ATV Safety in Agriculture: Injury, Illness, Analysis and Interventions

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Abstract. All-terrain vehicles (ATVs) have been implicated in over 14,000 deaths since 1982 and continue to be a major public health transportation related hazard. An estimated 78% of riders use ATVs for recreational purposes and the remaining 22% use the vehicles for various occupational applications. Recent data analysis reveals a 300% increase in work related ATV deaths. The agricultural community bares the greatest burden, experiencing 65% of all occupational related fatalities occurring on the farm or ranch. An examination of 1230 cases reveal that patterns exist between agent, host and environmental factors. Haddon's energy transfer injury theory provides an opportunity to develop human factors and ergonomic safety interventions. This presentation will include some of the historical background on the expanding popularity of ATVs, epidemiology of injury and illness related to loss of control events, case studies that demonstrate a range of interventions and application of human factors principles.

Keywords: All terrain vehicles · Quad bikes · ATV · Injury · Fatality · Agriculture

1 Introduction

The introduction of all-terrain vehicles (ATVs) in the 1970s was well received in the US increasing to an estimated 11 million units and 35 million riders in 2016 [1] The ATV Safety Institute (ASI) estimates that 78% of riders use their ATVs for recreational purposes and 22% use them for occupational applications. Lagerstrom et al. evaluated workers' compensation data on ATV related injuries from Montana for years 2007 through 2012. That data identified various occupations and industry types that were using ATVs in various operations. That study found that the vehicles were used predominately in agriculture but also in other industries such as public administration, construction, professional and technical services, administrative support services, utilities, manufacturing, mining, retail trade, finance, insurance, and food services [2]. Over the past four decades ATVs have flourished in popularity and their increased applications in occupational settings.

In the agricultural community the ATVs were seen as versatile equipment that bridged the gap between horse and pickup truck or tractor and horse [3]. All-terrain vehicles are uniquely designed and well suited for the landscape common to farms and

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ranches. The vehicles are high-centered for ground clearance with low pressure tires that effectively grip travel surfaces, are mounted like a motorcycle, have a straddle seat, foot rests and are steered with handlebars [3]. The ATVs are manufactured in three common sizes to accommodate youth, juniors and adults users. Motor sizes and vehicle weights range from 90 cubic centimeters (cc) and less than 300 lbs. for youth models, 150 cc and 350 lbs. for juniors to 1000 cc and 800 lbs. for adult models that can travel at high speeds nearly 80 miles per hour [3]. The three-wheel vehicles that entered the market in 1970 were phased out in 1988 by decree and agreement between the industry and the Consumer Product Safety Commission (CPSC) as a result of the increasing injuries associated with ATVs.

2 Epidemiology

In 2010, the CPSC reported the adverse health impacts of ATVs peaked at an estimated 400,000 injuries per year resulting in 139,000 emergency room visits for medical care and nearly 800 fatalities experienced in 2008 [3]. The most recent data from CPSC indicated that 14,129 ATV fatalities had been investigated since 1982. In 2015, CPSC received 340 death notifications related to ATVs and estimated that emergency room visits declined to 97,000, see Table 1 [4]. The five states with the most deaths reported between 1982 and 2017 were Texas (780), California (703), West Virginia (725), Pennsylvania (697) and Kentucky (652), see Fig. 1 [5].

Evaluation of workers' compensation injury data from Montana revealed that gender and age were factors. Lagerstrom et al. found that 87% of those injured were male and 23% were 20 to 29 years of age. The next most frequently injured age group were 50 to 59 years of age comprising 20% of claims. These findings were contrasted to the CPSC 2015 data where injuries were highest among riders under 16 years of age making up 27% of emergency room visits. Whereas those between 16 and 24 years comprised 25% of the total and those 55 years and older group totaled only 7% of all visits [4].

Lagerstrom et al. reported that 59% of all Montana injury claims were from the agricultural sector [2]. These data supported previous findings from Helmkamp, Biddle, March and Campbell that found 65% of fatalities among all occupational sectors were from agriculture. Their investigation evaluated workplace ATV deaths between 2003 and 2006 and identified Montana as the state with the highest number of fatalities in that time period. Injury and fatality rates among all occupational users is on a sharp increase of 300% between the years 1992 through 2007 suggesting a crisis is looming [6, 7]. As occupational applications of ATV have increased, there is great concern about the dramatic increase in deadly events. Effective interventions are needed to curb the growing number of incidents among workplace users. Investigators evaluated 1230 ATV fatality cases from the CSPC using an agent, host environment model to assess causation and opportunities for interventions [8].

