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CHARACTERISTICS OF ALL-TERRAIN VEHICLES AND THEIR OPERATORS ON KENTUCKY FARMS

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CHARACTERISTICS OF ALL-TERRAIN VEHICLES AND THEIR OPERATORS ON KENTUCKY FARMS

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Nursing
at the University of Kentucky

By
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Lexington, Kentucky

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ABSTRACT OF DISSERTATION

CHARACTERISTICS OF ALL-TERRAIN VEHICLES AND THEIR OPERATORS ON KENTUCKY FARMS

All-terrain vehicles (ATVs) were first developed and marketed in the U.S. in the 1970s. They have soared in popularity for occupational and recreational uses since that time. In 2008, there were approximately 10.2 million all-terrain vehicles (ATVs) in use in the United States. In 2001, it was estimated that 23 million Americans rode ATVs; 69% were adults and 31% children (CPSC, 2003). Deaths and injuries from ATVs have increased over time. According to the U.S. Consumer Product Safety Commission, Kentucky led the nation for ATV deaths from 2002-2006, with increasing numbers of fatalities annually.

ATV use on farms is increasing across the country because the vehicles provide an efficient and reliable replacement for horses and tractors for farm work, such as checking livestock, feeding, or fence repair. Aging farmers and farmers with physical disabilities can often increase their productivity by using ATVs for their transportation needs on the farm. ATVs also serve as an inexpensive and popular recreational vehicle used by families especially in rural areas.

In 2001, there were an estimated 481 ATVs per 1,000 (CI95% ± 27) farms in the southern region of the U.S.

A literature review and a descriptive cross-sectional study were conducted. The specific aims of this dissertation were to:

1. Critically analyze the state of the science on ATV-related injury risk factors and explore recreational and occupational use of ATVs on farms.

2. Describe individual characteristics and demographic factors that are associated with ATV ownership and ridership among adult farmers.

3. Describe individual characteristics and environmental factors that are associated with ATV injury on farms.

4. Test models for predicting ATV ownership, ATV ridership, and ATV injury risk factors among adult farmers.

KEYWORDS: All-terrain vehicle, Occupational use, Risk factors, Injury prevention, Farmer.

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July 3, 2012
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CHARACTERISTICS OF ALL-TERRAIN VEHICLES AND THEIR OPERATORS ON KENTUCKY FARMS

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To Kyle, the love of my life, and Morgan Kylie and Claire Alice, the lights of my life.

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There were two special influences early in my career to whom I am eternally grateful. I experienced research for the first time interviewing spousal caregivers in Eastern Kentucky with Dr. Patricia Calico and was inspired by the people which made research tangible in my world. Dr. Ann Lyons guided me through my own first research project and attended my first ever poster presentation at a conference in Minneapolis. I aspire to leave a legacy of impacting students that Drs. Calico and Lyons laid the foundation for.

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CHAPTER ONE

Introduction

In 2008, there were approximately 10.2 million all-terrain vehicles (ATVs) in use in the U.S. (Consumer Product Safety Commission [CPSC], 2010). In 2001, it was estimated that 23 million Americans rode ATVs; 69% were adults and 31% children (CPSC, 2003). Machinery poses the greatest risk of injury and death to farmers (National Safety Council, 1991). Deaths and injuries from ATVs have increased over time. Between 1999 and 2005, there were an estimated 1.1 deaths per 10,000 ATVs (U.S. Government Accountability Office [GAO], 2010). Kentucky led the nation in ATV deaths between 2002 and 2004 (CPSC, 2007) and is 4th in the nation in cumulative ATV-reported deaths since the CPSC began collecting that information in the 1980s (CPSC, 2010). The CPSC estimated the cost of ATV injuries and fatalities in 2007 at $22.3 billion (US GAO, 2010).

In a national random sample of farm operators, about 900,000 reported having ATVs on their farms, for a total of 1.2 million ATVs (National Agricultural Statistics Service [NASS], 2008). Approximately 1.1 million of the ATVs on farms were used for occupational purposes at least some of the time. The purpose of this dissertation study was to add to the limited knowledge regarding use of ATVs on farms. The overall goal was to identify individual and farm environment characteristics that predict ATV ownership and ridership, and determine ATV injury risk factors for adult farmers.

Definitions

For this dissertation, ATVs are defined as three- or four-wheel motorized off-highway vehicles with large low-pressure tires for off road use, seats designed to be straddled by one person, and handlebars for steering (Specialty Vehicles Institute of America [SVIA], 2012). There are two types of ATVs; “four-wheelers” which manufacturers refer to as Type 1 ATVs intended for single operators with no passengers; and Type II ATVs designed with seating intended for use by multiple riders. ATV-related injury is defined as getting hurt or incurring an injury while using an ATV that interferes with participating in usual activities for at least 4 hours (Goldcamp et al., 2006).

Background

ATVs vary in size and speed depending on the purposes for which they are used. They were introduced in the United States for recreation in the 1970's (American Honda Motor Company, 2012). By the early 1980s there were two fast-growing markets for ATVs: racing and utility. Farmers were attracted to the utility of ATVs because they made tasks like limited and lightweight towing, spraying, seeding, and fertilizing easier (American Honda Motor Company, 2012). Manufacturers added racks for carrying tools and hay bales, as well as improving traction and adding a rear brake to help with traversing muddy fields and shallow water crossings (American Honda Motor Company, 2012). The ATV uses only 8% of the fuel used by tractors, making it economically desirable.

While there have been many studies illustrating the severity of ATV injuries using hospital records and fatality reports, only one national case-control study (Rodgers & Adler, 2001) has identified ATV injury risk factors including driver characteristics, driver use patterns, and ATV characteristics. In that study (*N*= 133 cases and 460 controls), injury risk was highest for children under 16 years of age and risk declined with age. Overall, males were three times as likely to be injured as females. Injury risk declined with more driving experience and with the proportion of time ATVs were used for *non-recreational* purposes but remained high. Injury risk rose as engine size increased (Rodgers & Adler, 2001).

The literature has not critically examined occupational use of ATVs as it has recreational use and the focus has primarily been on injuries and deaths from ATVs. Studies of ATV use and injuries on farms have focused on children (Hafner et al., 2010; Burgus, Madsen, Sanderson & Rautiainen, 2009; Goldcamp et al., 2006; Hendricks, Myers, Layne, & Goldcamp, 2005; Jones & Bleeker, 2005; Darragh, Stallones, Sample, & Sweitzer, 1998; Freeman, Whitman, & Tormoehlen, 1998). There are gaps in the literature related to occupational use of ATVs by adult farmers, whether farmers' ATV use patterns differ from the general population of ATV drivers, and risk factors for injury among adult farmers who ride ATVs.

Theoretical Framework

The first step of epidemiologic reasoning is to determine whether associations exist between exposure to environmental agents, characteristics of the person, and study outcomes. The epidemiologic triad (host-agent-environment) is an ecological framework that has been traditionally used to describe factors that can cause human disease and is basic to public health in analysis of infectious disease and injury control (Gordis, 2004).

The Institute of Medicine reported an emerging consensus that research and interventions related to public health problems should be based on ecological models (Gielen & Sleet, 2003). Ecological models of health behavior propose that behaviors are influenced by intrapersonal, sociocultural, policy, and physical-environmental factors. These multilevel models consider the connections between people and their environments and focus attention on the influence of the environment on health behavior (Sallis & Owen, 2002).

Bronfenbrenner's ecological model (1979) was chosen to guide this dissertation because it uses a lifespan systems approach, emphasizing the role of the environment in determining health behavior (Sommers, 2006). This model goes beyond the individual's characteristics or behaviors and recognizes environmental characteristics that may influence or interact with individual characteristics to create the conditions for injury to occur. The model is a good fit for this study because the farm is a unique setting where families conduct work and play/leisure activities all in the same environment. There are many influences in that environment that affect health behavior and ultimately risk for injury (Morrongiello, Marlenga, Bern, Linneman, & Pickett, 2007).

According to Bronfenbrenner (1979), the individual is a growing, dynamic entity that exchanges and interacts with the environment in two-directional reciprocity. The individual's characteristics are a result of the interaction between the person and the environment throughout his/her life (Bronfenbrenner, 2005). The environment is as it is perceived, and extends beyond the immediate setting, incorporating interconnections between settings as well as external influences from the larger surroundings (Bronfenbrenner, 1979). Bronfenbrenner's model is a set of nested structures with the developing person contained in the immediate setting analogous to a set of Russian dolls

(Bronfenbrenner, 1979). Figure 1.1 depicts the theoretical framework used to guide this dissertation related to ATV use and injury in adult farmers.

The first level of influence is the microsystem, which was the primary focus of this dissertation. It includes intrapersonal and interpersonal interactions with significant others in specific settings such as with family, friends, or colleagues. Active engagement of the individual and others with the individual is the most potent in affecting one's development (Bronfenbrenner, 1979).

Examples of interactions occurring between the members of a farm household and significant others in the immediate setting (microsystem), and their influence on behavior, are evident in the agricultural literature. Socialization to farming typically occurs within the family (Nichols & Schwartz, 1998). Women are increasingly becoming involved in family farm businesses (Field, 2002). When injuries occur on the farm, women are more likely to incur injury from being run over by tractors or other farm machinery or from contact with animals while tending to livestock. Women are also often injured while assisting their spouses in activities such as helping hitch equipment to tractors (University of Illinois Extension, 2011). Men are more likely to be injured while operating tractors or other farm machinery.

Examples of microsystem level individual characteristics included in the dissertation were risky behaviors, age and gender. Examples of risky behaviors that were measured were riding as or carrying a passenger on the ATV and lack of helmet use which were identified in the ATV literature. Even though they are not modifiable factors, younger age and male gender are significant risk factors for work-related, agricultural, and ATV-related injuries (Mongin et al., 2007; Smith et al., 2005; Dimich-Ward et al., 2004; Rodgers & Adler, 2001).

Prior injuries and dangerous risk-taking attitude are also predictors of agricultural injury (Westaby & Lee, 2003) included in the framework microsystem for the dissertation. Prior injury is a risk factor that made farm household members 2.6 times more likely to be injured (Mongin et al., 2007). Dangerous risk-taking attitude is also positively associated with agricultural injuries in adolescents (Westaby & Lee, 2003). It is defined as an individual's willingness to engage in activities that knowingly have

elements of physical danger which is the result of past experience with risk and influence of significant others' attitudes toward risk.

The mesosystem, or second level of influence, refers to interactions among the various settings in which the person actively participates. For an adult this could include the interrelations among family, work, and social life. Farm families are a part of the larger farm society. The majority of their work and play occurs within the geographic boundaries of the farm. One study described the farm environment as 'hazard rich,' emphasizing the interaction between children and the environment (Morrongiello et al., 2007). Interactions among child behavior, level of environmental risk, and child age contributed to farm injuries. There were no comparable studies with adult farmers. However, agricultural machinery, working close to or with animals, and falls have been significant sources of injury on farms (Mongin et al., 2007). The increasing number of machines used in farm operations has amplified the injury rate (Mongin et al., 2007; Hendricks, Goldcamp, & Myers, 2005; Suutarinen, 2004). Tractor fatality rates have historically been much higher in Kentucky than the national average for these fatalities (Cole, McKnight, & Donovan, 2009). As ATVs have become more popular and have begun to replace tractors and other farm machinery (Ruen, 2009), there will likely be a natural progression from higher tractor fatality rates to higher ATV fatality rates. Further, larger sized ATV engines have been associated with fatal crashes (Rodgers, 1990). Additional examples of mesosystem level factors include farm type, ATV size, and formal ATV training.

The exosystem, or third level of influence, refers to settings in which the person is not an active participant but the events that occur in those settings affect what happens to the person. An example is the larger social system that can affect individuals and settings through economic forces, cultural beliefs and values, and policies. Certain policies exempt farmers, such as state laws related to helmet use while operating ATVs (Kentucky Revised Statute 189.515 retrieved from www.lrc.ky.gov/). Federal (Moore & Magat, 1997; Rodgers, 1993) and state (Keenan & Bratton, 2004; Helmkamp, 2001) policies regarding ATV use have been successful in preventing ATV injuries and deaths but they vary widely among the states (Specialty Vehicle Institute of America, 2012).

These factors were not considered as part of the dissertation findings but are important to consider in future ATV research.

The fourth and final level is the macrosystem which refers to consistencies that exist, or could exist, in the subculture or culture as a whole. The notion that injuries are accidents rather than predictable and preventable events is an example that is pervasive in our society (Christensen & Morrongiello, 1997). A related theme in the agricultural literature is the acceptance by farmers that risk is a part of the farming culture (Sprince et al., 2003; Reed & Claunch, 2000). Hardaker et al. (2004), describes coping with agricultural risks by applying a risk aversion model to a number of agricultural risks from food safety issues and crop insurance to animal and crop diseases. In this dissertation, risk acceptance, was defined as a consistency in the farming subculture that describes the degree to which an individual accepts risk of injury as an ordinary, uncontrollable consequence of farming (Sprince et al., 2003). These four levels of influence from the ecological systems model were used to guide the development of dissertation study measures.

Specific Aims and Organization of the Dissertation

Based on gaps in the research on occupational use of ATVs, the specific aims of this dissertation were to:

1. Critically analyze the state of the science on ATV-related injury risk factors and explore recreational and occupational use of ATVs on farms.
2. Describe individual characteristics and demographic factors that are associated with ATV ownership and ridership among adult farmers.
3. Describe individual characteristics and environmental factors that are associated with ATV injury on farms.
4. Test models for predicting ATV ownership, ATV ridership, and ATV injury risk factors among adult farmers.

In Chapter Two of this dissertation, a critical review of the literature summarizes and interprets: (a) risk factors associated with ATV injury and death in the United States, and (b) the state of the science related to ATV use on farms or for agricultural purposes. Limitations of the current state of the science are discussed and recommendations for the

design of future studies to test the impact of education and policy-related interventions are provided.

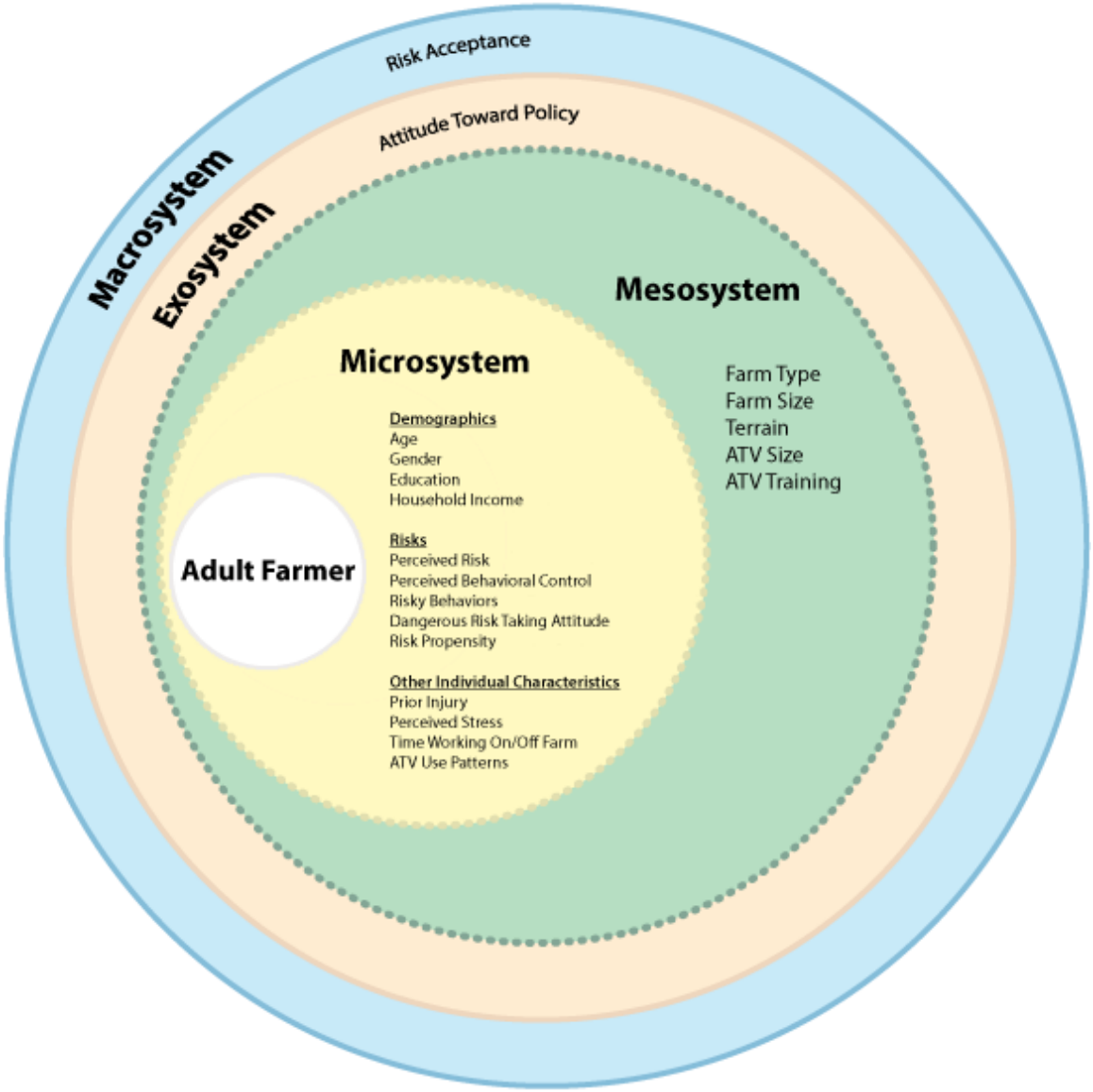
In Chapter Three, the results of a cross-sectional survey of a random sample of farmers is presented (*N*= 2292). The aims of the study were to: 1) describe the use of ATVs on farms; 2) determine the associations between individual characteristics of farmers and ATV ownership and ridership; and 3) determine predictors of ATV ownership and ridership. Descriptive analyses and frequencies were used to compare the characteristics of farmers who owned and did not own at least one ATV. Comparisons were also made between those farmers who reported ever riding an ATV and those who did not. The $\chi 2$ test was computed with odds ratios and confidence intervals for categorical variables. Comparisons for ordinal level variables were analyzed using the Mann Whitney U test. T-tests were performed to make comparisons between groups for interval level variables. Multivariate logistic regression was performed to examine the association between ATV ownership and farmer characteristics in the first model and ATV riding and farmer characteristics in the second model.

