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Off-highway vehicle parks: Combining environment, knowledge, and enforcement for all-terrain vehicle injury prevention

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ABSTRACT

The number of off-highway vehicle (OHV) parks continues to grow to meet the recreational needs of ATV enthusiasts and the increasing popularity of the vehicle. Little is known about how OHV park regulations and enforcement affect ATV safety among their users. This study was designed to determine whether there were differences in crash mechanisms and/or compliance with ATV safety laws and regulations when comparing off-road ATV crashes inside and outside state OHV parks. Relative to outside the parks, a smaller percentage of park victims were under the age of sixteen, a lower percentage were passengers, and a dramatically higher percentage were helmeted. Mean injury severity scores were not different inside and outside the parks, but 5% of outside victims had severe brain injuries, as compared to no park victims. Overall, park victims exhibited better compliance with ATV safety laws and regulations and suffered less severe brain injury outcomes. However, park crashes involved more jump-related injuries, suggesting that additional approaches are needed to improve park safety. These findings support the hypothesis that riding environments with safety regulations and effective enforcement can promote safe behaviors and may prevent injuries.

1. Introduction

1.1. Epidemiology and risk factors for ATV crashes

ATV-related deaths and injuries have been an increasing public health problem over the past four decades and there remains a disturbing lack of safety culture around these vehicles (Allan et al., 1988; Bansal et al., 2008; Cvijanovich et al., 2001; Levenson, 2003; Lister et al., 1998). In 2011, the Consumer Product Safety Commission reported that ATV crashes result in over 700 deaths and over 150,000 emergency department visits each year in the United States (U.S.) alone. The total annual U.S. cost of these crashes is estimated to be over $4.3 billion (Helmkamp et al., 2008a, 2009).

The epidemic of ATV-related injuries can be attributed, at least in part, to the vehicle's increasing popularity, and the burgeoning sales of bigger and faster machines. Some models now weigh over 800 pounds and are capable of speeds over 80 mph (Consumer Federation of America, 2007). In 2008, the number of ATVs in the U.S. was estimated to be 10.2 million, greater than triple the number a decade earlier (Consumer Federation of America, 2007). ATVs can perform on diverse terrains and are used in agriculture, industry, and law enforcement. However, the vast majority of ATV use and the greatest cause of injuries is recreational riding (Fisher et al., 2009; Hendricks et al., 2005; Kute et al., 2007; Rodgers, 1993).

A number of risk factors for ATV crashes and injuries have been identified, among them being male, under 16 years of age, inappropriate vehicle size for age and maturity of operator, lack of helmet use, multiple riders on single-person machines, and riding on the road (Aitken et al., 2004; Gittelman et al., 2006; Hall et al., 2009; Rodgers, 2008; Shulruf and Balemi, 2010). Laws for ATV use vary from state to state, but rarely address all known risk factors. In addition, enforcement of these laws, particularly at off-road sites, is extremely challenging (Aitken et al., 2004; Beidler et al., 2009; Helmkamp, 2006; McBride et al., 2011; Oliverio, 2003).

1.2. Environment, knowledge, and enforcement of ATV safety

Environment can play an important role in reducing vehicle crashes, and engineering approaches, like dedicated bicycle trails (Librett et al., 2003), have proven an effective means of reducing injuries. In addition, some studies have reported a positive impact associated with state ATV laws (Bansal et al., 2008; Beidler et al., 2009; Keenan and Bratton, 2004; Upperman et al., 2003), whereas

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Table 1
Iowa's ATV laws and off-highway vehicle (OHV) park regulations.

State of Iowa ATV laws
All riding locations
No multiple riders on a single-person ATV (includes private property)
Riding while under the influence of intoxicating liquor or narcotics is prohibited
Vehicles must be registered with the DNR
Resident-owned ATVs must display a valid DNR registration
Nonresident-owned ATVs must display a valid nonresident user permit
Public property/lands (including OHV parks)
Age limits
<12 – only during a safety training course, or under direct supervision with continuous visual and verbal contact of an adult with a valid driver's license
12–17 – training and ATV safety certificate required
Riding in wildlife areas is prohibited
Careless, reckless, or negligent operation is prohibited
Speed greater than reasonable or proper under all existing circumstances is prohibited
ATVs may not exceed an engine noise limit above 96 dB
Headlights and taillights are required if riding after dark
Riding on the road is prohibited except for the agricultural exemption where
• Operation must be between sunrise and sunset
• Operator must have a valid driver's license
• Machine must be operated at speeds less than 35 mph
• Owner of land or the owner's family may operate an ATV in the ditch area that is adjacent to their property (they must stop riding at the end of their property boundary)
OHV park regulations
OHV park regulations (all parks)
All state laws apply
Helmets are required for all riders (and passengers if vehicle has a specifically designed passenger seat)
Vehicles must stay on the marked trails
OHV park regulations (selected parks)
Riders under 12 years of age are prohibited
UTVs (side-by-side) are allowed, maximum width 62 inches, vehicle must have ROPS, and riders must wear safety harnesses