Table 1. Reported ATV-related fatalities (by Year); ATVs with 3, 4, or unknown number of wheels; reported for the period January 1, 1982 through December 31, 2015

Year	Reported number of deaths	Difference since last update (12/31/2014[a])
Total	14,129	+512
2015	340	+340
2014	547	+162
2013	581	+34
2012	573	−1
2011	622	−4
2010	650	−4
2009	720	−1
2008	759	+1
2007	832	−1
2006	831	−1
2005	799	0
2004	747	−6
2003	651	+ 1
2002	547	−3
2001	517	−3
2000	445	−2
1999	396	−1
1998	253	+ 1
1997	240	0
1996	249	0
1995	200	0
1994	198	0
1993	183	0
1992	220	0
1991	230	0
1990	235	0
1989	230	0
1988	250	0
1987	264	0
1986	300	0
1985	250	0
1984	156	0
1983	85	0
1982	29	0

Source; U.S. Consumer Product Safety Commission: Directorate for Epidemiology/Divsion of Hazard Analysis
Note: Italics indicate that reporting is ongoing for the years 2013-2015
Note: The heavy line marks the change from death certificate mortality coding under the Ninth Revision of the international classification of Diseases (ICD-9) to coding under the Tenth Revision (ICD-10)

[a]Comparison is relative to counts of reported death, in previous year's report which was based on incidents reported to CPSC by 12/31/2014. Further review of historic records revealed information supporting adjustments to date of death, vehicle classification (*i.e.*, ATVs with 4 wheels for which the number of wheels was not previously determined or out of scope vehicles such as utility vehicles), and scope. Application of alternative search schemes identified records that could be further associated as multiple reports of the same incident

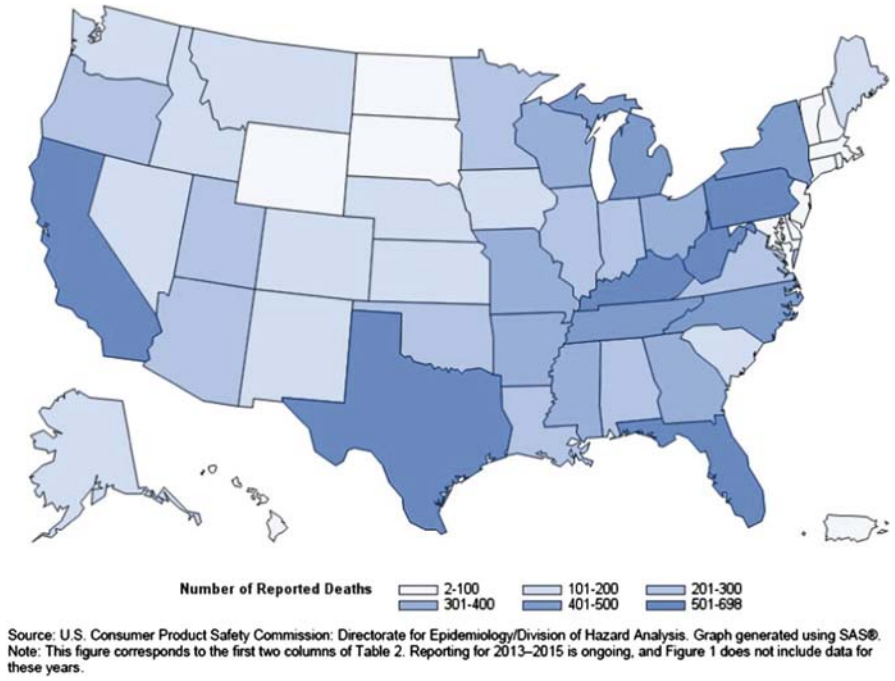

Fig. 1. Number of reported ATV-related fatalities by State (1982-2012)

3 Interventions

The ASI, in agreement with the CSPC, created a hands on, interactive rider course. The ASI has more than 2500 certified trainers nationwide that have trained nearly one million ATV owners [1]. The ATV safety training focuses on rider factors such as use of proper clothing, personal protective equipment, helmet use, pre ride check, starting, stopping, traveling up, down and across hillsides as well as managing obstacles. Additional interventions have been developed ranging from protective legislation and public health messaging to rollover protection devices. The agent, host and environment model provide an opportunity to consider strategies aimed at one or more aspect of energy transfer to mitigate or prevent the loss of control event and adverse health outcome. Training is directed at enhancing skills of the host while engineering devices are intended to improve agent performance. The transition of three to four wheel units was in fact, an engineering design change to improve stability of the ATV [3]. Unfortunately the benefits in safety derived through the introduction of the more stable quad bike were lost to the increasing size, power and speed of the ATVs [3]. In recent years more states have allowed ATVs on roadways resulting in more frequent auto-ATV collisions [8].