In Chapter Four, the results of a nested case-control study to determine the associations between ATV rider characteristics and behaviors, farm environmental factors, and self-reported lifetime ATV injuries are presented. A logistic regression analysis of predictors of ATV-related injury risk factors among adult farmers is included. This study compared 119 cases (farmers whose households owned at least one ATV at the time of the survey and self-reported at least one ATV-related injury in their lifetime) and 902 controls (farmers whose households owned at least one ATV at the time of the survey and did not report having been injured on an ATV in their lifetime). Prevalence-based case-control study methods were employed for the analysis. Chi-square tests of association and independent sample t-tests were used to identify relationships between variables. Logistic regression was used to identify predictors of ATV injury risk factors in this sample.

Chapter Five is an integrated discussion synthesizing dissertation findings to advance the state of the science on ATV-related injury and risk factors among adult farmers. Recommendations for practice and future research are provided. By learning

more about farmers' risk for ATV injury, interventions and policies can be developed and tested to reduce the risk of injury and save lives.

Figure 1.1 Theoretical Framework to Guide ATV Dissertation Research



Adapted from: Bronfenbrenner, U. (1979). *The Ecology of Human Development: Experiments by Nature and Design.* Cambridge: Harvard University Press.

CHAPTER TWO

Use and Risks Associated with All-terrain Vehicles on U.S. Farms

Abstract

Injuries and deaths attributable to individuals riding all-terrain vehicles (ATVs) have become a national public health problem. The purposes of this paper are to review the known risk factors associated with ATV injury and death in the United States and then evaluate the state of the science related to ATV use on farms or for agricultural purposes. ATV risk factors that contribute to morbidity and mortality in the general population of ATV users include younger age, male gender, lack of helmet use, riding as a passenger or carrying passengers, riding on public roadways, and larger sized engines. The majority of these risk factors are modifiable behaviors that can be addressed through educational strategies to change attitudes and behaviors and improve rider outcomes. The majority of research has focused on recreational ATV riding. ATVs are commonly used on farms for occupational purposes and recreation. A few studies of prevalence, use, and risk factors on farms have begun to emerge. The majority of those have focused on children. Major gaps exist in the literature on occupational use of ATVs.

Introduction

Injuries and deaths attributable to individuals riding all-terrain vehicles (ATVs) have become a national public health problem. Articles documenting crashes and ATV-related injuries began appearing in the research literature in the mid 1980s; slightly more than ten years after the first three-wheel ATVs were sold (McDonald & Stribling, 1983; Jenkerson & Middaugh, 1985). The purposes of this paper are to review the known risk factors associated with ATV injury and death in the United States and then evaluate the state of the science related to ATV use on farms or for agricultural purposes. Gaps are identified and needs for future research are suggested.

A literature search was done by reviewing the following research databases from 1985 to 2011: MEDLINE, AGRICOLA, Psychology and Behavioral Sciences Collection, and Health Source: Consumer Edition. Keywords used for the search were all-terrain vehicle, all-terrain vehicle injury, childhood injury, injury prevention, farm, and

agricultural injury. Additionally, the websites for the U.S. Consumer Product Safety Commission (CPSC), Natural Trails and Waters Coalition, and Specialty Vehicle Institute of America were used to obtain studies, and ancestry searching from the bibliographies of all sources was completed. This procedure yielded 138 studies. Single case reports and studies of ATV-injured patients with sample sizes less than 10 were excluded. Seventy-four peer-reviewed papers published in the United States since 1985 focusing on risk factors for ATV injury, types of ATV injuries, and ATV use on farms were selected for this review.

Background

All-terrain vehicles are four-wheel motorized vehicles with large low-pressure tires for off road use, seats designed to be straddled, handlebars for steering, and motorcycle-type engines (Rodgers & Adler, 2001) (See Figure 2.1). ATVs require active riding and vary in size and speed depending on the purposes for which they are used. ATVs for model years 2010/2011, advertised on four popular websites (www.usaatv.com, www.powersports.honda.com/, www.polarisindustries.com/, and www.kawasaki.com/), range from 180 pounds with a 110cm^3 engine, speed governor, and remote kill switch designed for a single youth up to vehicles that are 800 pounds with a 800 cm^3 engine, and exceeding 80 mph for a single adult rider. There were approximately 10.2 million ATVs in use in 2008 (the most recent year for which estimates are available) (CPSC, 2007). ATV ridership in 2001 was estimated at 23 million riders, consisting of whom 69% were adults and 31% were children (CPSC, 2003).

Deaths and injuries from ATVs have continued to increase over time. An estimated 134,900 people were treated in emergency rooms for ATV-related injuries in 2008, a 65% increase from 1999 (US GAO, 2010). The Consumer Product Safety Commission (CPSC) estimated the cost of ATV injuries and fatalities in 2007 at $22.3 billion (US GAO, 2010).

Federal and State Regulation of ATVs

The most effective public policy to decrease ATV-related injuries and deaths was the 1988 ATV Consent Decree

(http://www.cpsc.gov/library/foia/foia99/pubcom/consent4.pdf) by the Federal district court which was negotiated between CPSC and the ATV industry. Unfortunately, the decree expired in 1998. However, ATV manufacturers agreed to voluntarily: 1) cease production of three wheelers; 2) sell ATV engines 70 cc or larger only to children 12 and older and adult-size ATVs with engines in excess of 90 cc only to those aged 16 and older; 3) label ATVs to warn that children should not ride adult-size engines; 4) ensure that dealers comply with age recommendations and communicate them to purchasers; 5) launch a public awareness campaign to alert consumers of the hazards of ATVs; and 6) provide free training to ATV buyers and their immediate families (Rodgers, 1993; Moore & Magat, 1997).

Rodgers (1993) estimated that the decree reduced ATV sales by about 46%, resulting in 7% fewer injuries and 9% fewer fatalities between 1988 and 1990. Comparative risk analyses between 1985 and 1989 also provide evidence of improved driver safety behavior (Rodgers, 1993).

In 2008 Congress enacted the Consumer Product Safety Improvement Act which required the CPSC to adopt a mandatory industry standard for ATVs, ban importation and distribution of 3-wheeled ATVs, and require ATV manufacturers and distributors to file action plans prior to selling their products in the U.S. (US GAO, 2010). Under the Act, youth-size ATVs are defined by their maximum speed capabilities instead of engine size. The standard also requires adjustable speed governors on youth-size vehicles (US GAO, 2010).

In addition to these federal requirements, thirty-three states had minimum age requirements to drive ATVs and some states required adult supervision (Specialty Vehicle Institute of America [SVIA], 2012). Thirteen states required the operator to have a license to drive an ATV, 33 states required the ATV to be registered, and 30 required the ATV to be titled. Even though helmet use would decrease the number of ATV-related injuries and deaths, only 31 states had some form of helmet regulation. These laws were extremely variable in that some applied only to riding an ATV on public land; some exempted helmet use if riding the ATV for agricultural or other specific purposes; and some only applied to those under 16 or 18 years of age (SVIA, 2012). Special training was required by 24 states. States with no safety legislation (n= 7) from 1990 to 1999 had

a collective ATV death rate twice that of states that had either machine-related safety requirements (n= 23) or helmet and other safety equipment requirements (n=21) (Helmkamp, 2001). Keenan & Bratton (2004) compared Pennsylvania, a state with ATV legislation, to North Carolina, a state without ATV legislation. Helmet use was less common in North Carolina ($\alpha^2 = 32.8$, $p < .001$) and there were more children less than 11 years old injured or killed as a result of ATV use ($\alpha^2 = 4.5$, $p < .03$). Federal and state ATV legislation have resulted in safer ATV use.

ATV Risk Factors

A number of risk factors for ATV injury and death have been documented in the literature. While younger age and male gender are notable risk factors, most risk factors are modifiable behaviors of the ATV rider including: absence of helmet use, carrying passengers or riding as a passenger, riding the ATV on public roadways, and riding on ATVs with larger, more powerful engines not intended for use by children.

Younger age as a risk factor

Almost forty percent of the research conducted on ATVs worldwide since 1983 has focused on younger populations (Helmkamp, Furbee, Coben, & Tadros, 2008). The increased risk of injury in children under sixteen is attributed to their smaller size in relation to the size of the vehicle, lack of strength and motor skills, and poor judgment (American Academy of Pediatrics, 2000; American Academy of Orthopaedic Surgeons, 1999; Dolan, Knapp, & Andres, 1989). One in three children allowed to ride an ATV will be injured during the life of the vehicle and children are more than twice as likely to die in ATV-related incidents as adults (Maimon, 2002). Nationally, between 1982 and 2008, there were 2,588 ATV-related deaths among children under age 16 (27% of the total ATV fatalities recorded).

Rodgers and Adler (2001) conducted a national case-control study of injured ATV drivers reported through the CPSC National Electronic Injury Surveillance System, and found that the estimated ATV injury risk for children under 16 was the highest of all age groups. (CPSC, 2010). A total of 37,700 ATV-related injuries to children under 16 years were treated in emergency departments (ED); (28% of total ATV-related injuries treated in EDs). Risk generally declined with age. The odds ratio for children who

sustained ATV-related injuries requiring treatment in an emergency room relative to drivers over age 45 was 12.0 (95% CI: 4.6, 31.3).

Male gender as a risk factor

The literature consistently illustrates the higher injury risk among males who ride ATVs. The Consumer Product Safety Commission's injury and exposure studies (2003) estimated there were 13.5 million male ATV riders and 9.4 million female ATV riders in 2001. The injury estimates by gender for 2001 were 86,298 male riders injured and 22,832 females. Rodgers and Adler's (2001) national case-control study to determine and quantify ATV risk factors reported a significantly higher risk for males than for females (OR = 3.0; 95% CI: 1.6, 5.5). An ATV fatality database in West Virginia determined that males accounted for a death rate seven times greater than the female death rate (Helmkamp, 2008). Studies specific to children (Kute, Nyland, Roberts, & Hartwick-Barnes, 2007; Humphries, Stone, Stapczynski, & Florea, 2006; Prigozen et al., 2006; Brown et al., 2002; Bercher, Staley, Turner, & Aitken, 2001; Cvijanovich, Cook, Mann, & Dean, 2001; Lister et al., 1998; Lynch, Gardner, & Worse, 1998) have also shown that the male to female ratio of injured children is 2-3:1.

Absence of helmet use as a risk factor

Helmet use has been associated with a 64% reduction in the risk of head injury in nonfatal ATV crashes and a 42% reduction in fatal ATV-related crashes (Rodgers, 1990). In a 5 year national study of 11,589 patients hospitalized for ATV-related injuries, unhelmeted riders were more likely to sustain a traumatic brain injury than helmeted riders (OR 1.62, 95% CI 1.49-1.76, $p < 0.001$) and significantly more likely to die in the hospital (OR 2.58, 95% CI 1.79 – 3.71, $p < 0.001$) (Bowman, Aitken, Helmkamp, Maham, & Graham, 2009). Unhelmeted riders were slightly older than the helmeted (mean age 27.7 years vs. 25, $p < 0.001$), more likely to require a neurosurgical procedure (OR 2.60, $p < 0.001$), and more likely to have significant injuries to the neck and face regions (Bowman, et al., 2009).

A national probability sample of households owning ATVs was surveyed by telephone and 52% of those drivers reported frequently wearing helmets, 16% reported wearing them sometimes or rarely, and 32% reported never wearing them (Rodgers,

1999). In a West Virginia study of adults who died while operating ATVs, senior riders 65 or older were more likely to wear helmets (7%) than those under 65 (2%) (Helmkamp & Carter, 2009). Reported helmet use is much higher than actual use recorded in studies of those who have been injured or died in ATV-related crashes (Helmkamp & Carter, 2009).

Riding as a passenger and carrying ATV passengers as a risk factor

Although all ATVs were required to have warning labels recommending that no passengers ride on the ATV during the consent decree (www.cpsc.gov), since that time manufacturers have continued to include these warning labels on new ATVs. ATVs are designed to carry one person because they are rider-active vehicles, requiring the driver to stand or lean his/her weight in different directions depending on the slope or turn. Despite these warnings, 77% carry passengers, and 54% do so regularly. The mean reported passenger carrying time is 2.45 hours (SD ± 0.30) for every 10 hours of riding (CPSC, 2003). The estimated percent of children who are injured as passengers ranges from 17% (Lynch et al., 1998) to 31% (Brown et al., 2002). A survey of Illinois 4-H members between the ages of 8 and 18 who drive ATVs revealed that 50% carry passengers on ATVs at least occasionally (Hafner, Hough, Getz, Whitehurst, & Pearl, 2010). Girls are significantly more likely to be passengers than boys (Prigozen et al, 2006). A study of adolescent ATV-related deaths in West Virginia revealed that 8 of 25 (32%) of the fatally injured were passengers at the time of injury (Helmkamp, 2000).

ATV riding on public roadways as a risk factor

ATVs were developed for off-road use on rough, hilly, uneven terrain. Driving on paved roads more than doubles the risk of fatality associated with injury crashes (Rodgers, 1990). There were 220 ATV-related deaths in West Virginia during the 14-year period from 1990-2003 and nearly one-third of the ATV crashes occurred on public roads, streets, and highways (Helmkamp, 2003). Between 2004 and 2006, there were 112 fatal ATV crashes in West Virginia, of which 48% were traffic crashes (Hall et al., 2009). Some states prohibit riding on paved roadways or public highways (SVIA, 2012). No national studies were found that reported ATV-related deaths on public highways.

Larger ATV engine size as a risk factor

Larger, more powerful engines allow drivers to drive at faster speeds and create more dangerous situations. Fatal crashes are more likely on ATVs with larger engines (Rodgers, 1990) and engine sizes are known to increase with age of the rider (Rodgers & Adler, 2001). Engine sizes exceeding 90 cc are labeled for use by persons age 16 and over. However, the 1997 ATV exposure survey revealed that 95.9% of children under the age of 16 use ATVs intended for adults. The mean engine size for children under age 16 was 231 cc; for 16 to 24 year olds, 257 cc; and for drivers over age 24, 273 cc (Rodgers, 2001).

ATV risk factors that contribute to morbidity and mortality in the general population of ATV users include younger age, male gender, lack of helmet use, riding as a passenger or carrying passengers, riding on public roadways, and larger sized engines. The majority of these risk factors are modifiable behaviors that must be addressed through educational strategies to change attitudes and behaviors and improve rider outcomes.

Injuries Consequential to ATV Use

ATV crashes have produced serious injuries in every body system. Most studies of ATV injury capture only the most severe injuries because hospitalizations records in trauma centers and emergency departments are the most readily accessible. Many patients presenting to emergency departments with ATV-related injuries require some type of surgical intervention (Balthrop et al., 2007; Kelleher, et al., 2005; Bernard et al., 2003; Touma et al., 1999; Marciani, Caldwell & Levine, 1999; TerKonda, Greene, & Metzler, 1990).

