 1 trauma center. *J. Saf. Res.* **2016**, *59*, 61–67. [[CrossRef](#)] [[PubMed](#)]
35. Gorucu, S.; Murphy, D.; Kassab, C. Risk factors for roadway single- and multi-vehicle all-terrain vehicle crashes in Pennsylvania: 2010–2013. *Work* **2017**, *57*, 555–562. [[CrossRef](#)] [[PubMed](#)]
36. Hall, A.J.; Bixler, D.; Helmkamp, J.C.; Kraner, J.C.; Kaplan, J.A. Fatal all-terrain vehicle crashes: Injury types and alcohol use. *Am. J. Prev. Med.* **2009**, *36*, 311–316. [[CrossRef](#)]
37. Bowman, S.M.; Aitken, M.E.; Helmkamp, J.C.; Maham, S.A.; Graham, C.J. Impact of helmets on injuries to riders of all-terrain vehicles. *Inj. Prev.* **2009**, *15*, 3–7. [[CrossRef](#)]
38. Bansal, V.; Fortlage, D.; Lee, J.; Kuncir, E.; Potenza, B.; Coimbra, R. A 21-year history of all-terrain vehicle injuries: Has anything changed? *Am. J. Surg.* **2008**, *195*, 789–792. [[CrossRef](#)]
39. Helmkamp, J.C.; Aitken, M.E.; Lawrence, B.A. ATV and bicycle deaths and associated costs in the United States, 2000–2005. *Public Health Rep.* **2009**, *124*, 409–418. [[CrossRef](#)] [[PubMed](#)]
40. Jennissen, C.; Harland, K.; Wetjen, K.; Peck, J.; Hoogerwerf, P.; Denning, G. A school-based study of adolescent all-terrain vehicle exposure, safety behaviors, and crash experience. *Ann. Fam. Med.* **2014**, *12*, 310–316. [[CrossRef](#)] [[PubMed](#)]
41. Jennissen, C.A.; Harland, K.K.; Wetjen, K.; Hoogerwerf, P.; O'Donnell, L.; Denning, G.M. All-terrain vehicle safety knowledge, riding behaviors and crash experience of Farm Progress Show attendees. *J. Saf. Res.* **2017**, *60*, 71–78. [[CrossRef](#)] [[PubMed](#)]
42. Jennissen, C.; Denning, G. The Effect of Passengers on All-Terrain Vehicle (ATV) Crash Mechanisms and Injuries. U.S. Consumer Product Safety Commission. ATV Safety Summit: Keeping Families Safe on ATVs, October 11–12, Bethesda, MD. Available online: <http://www.slideshare.net/USCPSC/atv-safety-summit-state-legislation-enforcement-the-effect-of-passengers-on-atv-crash-mechanisms-injuries> (accessed on 13 February 2019).
43. Bowman, S.M.; Aitken, M.E. Still unsafe, still in use: Ongoing epidemic of all-terrain vehicle injury hospitalizations among children. *J. Trauma* **2010**, *69*, 1344–1349. [[CrossRef](#)] [[PubMed](#)]



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