Legislation ranges widely from state to state and primarily is aimed at protection of youth and restricting ATVs from roadways. Between 2004 and 2014 the number of states allowing limited access to roadways increased from 22 to 35, more often among the

agricultural communities. Despite the decline in numbers of fatalities in recent years the incidence of road related injuries and fatalities is likely to increase with greater numbers of ATVs sharing roadways with other vehicles.

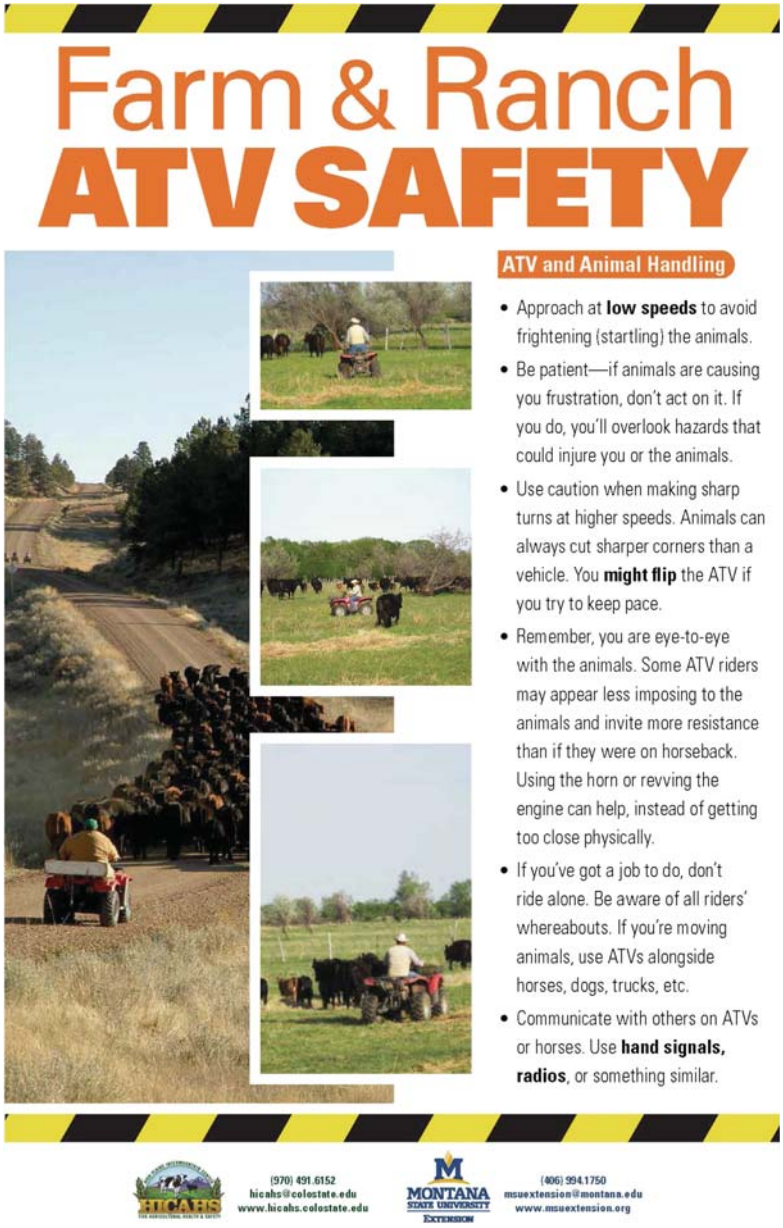

Fig. 2. ATV animal handling safety poster

Public health messaging has been used throughout agriculture communities to increase awareness of ATV related risks and hazards [9]. Investigators collaborated with extension agents and three local communities in Montana to develop an ATV safety tip sheet aimed at the common uses of ATVs on ranches. The four common job tasks included personnel transport, animal handling, fence mending and weed control. Posters and tip sheet were developed with community input and disseminated to all agricultural operations within McCone County, MT, see Fig. 2. Residents were surveyed about the effectiveness of the messages and relevance to their needs. Results from that investigation found that 97% had read the material, 93% felt that content was high quality safety and health information and 78% agreed that the information caused them to think about safety for themselves and/or workers and how to perform activities.