The most documented ATV-related injuries have been to the extremities, central nervous system, and maxillofacial areas. Upper and lower extremity fractures are the most common of all injuries in most studies (Shults, Wiles, Vajani, & Helmkamp, 2005; Bhutta, Greenberg, Fitch, & Parnell, 2004; Murphy & Yanchar, 2004; Cvijanovich et al., 2001; Lister et al., 1998; TerKonda, Greene, & Metzler, 1990). Central nervous system injuries (head and spinal cord injuries) are frequent and sometimes combined with multiple system injuries (Balthrop et al., 2007; Brandenburg, Archer & Mallonee, 2005;

Kelleher et al., 2005; Carr et al., 2004; Injury Prevention Service, 2001; Russell et al., 1998; Gibbs, Lawrence, & Reilley, 1997). Head injuries are often the cause of death in ATV-fatality crashes and usually the victims are not wearing helmets (Brandenburg, Archer, & Mallonee, 2005; Smith, et al., 2005; Bhutta et al, 2004; Carr et al, 2004; Murphy & Yanchar, 2004; Injury Prevention Service, 2001). The neurologically injured who survive may leave the hospital with residual neurological deficits requiring more care in another facility or with home health and may have barriers to completing their activities of daily living and returning to work (Injury Prevention Service, 2001; TerKonda, Greene, & Metzler, 1990). Maxillofacial injuries have also received a fair amount of attention in the literature (Graham, Dick, Parnell, & Aitken, 2006; Shults, et al., 2005; Holmes, et al., 2004; Touma et al., 1999; Marciani, Caldwell, & Levine, 1999).

Injury severity varies by age. Injury Severity Score (ISS), Glasgow Coma Score (GCS), hospital length of stay (LOS), admission to intensive care (ICU), and number of surgical interventions are the most common measures used to describe ATV-related injury severity. Smith et al. (2005) found that the 12 to 15 year old age group compared to all other age groups had a higher ISS ($p = 0.044$), greater numbers of major head injuries ($p = 0.009$), and lower GCS ($p = 0.031$) which further emphasizes the need for ATV injury prevention among adolescents. Injury severity has increased over time (Kelleher et al., 2005; Killingsworth et al., 2005) but no studies have specifically associated injury severity with larger ATV engines or faster speed.

Injury severity has also been analyzed by comparing injuries resulting from ATVs to injuries from bicycle, motorcycle, and motor vehicle crashes. In children, boys are more often involved than girls in both bicycle and ATV crashes. However, compared to bicycle crash victims, ATV crash victims are older and more often white (Yanchar, Kennedy & Russell, 2006). Injury severity is greater in ATV crashes when measured by number of injuries, need for surgical intervention, and length of hospital stay (Yanchar, Kennedy & Russell, 2006; Brown et al., 2002). The most common mechanism of injury for both bicycles and ATVs is falling off the vehicle. Collisions with motor vehicles are more common for bicyclists than ATV riders (Brown et al., 2002).

Victims of motorcycle injuries are significantly older than victims of ATV injuries (29.1 ± 11.5 vs. 23.9 ± 9.4 years, $p < 0.001$). ATVs have been associated with

higher morbidity and mortality when compared to motorcycles (Acosta & Rodriguez, 2003). The median ISS for the ATV group (16.0) was higher than the motorcycle group (13.0, $p = 0.106$). There was a higher incidence of head and neck injuries in the ATV group (56% compared to 30%, $p < 0.001$). Mortality was 20% in the ATV group compared to 14.2% in the motorcycle group ($p = 0.236$) (Acosta & Rodriguez, 2003). Another study also found that patients injured in ATV crashes resulting in maxillofacial fractures have more neurologic impairment on admission and longer hospital stays than patients sustaining motorcycle injuries; however, the ISS, GCS, and maxillofacial AIS scores were similar between the groups of injured ATV drivers and motorcyclists (Holmes, et al., 2004). Fonesca et al. (2005) compared victims of motorcycle and ATV crashes that were admitted to one level 1 trauma center and found that there were significantly more pediatric and female patients in ATV-injury population compared to motorcycle injury population. The helmet usage for motorcycle was 64.7% vs. 8.6% in ATV users ($P < 0.001$). There were no significant differences in length of stay, number of severely injured patients (ISS >15), or mortality. Most patients in both groups had multisystem injuries. There were significantly more head injuries in the ATV group (54.2% vs. 44.9%) than in motorcycle group ($P < .05$).

ATVs have produced serious injuries to all body systems in all age groups. The most common injuries have been extremity injuries while the most serious have been central nervous system injuries. ISS, GCS, LOS, ICU days, and number of surgical interventions have been used to measure ATV-related injury severity. ATV riders are typically younger than motorcyclists, wear helmets less, and have more severe injuries.

ATV Use on Farms

The majority of research has focused on recreational ATV riding. ATVs are also used for occupational purposes such as law enforcement, agriculture, oil production, and construction (American Honda Motor Company, 2012). Occupational riders may be exposed to some of the same hazards as recreational riders (Occupational Safety and Health Administration, 2006). The Bureau of Labor Statistics reported 1,625 injuries and 113 fatalities that occurred in the workplace related to ATV operation between 1992 and 2001. Between 1990 and 2006, OSHA investigated 24 fatalities and 26 injuries related to the operation of an ATV (Occupational Safety and Health Administration, 2006).

Between 2000 and 2007 the number of occupational deaths from ATVs increased dramatically (193%) in comparison to the overall ATV deaths for that same time period (75%) (Helmkamp, Marsh, & Aitken, 2011). The only study that has truly analyzed occupational ATV-related deaths in adult workers utilized data from the annual Census of Fatal Occupational Injuries through the Bureau of Labor Statistics from 1992-2007 (Helmkamp, Marsh, & Aitken, 2011). Five national, one regional, 10 state-specific, and one local research study in this review included some aspect of ATVs on farms (Table 2.1). These were primarily descriptive studies. Eight focused on children; one was about older adults; and one studied women.

ATV prevalence on farms

All-terrain vehicles are commonly used on farms. The 2006 Farm and Ranch Safety Survey (NASS, 2008) estimated 900,000 farm operators had ATVs on their farms. The total estimate of ATVs on farms was 1.2 million with an estimated 1.1 million of those used for farm work at least some of the time by the farm operator (NASS, 2008). The Midwest and South regions were estimated to have the majority of ATVs on farms (480,000 and 478,000, respectively). The first study that we know of to estimate ATV ownership among adult farmers discovered that 857,665 ATVs were in use on U.S. farms with a range of 0-19 ATVs per farm and an average of 0.5 ATVs per farm (Goldcamp et al., 2006). The estimated average ATV ownership rate was 519 (± 16) ATVs per 1,000 farms, with the highest rates in the West, and Midwest regions of the U.S. The usage pattern (times/month) was higher in the West, Midwest, and South regions compared to the Northeast region.

ATV use by children on farms

Several studies provide insight into the prevalence and use of ATVs by children on U.S. farms; however, there is very little information on adult use. A national study of children under 20 years who completed the Childhood Agricultural Injury Survey cited that 36% of farm youth operated an ATV in 2001 and that youth under age 16 are more likely to operate ATVs than a tractor (Goldcamp, Myers, Hendricks, Layne, & Helmkamp, 2006). A national study of minority farms found that 23% (6,514) of youth living on the farm drove an ATV (Hendricks, Myers, Layne & Goldcamp, 2005). A

random sample of junior and high school agricultural students in Arkansas reported that a significantly larger percentage of farm youth rode ATVs when compared to their nonfarm peers (74% versus 41%, OR = 4.04, 95% CI 2.90-5.64). Nearly 88% of youth 4-H Club participants in Illinois who lived on a farm or in a rural location reported driving an ATV in the past 6 months (Hafner, Hough, Getz, Whitehurst, & Pearl, 2010).

ATVs are often used in the course of work and recreation on the farm so it is difficult to determine if the risk factors are similar for both types of ATV use. It is also complicated to differentiate ATV-related work injuries from recreational injuries. Adolescent FFA members in Colorado who participated in focus groups discussed taking more risks while playing than while working, but explained that often play occurs in the context of work on the farm and both involve the same machinery such as ATVs. They described bending or breaking safety rules based on their personal assessment of the risk involved. These adolescents agreed that the age to start driving ATVs was 4 to 7 years old (Darragh, Stallones, Sample, & Sweitzer, 1998). A study of youth attending a National FFA Convention cited 70% used ATVs for work and recreation, 7% used ATVs only for work, and 23% used ATVs only for recreation (Burgus et al., 2009). Jones & Bleeker (2005) found that only one in four youth used ATVs primarily for work-related activities.

Risky behaviors

Risky behaviors that have caused ATV-related injury and death in the general population are also prevalent in the ATV riders on farms, but it is unclear if those risks play the same role on farms. A regional study was conducted in five Midwest states to learn about injuries to children in farm households during 1990. The injury rate ratios were slightly higher for children in farm households who worked with beef cattle, operated a harvester, and lived where ATVs were in use compared to children in farm households without these exposures (RR 1.64, 95% CI 1.00 to 2.68) (Gerberich, Gibson, French, Renier, Lee, Carr & Shutske, 2001). A study of Arkansas youth showed two significant predictors of injury: number of days per week the ATV was ridden and number of passengers on the ATV the last time it was ridden (Jones & Bleeker, 2005).

Reported helmet use on farms has been low. Hafner et al. (2010) reported helmet use in youth 4-H Club participants who rode ATVs was about 39%. Nearly 23% of those

youth rode ATVs to perform work on farms. Another study found helmet usage was 20% in farm youth and nonfarm peers who rode ATVs (Jones & Bleeker, 2005). A study of farm women in Louisiana found that helmet use was 11.6% and that there was no statistically significant difference in helmet use when riding ATVs by number of hours worked on the farm (Meeker, Carruth, Holland, 2002). No other studies were discovered that addressed ATV helmet use among adult farmers.

Participation in ATV safety training on farms was also low, ranging from 14.6% to 22% in farm youth (Hafner et al., 2010; Burgus et al., 2009). Burgus et al. (2009) found that helmet use was more common among farm youth who reported attending safety training (60% vs. 39%, $p < .0001$). Other studies supported that the majority of farm youth operated or rode on ATVs with engines larger than recommended for their age (Hafner et al., 2010; Goldcamp et al., 2006). Riding on paved surfaces was more common among those youth who had suffered ATV-related injuries (18% vs. 10%, $p = .006$) (Burgus et al., 2009).

Crashes and injuries on farms

The literature documents ATV-related crashes and injuries on farms. Sixty-seven percent of 280 Illinois youth 4-H Club of American participants had experienced a crash on an ATV in the past 6 months. Forty-four percent reported ATV-related injury (Hafner, Hough, Getz, Whitehurst, & Pearl, 2010). A Wisconsin surveillance study of off road vehicular injuries that included snowmobiles and ATVs noted 182 ATV crashes, including 64 farm residents. Injured farm residents were more likely to be less than 18 years compared to injured nonfarm residents ($\chi^2 = 6.344$, $p = 0.0118$) (Stueland & Zoch, 1995). A random sample of Utah Farm Bureau members who were surveyed about injuries occurring in the past 3 years determined there were 1.8 injuries per 100,000 hours of ATV exposure (Miller, Webster, & Mariger, 2004). In a series of 1,832 pediatric trauma patients injured on farms, 20% of the injuries to children under 18 years of age were due to ATVs (Little, Vermillion, Dikis, Little, Custer, & Cooney, 2003). A newspaper clipping service in Arkansas was used to identify farm injuries over an 11-year period. There were 318 cases of ATV incidents on farms during that period. It was unknown whether or not agricultural work was involved (Huitink, Struttmann, & Perkins, 2005).

Occupational ATV deaths

Sixty-eight percent of those killed while using ATVs for work were in the agriculture/forestry/fishing/hunting industry sector and 89% from that sector were involved in agriculture production. Eighty percent of crash victims from this industry sector were involved in non-highway events. Compared to all other worker groups, the highest risk of fatality from ATVs was in agriculture production workers 65 years and over. Helmkamp & Carter (2009) looked at ATV-related deaths in older adults in West Virginia and discovered that 39% (11 of 28) of the deaths between 1999 and 2007 occurred on farms. This study raises questions about the rising proportion of older adults who continue to farm full-time or part-time in retirement and who use ATVs to do their work (Helmkamp & Carter, 2009). ATVs are common on farms and are used for both work and recreation by those of all ages. A 20-year prospective cohort study in Keokuk County, Iowa found that members of farm households were more than twice as likely to have ridden an ATV in the last year as other community members (Merchant et al., 2002).

Discussion

ATVs have soared in popularity since the 1980s and become a significant source of injury and death. This review summarizes the prevalence and use of ATVs, ATV-related risk factors, and injuries and deaths. A few studies of prevalence, use, and risk factors on farms have begun to emerge. The majority of those have focused on children. Major gaps exist in the literature on occupational use of ATVs. It is difficult to differentiate between work-related and recreation-related ATV injuries and deaths on farms.

Overall, the ATV injury prevention literature has four major limitations: (1) non-representative samples; (2) age bias; (3) recall and self-report bias; and (4) lack of information about normative ATV behaviors. First, this literature review revealed a plethora of descriptive studies. These types of studies summarize ATV risks and injury outcomes, yet their primary reliance on small, non-random samples fails to provide generalizable evidence about ATV use patterns, rider characteristics such as behaviors, attitudes, and specific risk-taking that may contribute to injury and death, and is biased

toward the most severely injured. The lack of nationwide or even statewide surveillance has resulted in lack of data on patients who are treated and released from emergency departments or community hospitals. In addition, the geographic location of these studies is not widespread. National studies are needed due to differences in terrain, public policy, and potential difference in usage patterns, and need to be incorporated into existing surveillance. There have only been a handful of case-control and population focused studies and very few studies using a random selection of participants (Table 2.1).

Second, the bulk of ATV research focuses on children. There is scant information about adults and older adults who are injured or killed on ATVs, and these older groups make up the majority of the ATV ridership.

Third, recall and self-report bias are major limitations of the survey studies. Some study participants are contacted long after their injuries and may not recall the incident accurately. The issues surrounding ATV use are sensitive with regard to rider behavior and decision-making with variations in restrictive regulations in individuals may provide socially desirable responses about helmet use, participation in safety training, use of adult-sized vehicles in children, and riding on public roadways.

Fourth, due to the lack of focus on the population of ATV riders versus those who are injured, little is known about normative ATV behaviors. Without knowledge of the general population of ATV riders, it is difficult to make subgroup comparisons, such as occupational ATV users. There are many descriptive studies documenting ATV-related morbidity and mortality. However, some studies report injury frequencies while others report estimated rates per number of riders. If more studies used standardized measures, such as Gerberich et al. (2001) who reported injury rate ratios, they would yield more meaningful results. Currently it is very difficult to define the real scope of the problem and the trends in ATV injuries given there is no standard measure of ATV injury prevalence.

Research needs to move beyond describing the problem to testing the efficacy of evidence-based public health interventions to prevent injury and protect riders of all ages. Surveillance needs to be designed to collect detailed information about circumstances surrounding individual crashes, including whether they occurred during recreational or occupational use. Researchers need to describe parent and youth rider perceptions of

ATV risk and safety. Public policy and educational strategies to prevent injuries need to be implemented and evaluated. Despite the 1988 Consent Decree and warning labels, ATV use continues to escalate across all ages. Public policy related to helmet use and riding on public roads must be enacted and enforced. The documentation of ATV-related health care costs could be a significant strategy to persuade lawmakers that preventable ATV injuries and deaths are a financial burden to society. Finally, it is unclear if occupational exposure to ATVs produces the same risks as recreational riding.