others have described limited or no effects (McBride et al., 2011; Winfield et al., 2010). One should, however, consider a number of important aspects of this issue when interpreting these findings. For example, there are a large number of known risk factors – many of which are not covered by state ATV laws – that could confound study results on law effectiveness. There may also be a lack of knowledge of the laws among ATV users. In this respect, we found that primary care providers in our state, including those who were ATV users, were poorly knowledgeable of state ATV laws (Jennissen et al., 2012), and a survey of over 3000 middle school students in the state showed limited knowledge of both state laws and safety behaviors. Finally, law enforcement is an essential component of law effectiveness, and this was not measured in previous studies.

Because of the growing demand for recreational venues to ride ATVs, off-highway vehicle (OHV) parks have multiplied across the country. Our state has eight publically owned OHV parks that are maintained by private organizations and monitored by the Department of Natural Resources (DNR). Regulations in the parks overlap state laws, but also include mandated helmet use (Table 1). Regulations for park use are posted and DNR recreational safety officers monitor compliance during the busiest hours of park use. These OHV parks provide us an opportunity to examine how a dedicated riding environment, knowledge of regulations, and better enforcement might improve safety and thereby reduce the risk of injuries.

To address this question, we performed a retrospective study using our statewide ATV injury surveillance database. We compared off-road crashes inside and outside the state's OHV parks to determine whether there were any differences in rider behavior and/or injury mechanisms and outcomes.

2. Methods

2.1. Study design

We performed a retrospective study of ATV-related crashes and injuries that occurred off-road, outside and inside the state's OHV parks, from January 1, 2002 through December 31, 2009. Studies were performed using our statewide ATV injury surveillance database. Matching records from original data sources were identified using LinkPlus®, available from the Centers for Disease Control and Prevention (CDC), and final data reflect counting each crash victim only once. The University of Iowa Institutional Review Board (IRB) provided overall approval for the study.

2.2. ATV injury surveillance database

Our ATV injury surveillance database combines crash and injury records from three Iowa statewide sources. The Department of Transportation (DOT) monitors crashes on and adjacent to the roadway. Until 2005, the Department of Natural Resources (DNR) compiled all off-road crashes on public lands. Since 2005, only crashes on public trails and in OHV parks have been collected. The State Trauma Registry (STR) compiles data for all trauma patients from the state's trauma centers.

Each original database had some shared and some unique information relative to the other databases, and oftentimes different fieldnames and different coding systems for the same information. A standardized coding system was developed for the database. Research assistants compiled the original data and performed initial coding of narratives. The research scientist on the team independently checked all coding. Disagreements on coding were resolved by team discussion.

All data sources were well documented for demographics (gender, age). Consistent with their function, DOT and DNR records provided the highest number of crash and vehicle variables, but had highly limited injury information. Conversely, the STR provided detailed injury data, but was significantly more limited in documenting person-related (*e.g.*, helmet use), vehicle-related (*e.g.*, engine size) and crash-related (*e.g.*, crash mechanism and location) variables.

For injuries, the STR provided validated injury severity scores (ISS). The ISS is calculated by summing scores for the three most severely injured body regions, and values range from 0 to 75. The mean ISS scores were calculated by crash location. The ISS was also dichotomized to >15 (major trauma) and $\leq$15 for comparative analysis (Boyd et al., 1987). The Glasgow coma score (GSC) provided in the STR is a measure of the level of consciousness of a patient with a range of 3–15 and reflects the severity of brain injury. By accepted convention, GCS scores were categorized as no brain injury (GCS = 15) or as minor (GSC = 13–14), moderate (GSC = 9–12), and severe (GSC $\leq$ 8) brain injury. In addition, the GCS was dichotomized to the presence (GCS < 15) or absence (GCS = 15) of a brain injury for comparisons.

2.3. Data calculation and analyses

Descriptive analyses were performed for demographics, helmet use, crash and injury mechanisms, and injury outcomes using Microsoft Excel® 2008 version 12.3.5. For categorical variables (*e.g.*, gender), proportions were compared using the chi square test or the Fisher's exact probability test (cell sizes < 5) and the Vassar Website for Statistical Calculations, online at http://vassarstats.net/. For the continuous variable age, data were found to be non-Gaussian.