The development of rollover devices has been tested and found to reduce risk for crush injury [10–12]. Devices have become more common place in New Zealand and Australia where quad bikes are used widely in agricultural operations. The interest in stability and safety has led to the improved side by side, caged utility vehicles. Interventions aimed at the agent that reduce reliance on host skills and abilities provided added safety. Testing utility vehicles demonstrated that protected survival space is critical to reducing the probability for injury and that ATVs did not provide equivalent safety [13].

4 Future Studies

Future studies need to assess the effectiveness of training. While the ASI has trained nearly one million ATV owners in the US, an estimated 34 million riders may not have had training of any type. Exposure assessment using ergonomic instrumentation would be helpful to understand the demands and responses of the vehicle operator. Accelerometer and electromyography are useful tools in evaluating position and muscular response to stressors. While the data shows the newer caged utility vehicles are safer, seat belts must be worn and time is needed to determine if injury and fatality rates continue to fall. There remains over 10 million ATVs in the US being used and are not likely to be discarded. Market trends indicate that the new safer designs are gaining sales over the quadbike. The agriculture community is in need of multiple approaches to increase awareness and safety related to ATVs.

References

1. ATV Safety Institute: Industry background. (2016). http://www.atvsafety.org/downloads/INDUSTRY_BACKGROUND.pdf
2. Lagerstrom, E., Gilkey, D., Elenbaas, D., Rosecrance, J.: ATV-related injuries in Montana 2005–2012. Special issue - all-terrain (ATVs, quad bikes) and off-highway (ROVs, UTVs, SSVs, LSVs, LUVs, MUVs, XUVs). Safety **1**(1), 59–70 (2015). doi:10.3390/safety1010059
3. Government Accountability Office: ALL-TERRAIN VEHICLES, how they are used, crashes, and sales of adult-sized vehicles for children's use (2010) GAO-10-418 http://www.gao.gov/products/GAO-10-418

4. Consumer Product Safety Commission: 2015 Annual Report of ATV-Related Deaths and Injuries (2017). https://www.cpsc.gov/content/2015-annual-report-of-atv-related-deaths-and-injuries
5. Helmkamp, J.C., Biddle, E., Marsh, S.M., Campbell, C.R.: The economic burden of all-terrain vehicle related adult deaths in the U.S. workplace, 2003–2006. J. Agric. Saf. Health **18**, 233–243 (2012)
6. Helmkamp, J.C., Marsh, S.M., Aitken, M.E.: Occupational all-terrain vehicle deaths among workers 18 years and older in the United States, 1992–2007. J. Agric. Saf. Health **17**, 147–155 (2011)
7. Lagerstrom, E., Gilkey, D., Magzamen, S., Stallones, L., Rosecrance, J.: Understanding risk factor patterns in ATV fatalities: a recursive partitioning approach. J. Saf. Res. **59**, 23–31 (2016)
8. Consumer Federation of America: ATVs on roadways: a safety crisis (2014). http://www.consumerfed.org/pdfs/ATVs-on-roadways-03-2014.pdf
9. Lagerstrom, E., Hibiske, S., Gilkey, D., Rosecrance, J.: A case study: the development of safety tip sheets for ATV use in ranching. Safety, special issue - all-terrain (ATVs, quad bikes) and off-highway (ROVs, UTVs, SSVs, LSVs, LUVs, MUVs, XUVs). Safety **1**, 84–93 (2015). doi:10.3390/safety1010084
10. Franklin, R., Knight, S., Lower, T.: Mount Isa statement on quad bike safety. (2014). http://www.rrh.org.au/publishedarticles/article_print_2687.pdf
11. Lower, T., Trotter, M.: Adoption of quad bike crush prevention devices on Australian dairy farms. J. Agromed. **19**, 15–26 (2014)
12. Myers, M.: All-terrain vehicle safety-potential effectiveness of the quadbar as a crush prevention device. Safety **2**, 3 (2016). doi:10.3390/safety2010003. http://www.mdpi.com/journal/safety
13. Grzebieta, R., Rechnitzer G., Simmons K., Hicks D., Patton D., Mongiardini M., McIntosh A., Sherry D., Dal Nevo R.: The Australian Terrain Vehicle Assessment Program (ATVAP). In: Proceedings of the 24th International Technical Conference on the Enhanced Safety of Vehicles (ESV) Gothenburg, Sweden, June 8–11, 2015

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