Table 2.1 Overview of Research Studies about All-terrain Vehicles on Farms By Scope of Study (National to Local)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
National (*n*=5)					
Helmkamp, Marsh, & Aitken, 2011	Summarize characteristics of work-related ATV deaths among civilians ≥ 18 years in U.S from 1992 to 2007	Retrospective review	297 civilians who died from work-related ATV events	Bureau of Labor Statistics' Annual Census of Fatal Occupational Injuries	• 92% male, 93% white • Half of incidents involved overturns resulting in head and chest injuries • 60% of crashes occurred on farms and 20% on highways • Fatality rate among agricultural production workers significantly higher than the rates in all other industries • Death rates increased with age from 0.08/1,000,000 workers for 18-34 age group to 1.14/1,000,000 workers in ≥ 65 age group

Table 2.1 (Continued)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
Burgus, Madsen, Sanderson, & Rautiainen, 2009	Describe youth riding ATVs	Cross-sectional	Convenience sample of 624 survey respondents 12-20 years old representing 43 states 69% lived on farms	Survey at 2005 National FFA Convention	• 77% reported family owned ATV, 97% of sample ride ATVs • Median age started riding 9 years, mean 9.5 • 70% use ATV for work and recreation, 7% work only, 23% recreation only • 24% always wore helmet • 12% never allowed passenger • 19% never rode on paved roads • 22% had safety training • Helmet use was more common among those who attended safety training (60% vs. 39%, $p < .001$) • Riding on paved surfaces was more common among the injured (18% vs. 10%, $p = .006$) • Nearly all ATVs > 90cc

Table 2.1 (Continued)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
National Agricultural Statistics Service, 2008	Inquire about tractor use and other safety and health issues associated with the farm operators' farm	Cross-sectional	Random sample of 25,000 farm operations in U.S.	2006 National Farm and Ranch Safety Survey	• 900,000 operators had ATVs on farm for a total of 1.2 million ATVs • 1.1 million were being used for farm work tasks at least some of the time by the farm operator
Goldcamp, Myers, Hendricks, Layne, & Helmkamp, 2006	Provide estimates of ATV ownership and exposure on US farms and overview of injuries to youths from ATV use on the farm	Cross-sectional	Random sample of 30,744 farms in US	National Institute for Occupational Safety and Health and US Department of Agriculture 2001 Childhood Agricultural Injury Survey	• 36% of estimated 1.1 million youths living on farms had operated an ATV in 2001 • Those younger than 16 years were more likely to have operated an ATV than a tractor • 2,246 nonfatal ATV-related injuries occurred to youths younger than 20 and 74% were identified as members of farm household • Males accounted for 69% of injuries and the majority of injuries (70%) were in 10-15 year olds • 58% (970) ATV injuries were result of recreational use

Table 2.1 (Continued)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
Hendricks, Myers, Layne, & Goldcamp, 2005	Investigate the hazards faced by youth living on minority operated farms	Cross-sectional	Random sample of 27,170 minority operated farms	2008 Minority Farm Operator Childhood Agricultural Injury Survey	• Estimated 28,600 household youths on minority operated farms • 23% minority household youth operated ATVs • Youth on Native American farms were more likely to be exposed to ATVs than youth on Asian farms • 1 of every 12 injuries to these youth is associated with operating an ATV
Regional (*n*=1)					
Gerberich, Gibson, French, Renier, Lee, Carr, & Shutske, 2001	Identify the incidence and consequences of farming and non-farming related injuries and potential risk factors for farming related injuries among children and youth (0-19 years) who lived in farm households in a large region of the U.S.	Prospective Cohort study	Random sample of 3939 farm households	Regional Rural Injury Study-I cohort database	• Injury rate ratios were slightly higher for children in farm households who worked with beef cattle, operated a harvester, and lived where ATVs were in use (RR 1.64, 95% CI 1.00 to 2.68).

Table 2.1 (Continued)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
State (*n*=10)					
Hafner, et al., 2010	Describe the typical ATV safety and use patterns of rural youth.	Cross-sectional	280 youth (8-18 years) members of 4-H Club of America in four Central Illinois counties	Mail survey	• Majority of respondents were adolescent males from farms or rural locations • 60% drove ATVs ≤ 1 day/month • 36% used ATVs for recreation and 23% for work • 61.4% never wore helmets on ATVs, 14.6% had safety education • 67% had experienced an ATV crash and 44% of those were injured • Children with safety training had fewer crashes (P = .01)

Table 2.1 (Continued)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
Helmkamp & Carter, 2009	Describe the epidemiology of ATV deaths among persons ≥ 65 years in West Virginia 1999-2007	Retrospective review	39 older adults fatally wounded in ATV-related events	Death certificates identifying ATV fatalities based on ICD-10 diagnostic codes	• 38/39 deaths were in men and the mean age was 71 years • When comparing the 2 time periods 1985-98 and 1999-2007, there was in increase in deaths from 11% to 28% • Injuries to the upper and lower trunk were most common (62%) and head and neck injuries were the second most common (28%) • Fatality rate increased from 0.37/100,000 in 1990 to 2.14/100,000 in 2007
Jones & Bleeker, 2005	Determine differences in ATV-related behaviors, exposures, risk factors, and injuries between farm youth and nonfarm peers.	Cross-sectional	652 youths in agricultural education programs throughout Arkansas	Survey	• 60% had operated an ATV in past month • Those who rode ATVs were more likely white and male • Frequency of use and number of riders were risk factors for ATV-related injury

Table 2.1 (Continued)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
Huitink, Struttmann, & Perkins, 2005	Review the types of agricultural injuries occurring on Arkansas farms over an 11-year period	Prospective review	482 cases of injuries excluding ATV-related injuries	Newspaper clipping service	• 318 ATV cases were identified but excluded from study because it was not possible to confirm whether a work situation was involved
Miller, Webster, & Mariger, 2004	Identify the source and frequency of agricultural injuries in Utah	Cross-sectional	Simple random sample of 360 Utah agriculturalists	Mail survey	• Respondents were 19-93 years old, mean age 55.4 years • Activities with greatest number of injuries were working with livestock other than horses, working with horses, and servicing agricultural machinery other than tractors • The individual 3-year exposure for operating ATVs was 724 hours with 2 reported injuries and 1.8 injuries/100,000 hours
Little, et al., 2003	Describe a series of pediatric trauma patients injured on farms in Texas between 11/94 and 8/01.	Prospective review	Convenience sample of 1,832 trauma patients under 18 years	Institutional trauma registry	• 20% of injuries to kids on farms were related to ATVs

Table 2.1 (Continued)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
Meeker, Carruth, & Holland, 2002	Explore and describe health hazards affecting farm women in southeast Louisiana, preventive measures used by farm women, and their use of protective equipment with varying levels of time commitment toward farming operations.	Cross-sectional	Stratified random sample of 519 farm women	Louisiana Farm Health and Injury Survey Instrument	• No difference in helmet use on ATVs based on working 1-20 hours per week or more than 20 hours per week (11.6% for those working 1-20 hrs/week and 10.7% for those working more than 20 hrs/week)
Freeman, Whitman, & Tormoehlen, 1998	Establish realistic baselines concerning child safety practices for populations in rural Indiana	Cross-sectional	Random sample of Indiana farms stratified by county	Survey	• 29% reported children operate ATVs on their farm • 42% indicated children were "always" required to wear helmets on ATVs
Darragh, Stallones, Sample, & Sweitzer, 1998	Investigate perceptions of safety, behavior, and hazards of children working on farms	Focus groups	36 adolescents, age 14-18 who were members of FFA in eastern Colorado	Focus group interviews	• Adolescents have been at risk of injury on the farm while working, playing, and playing in context of work • Recognize importance of safety rules but often bend or break them based on personal assessment of risk • Take more risks while playing but both often occur together

Table 2.1 (Continued)

Author, Year	Study Aims	Design	Sample	Data Sources	Findings
Stueland & Zoch, 1995	Examine off road vehicles as agents of injuries in Central Wisconsin	Retrospective review	330 victims of off road vehicle mishaps between 1989 and 1992	Surveillance through an urgent care center	• 64 victims were farm residents but it is not reported how many of those were ATV events vs. snowmobiles • 182/330 events were associated with ATVs • Injured farm residents were more likely to be under age 18, more likely to be using the vehicle on their own property, and less likely to be using vehicle for recreation
Local (*n*=1)					
Merchant, et al., 2002	Describe, measure, and analyze prevalent rural and agriculturally related adverse health outcomes and their risk factors in Keokuk County, Iowa	Prospective cohort study	1,000 rural households (farm households were oversampled with 23% being farms)	In-person interviews, medical screenings, and environmental assessments of farms and homes	• Farmers were more than 2 times as likely to have ridden an ATV in the last year as other community members

Figure 2.1 Four-wheel all-terrain vehicle (ATV)

CHAPTER THREE

Predicting All-Terrain Vehicle Ownership and Ridership Among Farm Households

Abstract

All-terrain vehicles have grown in popularity for recreational and workplace use in the United States (US GAO, 2010; Helmkamp, Marsh, & Aitken, 2011). The US Consumer Product Safety Commission reported that from 1997 to 2001 ATV ownership increased by 39.5% and riding hours by 44.8% (CPSC, 2003). The purposes of this study were to: 1) determine if there were associations between individual characteristics and all-terrain vehicle (ATV) ownership and ridership, and 2) determine what characteristics of farmers predict whether they own or ride ATVs. Fifty-three percent (1,208) of the survey participants owned at least one ATV on their farm. Younger age, male gender, and fewer years of education were the significant predictors for ATV ownership. Younger age, male gender, and dangerous risk-taking attitude were the variables found to be significant in predicting ATV ridership in this sample of farmers. Future research is needed to examine the prevalence of ATV use on farms, and test the efficacy of educational ATV interventions to decrease ATV-related injury. Implications for policy change include tightening ATV regulations through registration and licensing, mandating formal ATV training, enforcement of safe riding behaviors and requiring personal protective gear.

Introduction

Farming was the most dangerous profession in Kentucky even before the surge in ATV popularity on farms (NASS, 2006). Kentucky led the nation in ATV deaths between 2002 and 2004 (CPSC, 2007) and is 4th in the nation in cumulative ATV-reported deaths since the Consumer Product Safety Commission first began collecting that information in the 1980s (CPSC, 2010). The purposes of this study were to: 1) determine if there were associations between individual characteristics and all-terrain vehicle (ATV) ownership and ridership, and 2) determine what characteristics of farmers predict whether they own or ride ATVs. Gaining a better understanding of which farmers are more likely to own and/or ride ATVs will assist in developing more specific education and training

interventions, and will help determine the target audience for these interventions to prevent ATV-related injury on the farm.

Background

All-terrain vehicles have grown in popularity for recreational and workplace use in the United States (US GAO, 2010; Helmkamp, Marsh, & Aitken, 2011). The US Consumer Product Safety Commission reported that from 1997 to 2001 ATV ownership increased by 39.5% and riding hours by 44.8% (CPSC, 2003). In 2001, a subsample of 16,456 adults was added to the Childhood Agricultural Injury Survey (Goldcamp et al., 2006). This was the first study that we know of to estimate ATV ownership on farms. The study discovered that 857,665 ATVs were in use on U.S. farms with a range of 0-19 ATVs per farm and an average of 0.5 ATVs per farm. The estimated average ATV ownership was 519 (± 16) ATVs per 1,000 farms, with the highest rates in the West, and Midwest regions of the U.S. The usage pattern (times/month) was higher in the West, Midwest, and South regions compared to the Northeast region. Sixty percent of ATVs were used 10 or more times per month on the farm. There was no difference in rates of ownership based on farm type; however, ATV usage (times/month) was slightly higher on livestock farms compared to crop farms. Thirty-six percent of farm household youth operated an ATV in 2001 but estimates for adult use were not reported in this study.

An Iowa study of 1,000 rural households found that farmers were twice as likely to have ridden an ATV in the last year compared to other adults in the community (Merchant et al., 2002). In 2006 it was estimated that about 900,000 farm operators had ATVs on their farms (NASS, 2008). Approximately 1.1 million of 1.2 million ATVs were used for occupational purposes by the farm operator some of the time. A 2008 survey by the U.S. Government Accountability Office estimated more than 10 million ATVs were in use by 16 million persons and between 20 and 25% of respondents used their ATVs for “work and chores” (US GAO, 2010).

ATVs have become increasingly popular for accomplishing farm work. A technical bulletin on safe use of ATVs in agriculture describes the following uses of ATVs on farms: inspect crops and livestock, repair irrigation systems and fence lines, fertilize and apply chemicals, herd livestock, mark timber, mow grass, move dirt and transport items (Murphy & Harshman, 2005). ATVs are also used as a mobility device

for those individuals with disabilities who want to maintain an active role in the farm operation.

The Occupational Safety and Health Administration published a bulletin on hazards associated with ATVs in the workplace in 2006 which infers that persons who use ATVs in their jobs are exposed to similar safety issues that are common to other riders who have experienced injuries and deaths (OSHA, 2006). Between 1992 and 2007 work-related deaths involving ATVs increased 275% (Helmkamp, Marsh, & Aitken, 2011). During that study period, 50% of those who died while operating an ATV in the workplace were self-employed or working in a family business and 45% were working for pay. Sixty-eight percent worked in the agriculture/ forestry/ fishing/ hunting industry sector. Younger age, male gender, working on farms with large numbers of livestock, more than 50 hours per week of work on the farm, having more than a high school education, and dangerous risk-taking attitude are risk factors that have been associated with injury in agricultural settings (Blair et al., 2005; Smith et al., 2005; Sprince et al., 2003; Westaby & Lee, 2003) but these factors have not been examined for ATV injuries in particular. More study of ATV ownership, use, and risk factors for injury on farms is needed to guide injury prevention efforts. This study will help fill the gap for Kentucky by determining factors that predict ATV ownership and ridership and inform strategies for ATV-related morbidity and mortality on farms.

Methods

Design

This was a cross-sectional, self-report survey from a stratified random sample of Kentucky farmers. Following approval by the Institutional Review Board, a random sample of 4,500 farm households was contacted by mail and invited to participate in the study. The sample size was determined based on an estimated 50% response rate to the mail survey, which would result in a study sample of at least 2,000 farm households. Based on the agricultural literature on ATVs (Goldcamp, et al., 2006) we estimated at least 48% of the households would own ATVs so there would be approximately 980 ATV-owning farm households and 1,040 that did not own ATVs. The listing of eligible farms was obtained from the USDA Kentucky Farm Service Agency (FSA) which

provides services to every county in Kentucky. FSA manages farm commodity, credit, conservation, disaster and loan programs as directed by Congress through a network of federal, state and county offices. The sample was chosen using SURVEYSELECT in SAS (SAS 9.3, 2010). The initial sampling frame included 55,769 farms in 119 counties. After excluding the counties with fewer than 10 farms, a 10% sampling rate stratified by 114 counties was utilized to yield 4,500 farms for the accessible sample.

A survey packet with a cover letter explaining the study was mailed to the sample. To be eligible to participate the farmer needed to be age 18 or older, farm acreage 10 acres or greater, and with active operation at the time of the study. The surveys were linked to the database by code numbers known only to the investigator for tracking. Several methods suggested by Dillman (2007) were used to increase the survey response rate. First, a $2 bill was attached to each survey as an incentive. Second, a reminder postcard was sent to each farm household about ten days after the survey packets were mailed. Finally, the reminder postcards were sent again to non-responders in a final attempt to receive a response. These efforts yielded a 53% response rate (*N*=2,292).

Measures

The 44-item survey was based on review of the agricultural injury literature and Bronfenbrenner's (1979) ecological model. The model uses a systems approach to identify individual characteristics and behaviors as well as recognition of the role of environmental factors that may influence or interact with individual characteristics to create the right conditions for injury (Sommers, 2006). The model (Figure 3.1) consists of concentric circles encompassing each level of overlapping influence. The farm is a unique setting where families work and engage in play/leisure activities in the same environment and there are multiple influences that may affect health behavior (Morrongiello et al., 2007). The microsystem, which includes individual characteristics and behaviors, is the primary focus of this study. The mesosystem, or second level of influence, refers to interactions among the various settings in which the person actively participates. The exosystem is the third level of influence which refers to settings in which the person is not an active participant but the events in those settings affect. The macrosystem is the final level which refers to consistencies that exist or could exist in the subculture or culture as a whole.

The survey contained 12 pages of items to assess demographics, individual rider characteristics and behaviors, and farm environmental factors. Selected questions about ATV use patterns from the Consumer Product Safety Commission surveys of injured and non-injured ATV drivers used in a previous national case-control study (Rodgers & Adler, 2001) were included for comparison.

The survey was reviewed by injury prevention experts for face and content validity. Sixteen farmers, some who owned and operated ATVs, were recruited at an agricultural field day to pilot test the survey. Adjustments were made to some survey questions based on feedback from farmers and injury prevention experts. Two readability tests available in Microsoft Office (2007) were performed on the survey to determine reading level. These tests are based on the average number of syllables per word and sentence. The Flesch-Kincaid Grade Level test rates text based on U.S. school grade levels. The optimal score ranges from 7.0-8.0 and the survey scored 6.3, or 6th grade reading level. The Flesch Reading Ease Test is based on a 100-point scale and the optimal score ranges from 60 to 70. The higher the score, the easier the document is to read. The score for the survey was 71.8.

For the purposes of this study, ATV was defined as a 3- or 4- wheel motorized off-highway vehicles with large low-pressure tires for off road use, seats designed to be straddled by one person, and handlebars for steering (SVIA, 2012). The dependent variables were ownership and ridership. It was assumed that if the farm household owned an ATV, the study participant owned the ATV because he/she was the head of the household. Ridership was defined as having ever ridden an ATV either as a driver or a passenger.

Ten individual characteristics and behaviors flowed from the microsystem, or first level of influence in the theoretical framework. Those included demographics such as age, gender, education level, household income, and number of hours worked on and off the farm each week. Also included in the microsystem were three measures of risk. Two of the measures, perceived risk and perceived behavioral control were single items developed by the investigator. Perceived risk was measured by extent of agreement to the statement, “ATVs are dangerous and should be ridden with caution” on a 4-point Likert scale from strongly disagree (1) to strongly agree (4). Perceived behavioral control (PBC)

is defined by Ajzen (1991) as a personal belief that individuals have about whether or not they can perform a behavior and that if they choose certain behaviors they can have more control over their health outcomes. PBC was measured in this study by participants rating their agreement from strongly disagree (1) to strongly agree (4), in response to the statement, "ATV crashes are freak accidents in which the driver has no control." The third risk measure, dangerous risk-taking attitude (DRTA) was defined as an individual's willingness to engage in activities that knowingly have elements of physical danger which is the result of past experience with risk and influence of significant others' attitudes toward risk. The DRTA measure is a 5-item scale which is positively associated with agricultural injuries in adolescents (Westaby & Lee, 2003). It is scored on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5) with a cumulative score ranging from 5-25 points. Higher scores indicate dangerous risk-taking attitude.

The second level of influence, or mesosystem, contained the independent variables farm size and farm type. In this study farm type was self-defined by participants selecting from the following list based on the primary commodity on their farm: livestock, crop, dairy, hobby, or other. The third level or influence, or exosystem, was not measured in this study.

The fourth level of influence, macrosystem, contained one independent variable. Risk acceptance, was measured using a 5-item scale specific to farming risks in which the possible responses were agree or disagree (Sprince et al., 2003). Risk acceptance is defined as the degree to which an individual accepts risk of injury as an ordinary, uncontrollable consequence of farming. Scores range from 0 to 5 with a cumulative score of 0 to 2 considered risk averse and 3 to 5 risk accepting.

Reliability of risk instruments

Cronbach's alpha for the dangerous risk-taking scale was 0.80 which indicates it was reliable in this sample of farmers. The reliability has not previously been reported (Westaby & Lee, 2003). The risk acceptance scale with dichotomous response choices "agree/disagree" had limited internal consistency (KR20= 0.4) probably because the items were fairly heterogeneous.

Data analysis

Data were analyzed in the SAS programming system (SAS 9.3, 2010). Descriptive analyses were used to compare the characteristics of farmers who owned at least one ATV and those who did not own ATVs. Comparisons were also made between those farmers who reported ever riding an ATV and those who did not. Comparisons were made using the $\chi 2$ test for categorical variables and odds ratios and confidence intervals were computed. Comparisons for ordinal level variables were analyzed using the Mann Whitney U test. This nonparametric analog tests the null hypothesis that two population distributions are identical against the research hypothesis that the distributions are not identical (Polit, 2010). Independent t-tests were performed to make comparisons between groups for interval level variables.

Multivariable logistic regression was performed to examine the association between participant characteristics and ATV ownership in the first model and participant characteristics and ATV riding in the second model. All study variables that were conceptual determinants for owning an ATV or riding an ATV were entered in the logistic regression models. Only variables that were significant at the alpha ≤ 0.05 were retained in the final models. Hosmer-Lemeshow goodness-of-fit test was conducted for both models to assess the fit to the best predictive model (Polit, 2010). The variables included in the final logistic regression were tested for multicollinearity by determining the variance inflation factors.

Results

Sample characteristics

The mean age of the sample (N = 2,292) was 60.7 years (SD ± 13.3). Young adults in the 18 to 29 age group comprised only 1% of the sample, 30-45 year-olds 11%, 46-64 year-olds 47%, and 65-95 year-olds 40%. Eighty-one percent were male and 99% were Caucasian. The mean years of education was 12.9 (SD ± 3.34). The number of hours participants worked on the farm per week ranged from 0 to 99 hours with a mean of 23 hours (SD ± 23). The number of hours worked away from the farm per week ranged from 0-90 (mean = 8 hours, SD ± 21). Farm type was split evenly at 25% each for livestock, crop, dairy, and hobby farms.

Ownership

Demographic characteristics based on ownership are summarized in Table 3.1. Fifty-three percent (1,208) of the survey participants owned at least one ATV on their farm. There was an average of 1.4 (*SD* ± 0.9) ATVs per farm among those participants who owned ATVs and the range was 1-10. Only 3% of those whose farm owned an ATV at the time of the survey reported never having ridden an ATV as an operator or passenger. The average age of ATV owners was 57 years (*SD* ± 12.4) compared to 64 years (*SD* ± 13.1) for nonowners. ATV owners were more likely to be male, have at least a high school education, owned larger farms, owned livestock farms, had significantly higher household incomes, and worked more average hours on and off the farm each week compared to ATV nonowners.

Use of ATVs on farms

Eighteen percent of those farm households who owned ATVs reported that the ATV was used for work 100% of the time. Only 4% of participants reported their ATV(s) was used for leisure only. The remainder of the sample reported that the ATV was used 63% (*SD* ± 35.9) of the time for farm-work related tasks and 27% (*SD* ± 30.5) for leisure activities. ATVs were used for the following reasons: monitoring property and livestock (82% of farms with ATVs), hauling and transporting supplies (73%), recreation or hunting (64%), and using attachments to work the fields (33%).

Associations between participant characteristics and ATV ownership

Younger age, male gender, livestock farming, larger farm size in acres, higher household income, more average hours worked on and off the farm per week, higher perceived risk, and higher perceived behavioral control were all statistically associated with owning an ATV in the bivariate analysis ($p < .05$) (Tables 3.2-3.4). Table 3.2 shows the categorical variables that were associated with ownership. Years of education and risk acceptance were not associated with owning an ATV. Table 3.3 shows the ordinal variables: household income, perceived risk, and perceived behavioral control, which were all associated with ownership. Table 3.4 shows the association between interval variables and ownership. All four interval variables: age, farm size, hours worked on and off the farm were statistically significant.

Significant head of household characteristics predictive of ownership

The logistic regression model predicting ATV ownership is summarized in Table 3.5. Younger age, male gender, and fewer years of education were the significant predictors for ATV ownership. The participants were less likely to own an ATV as they aged but the likelihood only decreased 2% for each year of age. Males were 1.55 (1.02-2.36) times more likely than females to own ATVs on the farm. For every one year increase in education, the farm head of household was 6% less likely to own an ATV.

Owning a livestock farm ($p = 0.07$) and having an ATV injury in the participant's lifetime ($p = 0.06$) were factors that approached significance for owning ATVs. The number of hours the participant worked on and off the farm, household income, perceived risk, and perceived behavioral control were not significant in the model when controlling for the other variables. The Hosmer Lemeshow goodness-of-fit test results were ($\chi^2 = 9.1457$, df 8, p=0.33) indicating the difference between the observed probability of the event and the predicted probability was small. The variables included in the final logistic regression were tested for multicollinearity by determining the variance inflation factors.

Lifetime ridership

Demographic characteristics based on ridership are described in Table 3.6. Seventy-three percent (1,627) of the farm head of household survey participants reported ever riding an ATV as an operator or passenger. The average age of adult farmers who had ridden ATVs was 58 years (SD ± 13) compared to 69 years (SD ±12) for those who had never ridden an ATV. Those who had ridden ATVs were younger, more likely to be male, had higher education levels, higher annual household incomes, and were more likely to live on larger livestock farms. Forty-five percent of those who reported not owning an ATV at the time of the survey had ridden an ATV.

Associations between participant characteristics and ATV ridership

There were significant associations between 10 participant and farm environment characteristics and ATV ridership in the bivariate analysis (Tables 3.7-3.9). The categorical variables and their association with ridership are presented in Table 3.7. Male participants were 3.60 (95% CI 2.88-4.50) times more likely to ride ATVs. Farmers with

livestock as their primary commodity were 1.39 (CI 95% 1.12-1.72) times more likely to ride ATVs than other types of farmers. Risk acceptance was not associated with riding ATVs.

The ordinal variables are presented in Table 3.8. Perceived behavioral control was not associated with ATV riding. Participants with higher mean household income (4.33 vs. 3.75, $p < 0.0001$) and lower perceived risk (3.59 vs. 3.67, $p = 0.0002$) were more likely to ride ATVs. Table 3.9 shows that all interval level variables were associated with ATV riding: younger age, higher education level, larger farm size, more hours worked on and off the farm, and higher dangerous risk-taking attitude.

Significant participant characteristics predictive of ridership

The final logistic regression model predicting ATV ridership among farmers can be found in Table 3.10. Younger age, male gender, dangerous risk-taking attitude, and larger farm size were the variables found to be significant in predicting ATV ridership in this sample of farmers. Every one year increase in age of these farmers decreased the likelihood of riding an ATV by 7%. Males were 2 times as likely as females to ride ATVs. Those who live on farms with fewer than 85 acres are less likely to ride ATVs compared to those who live on farms with greater than 200 acres. The higher the scores on the dangerous risk-taking attitude scale, the more likely participants were to ride an ATV. Education level, income, farm type, risk acceptance, hours worked off the farm, perceived risk, and perceived behavioral control were not significant in the model when controlling for the other variables. The Hosmer Lemeshow goodness-of-fit test results were ($\chi^2 = 11.01$, df 8, $p= 0.20$) indicating the difference between the observed probability of the event and the predicted probability was small. The variables included in the final logistic regression were tested for multicollinearity by determining the variance inflation factors.

Discussion

Ecological models of health behavior propose that behaviors are influenced by intrapersonal, sociocultural, policy, and physical-environmental factors. These multilevel models consider the connections between people and their environments and focus attention on the influence of the environment on health behavior (Sallis & Owen, 2002).

Bronfenbrenner's (1979) ecological model used that guided this study was useful in helping to identify individual characteristics, including risk-taking influences, in the microsystem which affect ATV ownership and ridership and one environmental factor, farm size, in the mesosystem.

Younger age, male gender, and fewer years of education were the significant predictors for ATV ownership. Predictors for lifetime ridership among farmers were younger age, male gender, dangerous risk-taking attitude, and larger farm size. This is the first study that used a random sample of farmers to predict ATV ownership and ridership. The demographic characteristics of this random sample of farmers are very similar to the demographics of the population of farmers in Kentucky based on the 2007 agricultural census for Kentucky (NASS, 2007). Eighty-nine percent of the principal operators were male in the 2007 census and 81% of this sample was also male. This sample was slightly older and had more females. There were several extremely large farms in this sample which skewed the average size in comparison to the census.

ATVs were prevalent in farm households and the majority of head of households report that the ATVs are used for occupational and recreational purposes. ATV owners span the age spectrum but the younger farmers are more likely to own ATVs compared to the older farmers. In Rogers and Adler (2001) ATV user survey of the general population, only 36% of those in the sample who were using ATVs were over 36 years old. In this sample 95% of ATV owners were over 36 years old. Given the broad age span for ATV ownership, interventions for safety regarding ATV use should be guided by best practices for adult learning.

This study supported the previous finding (Goldcamp et al., 2006) that ATV ownership did not differ based on farm type. It also confirmed uses for ATVs on farms that were previously cited in the literature such as monitoring livestock and crops and hauling supplies (Murphy & Harshman, 2005).

While ATV use has not been studied specifically in adult farmers in the research literature, it is interesting that the same characteristics that predicted ATV ownership and ridership (e.g. younger age and high dangerous risk-taking attitude) have also been found to be significant risk factors for farm work-related injury (Sprince et al., 2003).

Those with a higher dangerous risk-taking attitude were more likely to ride ATVs in this study. There are few standard instruments in the agricultural literature. The dangerous risk-taking attitudes scale used in this study holds promise for studying associations between specific individual characteristics and risky behaviors. A previous longitudinal analysis of psychological mediators of injury in youth in agricultural settings utilized the dangerous risk-taking attitude instrument and found it to be one of the strongest predictors of injury (Westaby & Lee, 2003). Path coefficients revealed strong time 1 to time 2 reliability (path = .66) and also contribution to prediction of injury at time 2 (path = .09). Risk acceptance was not found to be associated with ATV ownership or ridership in this study. It was previously used in a study of 904 adult farmers in Iowa and was not associated with agricultural injury in that study (Sprince et al., 2003).

While household income, farm size, number of hours worked on and off the farm per week, perceived risk and perceived behavioral control were associated with owning an ATV, they were not significant predictors of ATV ownership when controlling for other variables. When predicting ridership, education level, household income, farm type, number of hours worked on and off the farm per week, and perceived risk were not retained in the regression model when controlling for other variables.

Limitations

Recall and self-report bias are major limitations of survey studies. In this study, participants were asked to recall riding on an ATV at any time in their lives. In addition, cross-sectional studies do not adequately capture prevalence over time. There are inherent limitations in using the odds ratio as the effect measure for higher prevalence outcomes (Spiegelman & Hertzmark, 2005; Zhang & Yu, 1998). Type 1 error is possible as the large sample size may have uncovered relationships with small effect sizes that may not have been found in a smaller study.

Conclusions

The ATV issue on farms may have been overshadowed by tractor safety initiatives because Kentucky also ranks first in tractor-related fatalities (Cole, McKnight, & Donovan, 2009). As ATVs have become more popular and have begun to replace tractors and other farm machinery (Ruen, 2009), and are used for work and recreation by

most farm household members, we project there may continue to be a natural progression to higher ATV fatality rates over time.

Identifying the predictors of ATV ownership and ridership is useful in determining next steps for public health practice, policy, and research. Farmers need increased awareness about the dangers of ATV riding through interventions delivered by cooperative extension, professional organizations such as the Cattleman's Association, and media campaigns. Future research is needed to examine the prevalence of ATV use on farms, and test the efficacy of educational interventions to increase knowledge about safe ATV use on farms and change attitudes about dangerous risk-taking. Implications for policy change include tightening ATV regulations through registration and licensing, mandating formal ATV training, and enforcement of safe riding behaviors and requiring personal protective gear.

Table 3.1 Distribution of Select Demographics by Owner Status ($N = 2292$)

Demographic	Owner	Nonowner	χ^2	p-value
	n (%)	n (%)		
Age (Years)				
18-29	27 (2.3)	4 (0.4)	142.59	< 0.0001
30-45	170 (14.4)	77 (7.5)		
46-64	641 (54.4)	405 (39.4)		
65-95	340 (28.9)	543 (52.8)		
Gender				
Male	1050 (88.1)	766 (73.2)	81.04	<0.0001
Female	142 (11.9)	281 (26.8)		
Education				
< High School	152 (13.1)	171 (16.8)	5.88	0.02
≥ High School diploma	1012 (86.9)	850 (83.3)		
Farm Type				
Livestock	457 (47.6)	324 (38.1)	16.54	<0.0001
Other	503 (52.4)	526 (61.9)		
Farm Size (Acres)				
10-65	240 (20.7)	305 (30.4)	57.83	<0.0001
66-126	255 (22.0)	285 (28.4)		
127-278	323 (27.8)	217 (21.6)		
279-10,000	342 (29.5)	198 (19.7)		
Household Income (Annual $)				
< 40 K	300 (29.7)	380 (42.3)	33.15	<0.0001
≥ 40 K	711 (70.3)	518 (57.7)		

[1]Sum may not equal (N= 2292) due to missing values

Table 3.2 Categorical variables and their Association with ATV Ownership

Variable	Total Participants	ATV Owners		χ^2	*OR* (*95% CI*)
		n	%		
Gender	2239	1192	(53.2)	81.04	2.71 (2.17-3.39)****
Male	1816	1050	(88.1)		
Female	423	142	(11.9)		
Education	2185	1164	(53.5)	5.88	0.75 (0.59-0.95)**
< High School	323	152	(13.1)		
≥ High School	1862	1012	(86.9)		
Farm Type	1810	850	(47.0)	16.54	1.48 (1.22-1.78)****
Livestock	781	457	(47.6)		
Other	1029	503	(52.4)		
Lifetime ATV Injury	1641	1180	(71.9)	13.93	2.34 (1.48-3.70)***
Yes	152	129	(10.9)		
No	1489	1051	(89.1)		
Risk Acceptance	2289	1208	(52.8)	0.0025	1.01 (0.81-1.24)
≥3 Risk accepting	416	220	(18.2)		
<3 Risk averse	1873	988	(81.8)		

*$p < 0.05$; **$p < 0.01$; *** $p < 0.001$; ****$p < 0.0001$
n differs by variable due to missing data

Table 3.3 Ordinal Variables and their Association with ATV Ownership

Variable	Owners Median	Nonowners Median	MWU	Level of Significance
Household Income[1]	4.00	4.00	780996.50	< .0001
Perceived Risk[2]	4.00	4.00	1118989.50	< .001
Perceived Behavioral Control[3]	1.00	1.00	1029021.00	.01

[1] Household Income Categories: 1: ≤ $10K, 2: $10,001-$20,000, 3: $20,001- $40,000, 4: $40,001-$60,000, 5: $60,001 to $80,000, 6: > $80,000

[2,3] Measured on 4-point Likert scale from 1- Strongly Disagree to 4- Strongly Agree

Table 3.4 Interval Variables and their Association with ATV Ownership

Variable	Owner	Nonowners	t	Level of Significance
	$\bar{x}$ (SD)	$\bar{x}$ (SD)		
Age (Years)	57 (12.4)	64 (13.1)	-14.01	< .0001
Farm Size (acres)	359 (695)	234 (527)	4.66	< .0001
Average hours worked on farm per week	27 (23)	18 (21)	9.95	< .0001
Average hours worked off farm per week	20 (22)	15 (21)	4.95	< .0001
Dangerous Risk- Taking Attitude	9 (4)	9 (4)	0.63	0.53

Table 3.5 Logistic Regression Model Predicting ATV Ownership in Farmers (N = 1017)

Variable	Coefficient (SE)	Wald χ^2	Adjusted OR	95% CI
Intercept	2.45 (0.76)			
Age (Years)	-0.02 (0.01)	8.85	0.98	(0.97-0.99)**
Gender				
Male	0.22 (0.11)	4.20	1.55	(1.02-2.36)*
Female			--	
Education (Years)	-0.06 (0.02)	6.28	0.95	(0.90-0.99)**
Household Income	0.05 (0.06)	0.63	1.05	(0.93-1.18)
Farm Type				
Livestock	0.14 (0.08)	3.28	1.31	(0.98-1.76)
Other			--	
Farm Size (Acres)				
10-84	-0.23 (0.11)	4.66	0.78	(0.53-1.14)
85-200	0.21 (0.10)	4.05	1.21	(0.83-1.76)
201-10,000			--	
Work on Farm (Avg. Hours/Week)	0.00072 (0.004)	0.25	1.001	(0.99-1.01)
Work Off Farm (Avg. Hours/Week)	-0.0011 (0.004)	0.06	1.00	(0.99-1.01)
Lifetime ATV Injury				
Yes	0.26 (0.14)	3.50	1.69	(0.98-2.91)
No			--	
Perceived Risk	0.01 (0.09)	0.02	1.01	(0.85-1.21)
Perceived Behavioral Control	0.17 (0.09)	3.73	1.19	(0.98-1.41)

Model based on analysis of 716 ATV owners and 301 nonowners
-- Reference Group
*$p \leq 0.05$; **$p < 0.01$

Table 3.6 Distribution of Select Demographics by Lifetime Ridership Status ($N = 2292$)

Demographic	ATV Riders *n* (%)	Never Ridden an ATV *n* (%)	χ^2	*p*-value
Age (Years)				
18-29	29 (1.8)	2 (0.3)	235.6	< 0.0001
30-45	234 (14.7)	13 (2.2)		
46-64	848 (53.3)	191 (32.5)		
65-95	481 (30.2)	382 (65.0)		
Gender				
Male	1402 (87.3)	395 (65.6)	135.9	<0.0001
Female	204 (12.7)	207 (34.4)		
Education				
< High School	202 (12.8)	110 (19.1)	13.5	0.0002
≥ High School	1377 (87.2)	466 (80.9)		
Farm Type				
Livestock	593 (45.1)	178 (37.2)	9.1	<0.01
Other	721 (54.9)	301 (62.8)		
Farm Size (Acres)				
10-65	364 (23.2)	178 (31.0)	53.5	<0.0001
66-126	346 (22.1)	182 (31.7)		
127-278	416 (26.6)	120 (20.9)		
279-10,000	440 (28.1)	95 (16.5)		
Household Income (Annual $)				
< 40 K	426 (30.8)	240 (47.9)	47.2	<0.0001
≥ 40K	958 (69.2)	261 (52.1)		

[1]Sum may not equal (N= 2292) due to missing values

Table 3.7 Categorical Variables and their Association with ATV Ridership

Variable	Total Farmers	ATV Riders	χ^2	*OR* (*95% CI*)
Gender	2208	1606 (72.7)		
Male	1797	1402 (87.3)	135.89	3.60 (2.88-4.50)****
Female	411	204 (12.7)		
Farm Type	1793	1314 (73.3)		
Livestock	771	593 (45.1)	9.09	1.39 (1.12-1.72)**
Other	1022	721 (54.9)		
Risk Acceptance	2237	1627 (72.7)		
>3 Risk accepting	408	296 (18.2)	0.01	1.01 (0.80-1.29)
<3 Risk averse	1829	1331 (81.8)		

*$p < 0.05$; **$p < 0.01$; *** $p < 0.001$; ****$p < 0.0001$

Table 3.8 Ordinal Variables and their Association with ATV Ridership

Variable	ATV Riders Median	Never Ridden ATV Median	MWU	Level of Significance
Household Income[1]	4.00	4.00	394286.50	<0.0001
Perceived Risk[2]	4.00	4.00	640663.50	0.0002
Perceived Behavioral Control[3]	1.00	1.00	586915.00	0.55

[1] Household Income Categories: 1: ≤ $10K, 2: $10,001-$20,000, 3: $20,001- $40,000, 4: $40,001-$60,000, 5: $60,001 to $80,000, 6: > $80,000

[2,3] Measured on 4-point Likert scale from 1- Strongly Disagree to 4- Strongly Agree

Table 3.9 Interval Variables and their Association with ATV Ridership

Variable	Rider	Never Ridden	*t*	Level of Significance
	$\bar{x}$ *(SD)*	$\bar{x}$ *(SD)*		
Age (Years)	58 (13)	69 (12)	-18.61	<.0001
Education (Years)	13.04 (3.32)	12.71 (3.38)	1.99	.05
Farm Size (Acres)	344 (690)	176 (237)	5.69	<.0001
Work on Farm (Hours/week)	26 (23)	15 (20)	10.63	<.0001
Work off Farm (Hours/week)	20 (22)	12 (19)	7.68	<.0001
Dangerous Risk-Taking Attitude	9 (4)	8 (3)	5.77	<.0001

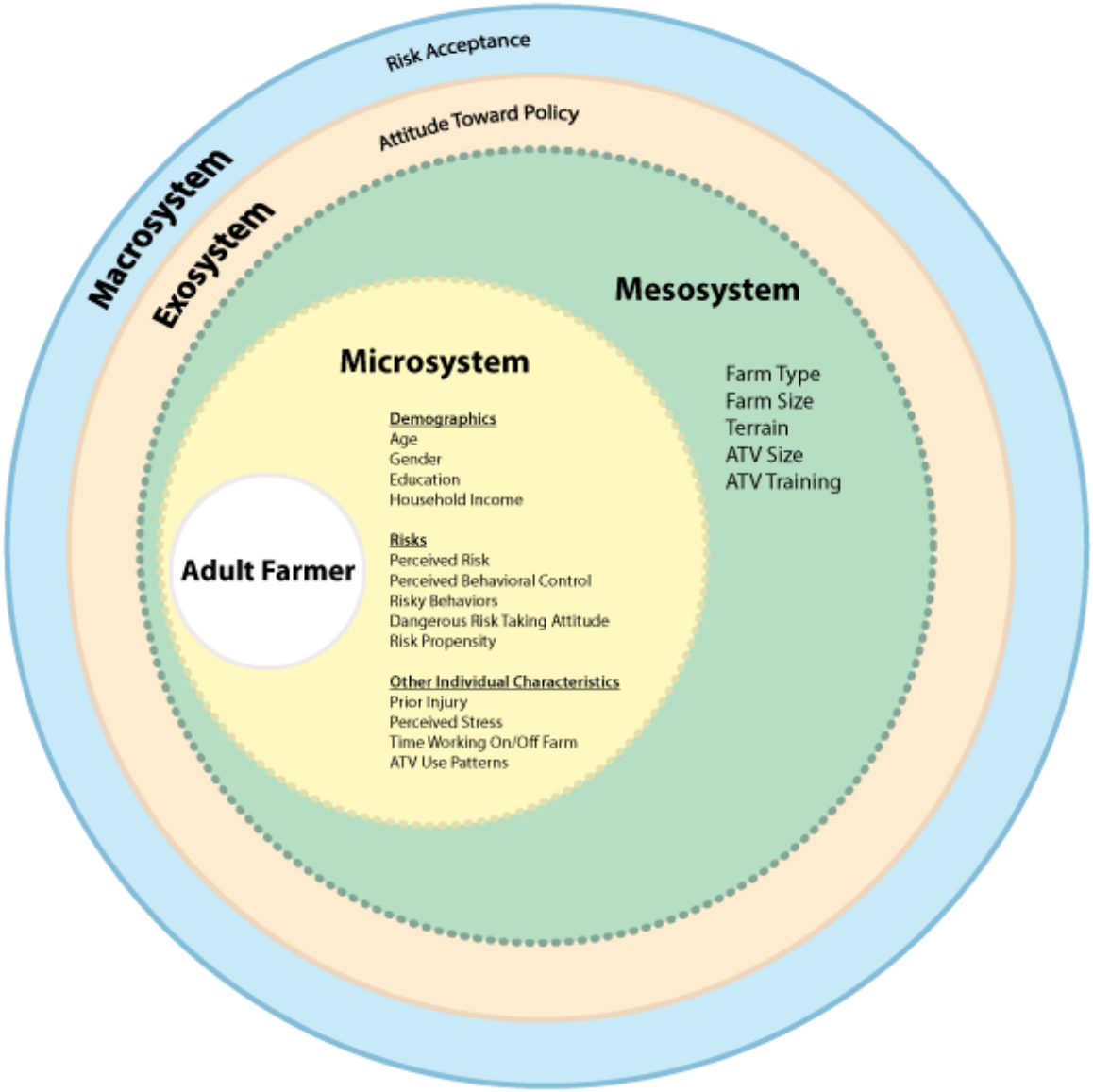
*$p \leq 0.05$; **$p < 0.01$; *** $p < 0.001$; ****$p < 0.0001$

Table 3.10 Logistic Regression Model Predicting Lifetime ATV Ridership in Farmers ($N = 1017$)

Variable	Coefficient (SE)	Wald χ^2	Adjusted OR	*95% CI*
Intercept	5.30 (0.89)			
Age (Years)	-0.07 (0.01)	71.20	0.93	(0.91-0.95)****
Gender				
Male	0.35 (0.10)	12.88	2.02	(1.38-2.97)***
Female			--	
Dangerous Risk-Taking	0.07 (0.02)	9.74	1.07	(1.03-1.12)**
Farm Size (Acres)				
0-84	-0.24 (0.11)	4.77	0.59	(0.39-0.89)*
85-200	-0.06 (0.10)	0.28	0.71	(0.48-1.05)
201-10,000			--	
Work on the Farm (Hours/Week)	0.01 (0.00)	4.36	1.01	(1.00-1.02)

*$p \leq 0.05$; **$p < 0.01$; *** $p < 0.001$; ****$p < 0.0001$

Figure 3.1 Theoretical Framework to Guide ATV Dissertation Research



CHAPTER FOUR

Risk Factors for All-Terrain Vehicle Injuries on Kentucky Farms

Abstract

There is limited research on the prevalence of ATV use on farms or ATV-related injury among adults on farms. An industry study of ATV owners conducted in 2008 found 79% of the respondents used ATVs for recreation and 21% used them for work or chores (Government Accountability Office, 2010). The 2006 Farm and Ranch Safety Survey indicated approximately 900,000 farm operators had ATVs on their operations and 1.1 million of those ATVs were being used for farm work tasks at least some of the time by the farm operator (National Agricultural Statistics Service, 2008).

Bronfenbrenner's ecological model (Bronfenbrenner, 1979) was chosen to guide this study because it uses a systems approach which includes identification of individual characteristics and behaviors as well as recognizing the role of environmental characteristics that may influence or interact with individual characteristics to create the conditions for injury to occur (Sommers, 2006). The purposes of this study were to: 1) determine if there are associations between individual characteristics and behaviors, farm environmental factors, and other levels of influence on the individual and self-reported lifetime ATV injuries in Kentucky farmers; and 2) determine ATV-related injury risk factors for farmers that predict injury.

Younger age, riding ATVs on public roads, carrying passengers, having a high score on the dangerous risk-taking attitudes scale, and high risk propensity score were significant predictors of ATV injuries in this sample of farmers. Education and enforcement, two primary strategies for injury prevention, must be implemented to reduce the risk of ATV-related injury among adult farmers. ATV education should be mandatory for all riders and age-appropriate in order to decrease risk-taking and change attitudes toward risk. State laws that exempt occupational users of ATVs from following the same guidelines as other users and that allow riding on public roadways need to be further examined. Development of comprehensive helmet laws are warranted. Enforcement of laws and regulations regarding riding on public roadways and carrying passengers on ATVs is necessary to reduce injury risk.

Introduction

The purposes of this study were to: 1) determine if there are associations between individual characteristics and behaviors, farm environmental factors, and other levels of influence on the individual and self-reported lifetime ATV injuries in Kentucky farmers; and 2) determine ATV-related injury risk factors for farmers that predict injury. One national case-control study (*n* =133 cases and 460 controls) identified driver characteristics, driver use patterns, and vehicle characteristics as injury risk factors among ATV drivers (Rodgers & Adler, 2001). Injury risk was highest for children less than 16 years of age and ATV risk declined with age. Males were three times as likely to be injured as females. Injury risk declined with more driving experience and with the proportion of time ATVs were used for non-recreational purposes. Injury risk rose as engine size increased.

Background

There is limited research on the prevalence of ATV use on farms or ATV-related injury among adults on farms. Most research on ATV morbidity and mortality is focused on recreational use of ATVs by children and is rarely differentiated by occupation of the user (Goldcamp, et al., 2006; Hendricks, Layne, Goldcamp, Myers, 2005; Hendricks, Myers, Layne, Goldcamp, 2005; Jones & Bleeker, 2005; Little, Vermillion, Dikis, Little, Custer, & Cooney, 2003; Gerberich, Gibson, French, Renier, Lee, Carr, & Shutske, 2001). In 2001, approximately 643,348 farms in the United States reported ownership of ATVs (Goldcamp et al., 2006). The estimated average ATV ownership was 519 (± 16) ATVs per 1,000 farms, with the highest rates in the west, and Midwest regions of the U.S. The usage pattern (times/month) was highest in the West, Midwest, and South regions compared to the Northeast region. Ownership was consistent regardless of farm type; however, ATV usage was slightly higher on livestock farms compared to crop farms. Thirty-six percent of farm household youth operated an ATV in 2001 but estimates for adults were not reported in this study. The ATV-related injury rate was 4.3 per 1,000 youths (ages 0-19 years) who operated ATVs. The injury rate for those on livestock farms was 5.1/1,000 farm household youths who had operated an ATV compared to 3.4/1,000 on crop farms. The injury rate was 5.0/1,000 for farm household

males and 3.4/1,000 for farm household females. Fifty-eight percent of the injuries occurred during recreational use of the ATV, the remainder resulted from use for farm work or general transportation.

An industry study of ATV owners conducted in 2008 found 79% of the respondents used ATVs for recreation and 21% used them for work or chores (Government Accountability Office, 2010). The 2006 Farm and Ranch Safety Survey indicated approximately 900,000 farm operators had ATVs on their operations and 1.1 million of those ATVs were being used for farm work tasks at least some of the time by the farm operator (National Agricultural Statistics Service, 2008). Farms in the South and Midwest regions had the most ATVs reported with 478,000 and 480,000 respectively. In 2008, there were an estimated 10.2 million ATVs in use in the U.S. (Government Accountability Office, 2010). Based on these estimates, approximately 10% of ATVs were operated on farms at that time.

Helmkamp et al. (2011) analyzed work-related ATV deaths from the Bureau of Labor Statistics' annual Census of Fatal Occupational Injuries, from 1992-2007. Work-related ATV deaths increased 275% during the 15 years of study. Sixty-eight percent (202 of 297) of workers killed in ATV incidents worked in the agriculture/forestry/fishing/ hunting industry sector (4.23 deaths per 1 million workers), and 89% of deaths from that sector were in the agriculture production industry. The ATV fatality rate for all other industries was 0.04 per 1 million. Those with the highest risk of ATV-related fatality compared to all other groups of workers were agricultural production workers ≥ 65 years of age (13.5 deaths per 1 million workers). This was more than 2 times higher than the overall ATV fatality rate for agriculture production. The proportional increase in occupational ATV deaths between 2000 and 2007 was more than double the estimated increase for all ATV deaths during that same time period.

A 20-year prospective cohort study in one Iowa county studied injuries in rural households including those from riding ATVs (Merchant, Stromquist, Kelly, Zwerling, Reynolds, & Burmeister, 2002). Residents of farm households and men reported more risk behaviors associated with injury than rural/nonfarm residents, residents who lived in town, and women. Men (OR = 3.21), farm household residents (OR = 3.87), and those

who had ever farmed (OR = 2.39) were more likely to have reported riding an ATV in the last year.

Theoretical model

Bronfenbrenner's ecological model (Bronfenbrenner, 1979) was chosen to guide this study because it uses a systems approach which includes identification of individual characteristics and behaviors as well as recognizing the role of environmental characteristics that may influence or interact with individual characteristics to create the conditions for injury to occur (Sommers, 2006). See Figure 1. The *microsystem* which encompasses individual characteristics and behaviors is the primary focus of this study. The *mesosystem*, or second level of influence, refers to interactions among the various settings in which the person actively participates. The *exosystem* is the third level of influence which refers to settings in which the person is not an active participant but the events in those settings affect what happens in the setting the person is in. The *macrosystem* is the final level which refers to consistencies that exist or could exist in the subculture or culture as a whole.

Eleven individual characteristics and behaviors in the *microsystem* were hypothesized to be associated with ATV injury in adult farmers. Younger age and male gender have previously been associated with injury in agricultural settings (Blair et al., 2005; Smith et al., 2005; Sprince et al, 2003; Westaby & Lee, 2003). In one study, farm household members with prior injury were 2.6 times more likely to be injured on the farm again (Mongin et al., 2007). Perceived risk was a factor developed by the investigator to determine respondents' perceptions about whether or not ATVs are dangerous and present a risk for potential injury. Very few factors related to risk-taking have been studied in samples of agricultural workers to look for associations with injury.

Risk propensity is a measure of an individual's risk-taking behavior across situations and time (Nicholson, Soan, Fenton-O'Creevy, & Willman, 2005). Dangerous risk-taking attitude is an individual's willingness to engage in activities that knowingly have elements of physical danger which is the result of past experience with risk and the influence of significant others' attitudes toward risk (Westaby & Lee, 2003). Perceived stress is a subjective measure of the individual's perception of overall life stress based on the combined influences in the individual's environment. Simpson et al. (2004) used the

perceived stress scale in farmers and found that higher levels of perceived stress were associated with injury in farmers.

Perceived behavioral control is a personal belief individuals have about whether or not they can perform a behavior and that if they choose certain behaviors they can have more control over their health outcomes (Azjen, 1991). There were 2 types of risky behaviors assessed in this study. The first type was those risky behaviors specific to ATV riding such as carrying passengers or riding as a passenger on an ATV and not wearing a helmet while riding. The other risky behaviors were activities respondents engage in on the farm that are known hazards and have been associated with injuries such as operating a tractor, working with large animals, and using machines such as balers or augers. The amount of time the individual works on and off the farm could affect how much exposure they have to ATVs. ATV use patterns refer to how much time the individual spends riding the ATV and how much of that use is for recreation or occupational use.

The other levels of influence are detailed here. Four items in the survey ascertained *mesosystem* influences. Those included what type of farm the individual worked on, the type of terrains he/she drive the ATV on around the farm, engine sizes of the ATVs on the farm, and whether or not the individual received formal ATV training. The *exosystem* encompassed attitudes toward ATV policy which were measured in the survey, but was not a focus of this study. An example of the *macrosystem* related to ATV injury that is pervasive in our society is the notion that injuries are accidents rather than predictable and preventable events. Risk acceptance is the degree to which an individual accepts the risk of injury as an ordinary, uncontrollable consequence of farming. This instrument has previously been measured in farmers and was included in this study (Sprince et al., 2003)

Specific Aims

The specific aims for this study were to: 1) determine if there are associations between individual characteristics and behaviors, farm environmental factors, and other levels of influence on the individual and self-reported lifetime ATV injuries in Kentucky farmers; and 2) determine ATV-related risk factors that predict injury among adult farmers. The hypotheses were: 1) Cases will be more likely to report risky riding behaviors and more exposure to other risky activities on the farm than controls; 2)

Perceived risk, perceived behavioral control, risk propensity, dangerous risk-taking attitude, and risk acceptance will be associated with ATV-related injury among farmers who ride ATVs, and 3) Younger age, male gender, more hours riding ATVs, risky riding behavior, high risk propensity, dangerous risk-taking attitude, and risk acceptance will predict ATV-related injury among adult farmers.

Methods

Design

This was a cross-sectional, self-report survey from a stratified random sample of Kentucky farmers. Following approval by the Institutional Review Board, a random sample of 4,500 farm households was contacted by mail and invited to participate in the study. The listing of eligible farms was obtained from the USDA Kentucky Farm Service Agency (FSA) which provides services to every county in Kentucky. FSA manages farm commodity, credit, conservation, disaster and loan programs as directed by Congress through a network of federal, state and county offices. The sample was chosen using SURVEYSELECT in SAS (SAS 9.3, 2010). The initial sampling frame included 55,769 farms in 119 counties. After excluding the counties with less than 10 farms, a 10% sampling rate stratified by 114 counties was utilized to yield 4,500 farms for the sample.

The sample size was chosen based on an estimated 50% response rate to the mail survey, which would result in a study sample of at least 2,000 farm households. Based on the agricultural literature on ATVs (Goldcamp, et al., 2006) we estimated at least 48% would own ATVs so there would be approximately 980 ATV-owning farm households and 1,040 that did not own ATVs. We anticipated a priori that 20% of the ATV-owning farm households would report injuries which would provide 192 cases for the analysis.

The response rate was 53% (N=2,292). Cases (n = 118) and controls (n = 913) were identified from the full sample. For the purposes of this study, cases were defined as respondents who owned at least one ATV on their farm at the time of the survey and self-reported at least one ATV-related injury in their lifetime. Controls were respondents who owned at least one ATV on their farm at the time of the survey and did not report having been injured on an ATV in their lifetime. Any respondent who had a missing value for

one of the predictor variables in the logistic regression was excluded from the analysis. There were no differences between cases and controls on the pattern of missing values.

The survey was reviewed by injury prevention experts for face and content validity. Sixteen farmers, some who owned and operated ATVs, were recruited at an agricultural field day to pilot test the survey. Adjustments were made to some survey questions based on feedback from farmers and injury prevention experts. A survey packet with a cover letter explaining the study was mailed to the sample. To be eligible to participate the farmer needed to be age 18 or older, farm acreage 10 acres or greater, and active farm operation. The surveys had no personal identifiers. Surveys were tracked by codes on the return envelopes. Several methods suggested by Dillman (2007) were used to increase the survey response rate. First, a $2 bill was attached to each survey as an incentive. Second, a reminder postcard was sent to each farm household about ten days after the survey packets were mailed. Finally, nonresponders after the reminder postcard were sent one more survey packet as a final attempt to receive a response.

Measures

The 44-question, 12-page survey was based on a review of the literature and assessed demographics, ATV ownership, ATV rider characteristics, ATV rider use patterns, and environmental factors on the farm. Questions from the Consumer Product Safety Commission surveys of injured and noninjured ATV drivers used in a previous national case-control study (Rodgers & Adler, 2001) were included.

The dependent variable was prior lifetime ATV-related injury. The case definition for injury was an injury that incurred in their lifetime while operating an ATV that resulted in loss of at least 4 hours of usual activity (Goldcamp et al, 2006). Independent variables included characteristics of three of the four levels of influence on the individual derived from the theoretical model. Individual characteristics and behaviors measured were: age, gender, prior farm machine injury, perceived risk, risk propensity, dangerous risk-taking attitude, perceived stress, perceived behavioral control, risky ATV behaviors such as carrying passengers or riding as a passenger and riding without a helmet, risky farm behaviors such as riding a tractor and operating a baler, and other demographics such as years of experience riding ATVs, hours per month of riding ATVs, and hours worked on and off the farm per week. Farm environment variables were type of farm,

types of terrain such as riding on public roads, and formal ATV safety training. The subculture variable was risk acceptance.

An explanation about the measurement of select variables follows. Perceived risk was measured by extent of agreement to the statement, "ATVs are dangerous and should be ridden with caution" on a 4-point Likert scale from "strongly disagree" to "strongly agree." Respondents were asked to describe their stress on a 10-point Likert scale; 1 "not stressful at all" and 10 "extremely stressful." Perceived behavioral control was rated by respondents based on a 4-point Likert scale in response to the statement, "ATV crashes are freak accidents in which the driver has no control."

Three risk-related instruments were adopted from the literature. First, risk propensity (Nicholson, Soane, Fenton-O'Creevy, & Willman, 2005) is a 12-item scale which asks participants to identify how often they have faced risks now and in their adult past in various categories such as recreation, health, career. Responses range from 1 "never" to 5 "very often." Possible scores range from 12 to 60. Cumulative risk propensity scores were treated as a continuous variable and increased scores were indicative of higher overall risk-taking by the individual. Second, risk acceptance, was measured using the cumulative score on a 5-item scale specific to farming risks previously used by Sprince et al. (2003). The possible responses for each of the 5-items were agree/disagree. Two of the items were reverse scored. Cumulative scores can range from 0 to 5. Scores ranging from 0 to 2 indicate the respondent is risk averse. Scores of 3 to 5 indicate the respondent is risk accepting. Third, dangerous risk-taking attitude (DRTA) (Westaby & Lee, 2003) includes 5 items. It is scored on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5) with a cumulative possible score ranging from 5-25 points. Increased scores indicate higher dangerous risk-taking attitude of the participant.

Data analysis

Prevalence-based case/control study methods were employed for the analysis (Rosner, 2011). Data were analyzed using the SAS programming system (SAS 9.3, 2010). Descriptive analyses and frequencies of exposure between the cases and controls were considered and comparisons were made using the $\chi 2$ test for categorical variables. Odds ratios and confidence intervals were computed. Comparisons between cases and

controls for ordinal level variables were analyzed using the Mann Whitney U test. Independent t-tests were performed to make comparisons between case and control groups for interval level variables. All variables that were supported by the literature and potential risk factors for injury were entered in the logistic regression model. Multivariate logistic regression was performed to examine the association between injury and the potential risk factors for injury. Only variables that were significant at the alpha ≤ 0.05 level were included in the final model. The Hosmer-Lemeshow goodness-of-fit test was conducted to assess the fit to the best predictive model (Rosner, 2011). The variables included in the final logistic regression were tested for multicollinearity by determining the variance inflation factors.

Results

Sample characteristics

The total sample ($N = 1,155$) for this study consisted of adult farmers age 18 and over who reported they were the head of household on a ≥ 10 acre farm in active operation, and the household owned at least one ATV (Table 4.1). The mean age was 57 years ($SD \pm 12.4$), and 89% were male. Eighty-seven percent of the sample had at least a high school education and 99% were Caucasian. Seventy-one percent had an annual household income of at least $40,000. Farmers living on livestock farms made up 52% of the sample while 22% lived on crop farms and 17% on hobby farms. The mean number of members living in the farm household was 2.6 ($SD \pm 1.18$, 1-11). Seventy-three percent of the total sample had ridden an ATV in their lifetime. Most farmers whose household owned an ATV had ridden before (98%).

Eleven percent (128) reported having been injured while operating an ATV in their lifetime. There was a statistically significant difference in age between cases and controls ($t= 5.72$, 1153, $p < .0001$) with cases being younger than controls. The mean age for cases was 51 years ($SD \pm 14.2$) vs. 58 years ($SD \pm 11.9$) for controls. Ninety-one percent of the injured (cases) were males. The sample was too homogeneous to determine if there was a difference in injury based on gender.

Associations between individual characteristics and behaviors and ATV injury

Age under 45 years, younger age when beginning to ride an ATV, prior farm machine injury, perceived stress, risk propensity, dangerous risk-taking attitude, and risk acceptance were all statistically associated with self-reported lifetime ATV injury in farm head of households in the bivariate analysis ($p < .05$) (Tables 4.2-4.5). Farmers who rode ATVs in the 18 to 29 age group were 6.86 (*95% CI* 2.76-17.05) times more likely to be injured compared to the referent group (65-95 age group). ATV riding farmers in the 30-45 years age group were 3.85 (95% CI 2.19-6.78) times more likely to be injured and 46-64 year olds were 1.43 (0.86- 2.38) times more likely to be injured when compared to the referent group (Table 4.2).

Age at the time participants first started riding as the driver or passenger on ATVs was also an injury risk factor. The mean age that participants first rode an ATV was significantly younger for cases than controls (t=6.83, $p < 0.0001$) (Table 4.5). The mean age for first riding among cases was 22.5 years (*SD* ± 15.50) vs. 32.8 years (*SD*± 15.84) among controls.

Additional individual characteristics and behaviors were identified as risk factors for ATV injury. Cases were significantly more likely than controls to report prior injury on other farm machinery (χ^2= 22.54, $p < .0001$). Cases had a statistically significant higher mean stress level than controls ($\bar{x}$ = 5.33 vs. $\bar{x}$ = 4.82, $p = 0.02$). Cases had a higher risk propensity score (χ^2 = 26.07, $p <.0001$) compared to controls, and were 1.97 (*95% CI* 1.32, 2.93) times more likely to have a high dangerous risk-taking attitude than controls. Risk acceptance was associated with injury (χ^2= 6.92, $p = 0.01$). For farmers who were risk averse, there was a protective effect from ATV injury (OR=0.57; 0.37, 0.87). Gender, perceived risk of riding ATVs, and perceived behavioral control were not significant predictors of injury status.

There were significant associations between a number of risky ATV riding behaviors and use patterns (Tables 4.2, 4.3, and 4.5). The number of hours per month farmers rode ATVs was significantly associated with ATV-related injury (t = -2.37, 1102, $p = 0.02$). The mean hours per month of ATV riding for cases was 30.58 hours (*SD* ± 28.72) vs. 22.97 (*SD* ± 34.33) for controls. There were 4 separate riding behavior variables that were hypothesized to have an influence on injury status. Wearing a helmet

and attending an ATV safety course were expected to be protective while riding as a passenger or carrying passengers were expected to be risk factors for injury.

Helmet use was found to be a protective factor (OR = 0.60; 0.33, 1.12) when comparing cases and controls. Those who never wore a helmet when riding were compared to those who wore a helmet 1-10 hours of every 10 hours of riding; however, only 6% of ATV riders in the study (61 of 913 farmers) reported ever wearing a helmet. Cases were 2.34 (*95% CI*: 1.59, 3.45) times more likely to carry passengers while riding ATVs than controls (χ^2 = 19.55, p = < .0001) and were 1.64 (*95% CI*: 1.10, 2.43) times more likely to ride as a passenger on an ATV than controls (χ^2= 6.07, p= 0.01).

Having more exposure to activities known to be risky on the farm such as riding a tractor and working around animals was associated with ATV injury (t = -2.57, p = 0.01) (Table 4.5). Number of hours working on the farm did not differ by study group. Similarly, cases and controls did not differ in the number of hours worked off the farm each week nor did they differ on the percent of time the ATV was used for work and leisure (t = 0.72, p = 0.47; t = -1.53, p = 0.13, respectively (Table 4.5).

Farm environment factors

The farm environment factors assessed were farm type, terrain, and participating in an ATV safety course. Farm type was not significantly associated with injury. The presence of livestock was also not found to be significantly associated with injury (χ^2= 0.57, p = 0.45) (Table 4.3). ATVs were used on different terrains but only riding on public roads was significantly associated with injury. Cases were 2.92 (*95% CI*: 1.90, 4.52) times more likely than controls to report riding their ATV on public roads. Only nine percent of farmers in the total sample had ever attended an ATV safety course, but not attending was significantly associated with injury (χ^2= 15.0, p < 0.0001).

Significant ATV injury risk factors

Two logistic regression models predicting ATV injuries in farmers can be found in Table 4.6. Younger age, riding ATVs on public roads, carrying passengers, having a high score on the dangerous risk-taking attitudes scale and high risk propensity score were significant predictors of ATV injuries in this sample of farmers. The difference in the two models is that the first includes the risk propensity variable and the second one

does not. Risk propensity is a measure of the individual's overall risk over time. Variance inflation factors were assessed and were all around 1, indicating that the risk propensity measurement is different from the dangerous risk-taking attitude scale. Based on AIC and likelihood ratio estimates, the simpler model without risk propensity is a superior model. The sample size is also larger for the simpler model because there were 236 repondents who left out one or more responses in the risk propensity scale. Twenty-five percent of those with missing data did not complete any of the scale. However, the model with risk propensity shows that it is significantly associated with injury and thus significantly adds to the literature.

The estimated risk was highest for the 18-29 age group of adult farmers riding ATVs and declined with age with a dramatic shift at age 46. However, the 30-45 year old ATV riders were also more likely than the 65-95 year old riders to be injured. Linear regression was computed to determine the variance inflation factors of the variables which were all around 1, indicating multicollinearity was not an issue.

Discussion

The results of this study identified five risk factors for ATV injury: younger age, riding on public roadways, carrying passengers, dangerous risk-taking attitude, and risk propensity. The finding that younger adult ATV riders on farms are more likely to suffer injuries than older ATV riders supports the previous findings of Rodgers and Adler's (2001) national case-control study that the estimated injury risk for ATV drivers generally declined with age. Rodgers (1990) also studied the risk factors for ATV-related fatalities and found that the risk of death declines as a driver ages until they reach forty, after which the risk begins to increase.

The injured farmers in this study began riding ATVs at a younger age than the noninjured farm riders and rode more hours per month. The more exposure farmers have to ATVs, the more likely they are to be injured. This supports previous findings from a national study of ATV drivers that estimated risk of injury generally rose with greater time spent driving ATVs (Rodgers & Adler, 2001).

ATVs were developed for off-road use on rough, hilly, uneven terrain with their large, balloon-type tires. They were not intended for use on public roadways where there is further risk of collision with other moving vehicles. Many states, including Kentucky,

permit ATV drivers to ride on public roadways if they are using the ATV for an "occupation," or to cross the roadway if the distance is short. It is unknown how much ATV operation on roadways is for the purpose of work or recreation. While we do not know whether the reported injuries occurred on the roadway in this study, we know that those who reported riding on public roads as part of their usual pattern of ATV use were more likely to have experienced an ATV-related injury. This provides evidence to support policy changes to either prevent ATVs from being operated on public roadways altogether, or restricting roadway operation to daylight hours, requiring headlights while on roadways, and possibly permitting roadway crossing in specific areas designated by road signs. Rodgers (1990) found that driving ATVs on paved roads more than doubled the risk of fatality associated with ATV injury crashes. The Consumer Product Safety Commission (2010) reported 5,192 on-road ATV deaths between 1982 and 2007. Forty-seven percent (4,013) of those were on public roads. There were 220 ATV-related deaths in West Virginia from 1990-2003 and nearly one-third of the ATV crashes occurred on public roads, streets, and highways (Helmkamp, 2003). Between 2004 and 2006 there were 112 fatal ATV crashes in the same state, of which 48% were traffic crashes (Hall et al., 2009).

All ATVs have warning labels that were intended to inform riders that they should not carry passengers or ride as a passenger. ATVs are rider-active vehicles made for one person. There are multiple examples of studies that report people ride as passengers on ATVs and that extra riders can cause vehicle instability and cause injuries to the driver and passengers (Hafner et al., 2010; Prigozen et al, 2006; Brown et al., 2002; Helmkamp, 2000; Rodgers, 1999; Lynch et al, 1998; Tormoehlen & Sheldon, 1996). This study further supports those findings. Both riding as a passenger and carrying a passenger were significantly associated with ATV injuries among farmers with ATVs. Farm families need education about the dangers of carrying passengers.

Individual risk-taking characteristics have rarely been studied in the agricultural injury prevention literature. The findings reported here support these associations may linger in adulthood and provide impetus for measuring individual risk-taking attitude in injury prevention research as well as developing and testing risk reducing interventions targeting past risk and social influence to decrease ATV injury. One study (Westaby &

Lee, 2003) reported that dangerous risk-taking attitude by adolescents on farms predicts injury.

Helmet use in this study was alarmingly low among cases and controls. We intended to include helmet use in the regression model but could not due to the small number who ever wore a helmet. Clearly, interventions to increase helmet use among farmers on ATVs are warranted. It is well-established that helmet use would decrease the number of ATV-related injuries and deaths (Bowman, Aitken, Helmkamp, Maham, & Graham, 2009; Helmkamp, 2000; Rodgers, 1990). Only 31 states have some form of helmet regulation. These laws vary in that some apply only to riding an ATV on public land, some exempt helmet use if riding the ATV for agricultural or other specific purposes, and some helmet laws only apply to those under 16 or 18 years of age (Specialty Vehicle Institute of America, 2012). Future studies need to examine the effectiveness of helmet use regulation on injury outcomes.

Gender was not a significant risk factor for injury in this study. This may be related to the larger percent of male respondents compared with females so further study is needed. Prior studies have shown that men have higher injury rates than women on the farm (110.9 vs. 36.2/ 1,000 persons per year) (Mongin et al., 2007). Multivariate analysis for agriculture-related injury incurred on the farmers own operation adjusted for age and state of residence, indicated men were 3.08 times more likely than women to be injured (Mongin et al., 2007). However, when men and women were compared using the hours worked as a denominator, the risk for injury was similar in the two groups The Canadian Agricultural Injury Surveillance Program studied farm work injuries and fatalities from 1990-1996. There were 11 times more farm fatalities in men than women and the machine injuries that required hospitalization in men to women were 9:1 (Dimich-Ward et al., 2004). In the general population of ATV users, males were three times more likely to be injured as females (Rodgers and Adler, 2001). Studies of ATV use by women on farms need to be conducted.

There were no associations between ATV use for farm work and injury status. On average, 90% of the total sample reported using ATVs for farm work. Our findings are inconsistent with research on the general population of ATV riders. In one study of ATV users, as use of ATVs in non-recreational applications increased, the estimated risk for

injury decreased (Rodgers & Adler, 2001). In the current study, farmers were asked about the ATV use and not specifically how much time they used the ATV for work or leisure which biased the findings. More research is needed to study the particular parameters of recreational and non-recreational ATV use on farms and whether or not this makes a difference in injury risk.

The demographic characteristics of this random sample of farmers are very similar to the demographics of the population of farmers in Kentucky based on the 2007 agricultural census for Kentucky (NASS, 2007). The mean age for the sample was 57 years and the average age for principal operators in the census was 56.5 years. Eighty-nine percent of the principal operators in the 2007 census were male and 89% of this sample was also male. Fifty-two percent of the farmers in this sample lived on livestock farms and based on information about farms by concentration of market value of agricultural products sold in Kentucky in 2007 56% of the farms sold livestock including primarily cattle and calves, milk cows, and hogs and pigs (National Agricultural Statistics Service, 2007). The average farm size in Kentucky in 2007 was 165 acres. Farms in this sample ranged from 10 to 10,000 acres with a mean of 301 acres ($SD \pm 625$) and a median of 126 acres.

Limitations

Results of this analysis should be interpreted with caution. This study represents a conservative analysis of the actual injuries that may have occurred. The self-reports of injuries were for those occurring while the respondent was operating the ATV, but it is possible that other injuries may have occurred while they were riding as a passenger on an ATV and were not reported in this study. The ATV-related injuries in this study cannot be classified as occupational or recreational. Many farm households use ATVs for both purposes and it is very difficult to make this distinction. Responses to the survey may be subject to recall bias because the questions required historical information. Information about risk-taking behavior and hours of ATV riding may have varied from the time when the injury event actually happened. Also, respondents were asked to recall any ATV-related injury in their lifetime so less severe injuries may have been missed. While recall bias is a potential limitation, there is no reason to believe it had systematic impact on the statistical results. Utilizing *lifetime* ATV injury as the dependent variable is

a limitation because the prevalence is not comparable to annual injury rates in other studies. Also assumptions were made that behaviors and attitudes of participants have not changed through time. Since risk factors were not assessed based on the participants' specific injury events, the potential for the injury risk factors to vary based on the type of crash exist.

Conclusions

ATV injury risks on farms are related to a number of rider characteristics, behaviors, and farm environment factors. As hypothesized, cases were more likely to report risky riding behaviors such as carrying passengers. However, exposure to risky activities on the farm such as riding tractors and working with large animals were negatively associated with ATV injury. Perceived behavioral control, risk propensity, dangerous risk-taking attitude, and risk acceptance were significantly associated with ATV injury among farmers. The risk propensity scale was lengthy and a number of respondents left it blank or missed parts of the scale, so that variable was not included in the regression model as it would have significantly decreased the number of cases and controls for analysis. Risk acceptance was not significant when controlling for other variables in the model.

Community-based educational interventions for ATV riders need to be tailored to meet the needs of farmers. Farmers should receive education on the significant risk factors for injury with an emphasis on age as a risk factor. Farmers need to be encouraged to require every member of the farm household to have ATV-specific education to ensure safer riding practices. Farmers perceive that there are risks involved with using ATVs. Increasing awareness of the specific risk factors for ATV-related injury on the farm is warranted. Future research needs to measure these rider characteristics and behaviors in a national random sample of farmers to determine if these findings are generalizable to all farmers, or if there are state-specific variations in ATV injury risk factors among farming communities.

Prospective studies of farmers who experience ATV-related injuries are recommended so crash characteristics can be documented for educational and policy-relevant purposes. Surveillance studies of the occupational use of ATVs on farms need to be conducted to determine if farm jobs can be carried out more safely with the use of

ATVs or other machinery. Members of farm households live, work, and play where the farm work occurs and they have exposure to ATVs at work, recreation, or both. Further examination of how farmers learn to use ATVs, what supervision children have when riding ATVs on the farm, and what household rules apply to different family members needs to be assessed in order to develop and test prevention intervention strategies.

Future research should measure the same rider characteristics presented in this theoretical model in a national random sample of farmers to determine if the dissertation findings are generalizable to all farmers, or if there are state-specific variations in ATV injury risk factors among farming communities. In conclusion, education and enforcement, two primary strategies for injury prevention, must be implemented to reduce the risk of ATV-related injury among adult farmers (Christoffel & Gallagher, 1999). ATV education should be mandatory for all riders and age-appropriate in order to decrease risk-taking and change attitudes toward risk. State laws that exempt occupational users of ATVs from following the same guidelines as other users and that allow riding on public roadways need to be further examined. Enforcement of laws and regulations regarding riding on public roadways and carrying passengers on ATVs is necessary to reduce injury risk. Finally, although not included in this study, engineering factors need to be examined to decrease injury risk.

Table 4.1 Distribution of Select Demographics by Case/ Control Status ($N = 1155$)

Demographic	Cases (***n*** = 128)	Controls (***n*** = 1027)	χ^2	p-value
	n %	*n* %		
Age (years)				
18-29	9 (7)	18 (2)	41.39	< 0.0001
30-45	37 (29)	132 (13)		
46-64	60 (47)	575 (56)		
65-88	22 (17)	302 (29)		
Gender				
Male	117 (91)	917 (88)	0.67	0.41
Female	12 (9)	122 (12)		
Education				
< High School	18 (15)	129 (13)	0.33	0.57
≥ High School graduate	106 (85)	888 (87)		
Race				
Caucasian	129 (100)	1034 (99)	0.75	0.39
Minority	0 (0)	6 (1)		
Farm Type				
Livestock	68 (54)	535 (52)	3.76	0.44
Crop	31 (24)	220 (21)		
Hobby	16 (13)	179 (17)		
Dairy	2 (2)	33 (3)		
Other	10 (8)	61 (6)		
Farm Size (acres)				
10-65	24 (19)	208 (21)	0.97	0.81
66-126	28 (23)	225 (22)		
127-278	31 (25)	284 (28)		
279-10,000	41 (33)	297 (29)		
Income				
<40K	22 (20)	270 (31)	5.02	0.03*
≥40K	87 (80)	614 (69)		

[1] Sum may not equal 1155 due to missing values

Table 4.2 Univariate Logistic Analysis of Risk Factors for ATV-Related Injuries

Variable	# of Riders	# Injured	Event Rate/100 riders	Odds Ratio (95% CI)
Age (Years)				
18-29	27	9	33.3	6.86 (2.76-17.05)
30-45	169	37	21.9	3.85 (2.19-6.78)
46-64	635	60	9.5	1.43 (0.86-2.38)
65-95	324	22	6.8	*1.00
Ride on Public Roads				
Yes	150	35	23.3	2.92 (1.90-4.52)
No	976	92	9.4	*1.00
Carry Passengers				
Yes	504	81	16.1	2.34 (1.59-3.45)
No	596	45	7.6	*1.00
Dangerous Risk-Taking				
High Score	585	83	14.2	1.97 (1.32-2.93)
Low Score	516	40	7.8	*1.00
Gender				
Male	1034	117	11.3	1.3 (0.70-2.42)
Female	134	12	9.0	*1.00

* Indicates reference group

Table 4.3 Categorical Variables and their Association with ATV-related Injury

Variable	Total Riders	Cases	Controls	$\chi 2$	OR (95% CI)
Risk Acceptance	957	111	846	7.61	1.87 (1.19-2.94)**
Score >3	176	31	145		
Score <3	781	80	701		
Risk Propensity	957	111	846	26.07	3.05 (1.96-4.76)****
High	489	82	407		
Low	468	29	439		
Prior Farm Machine Injury	931	104	827	22.54	2.38 (1.58-3.59)****
Yes	320	55	265		
No	611	49	562		
Safety Course	944	110	834	15.0	0.36 (0.21-0.61)****
No	858	89	769		
Yes	86	21	65		
Ride as a Passenger	894	107	787	6.07	1.47 (0.96-2.26)
Yes	245	37	208		
No	649	70	579		
Carry Passengers	904	109	795	19.55	2.33 (1.53-3.54)****
Yes	434	72	362		
No	470	37	433		
Farm Type	788	91	697	0.57	0.92 (0.59-1.43)
Livestock	378	42	336		
Other	410	49	361		
Helmet Use	913	109	804	2.70	0.67 (0.33-1.36)
No	852	99	753		
Yes	61	10	51		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$

Table 4.4 Ordinal Variables and their Association with ATV-related Injury

Variable	Cases Median	Controls Median	MWU	*p*-value
Perceived Risk	4.0	4.0	71979.00	0.50
Perceived Behavioral Control	2.0	1.0	76592.00	0.01
Perceived Stress	5.0	5.0	79259.00	0.02

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$

Table 4.5 Interval Variables and their Association with ATV-related injury

Variable	*t*	*p*-value
Age 1st rode ATV (Years)	6.83	< 0.0001
Experience (Current Age-Age 1st rode)	-3.78	0.0002
Average hours worked on the farm (per week)	-1.07	0.29
Average hours worked off the farm (per week)	-1.54	0.12
Time ATV used for work (%)	0.72	0.47
Time ATV used for leisure (%)	-1.53	0.13
Risky Farm Behaviors	-2.57	0.01

Table 4.6 Two Logistic Regression Models Predicting ATV injuries among farmers, With and Without Risk Propensity

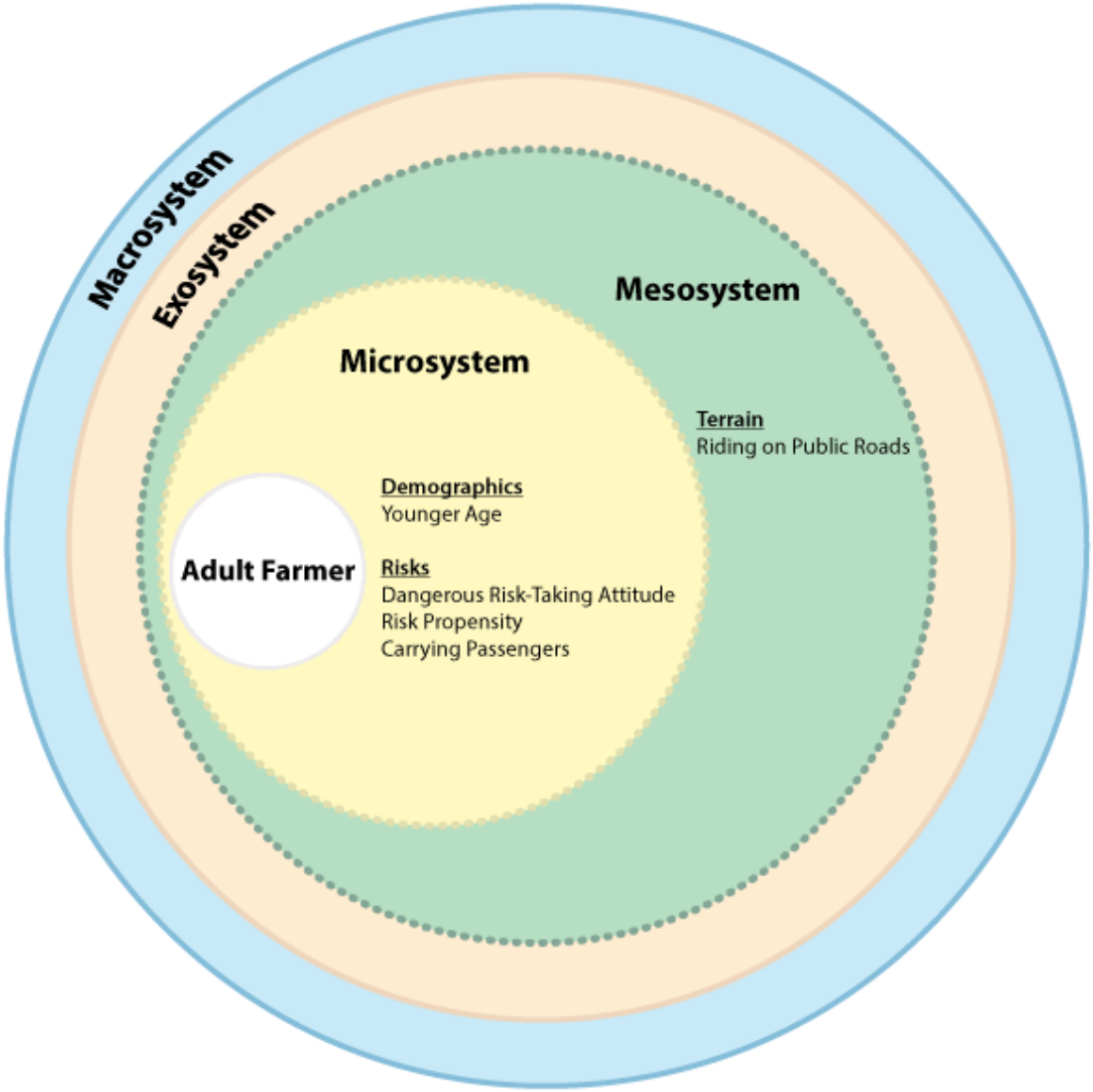
Variable	Model including Risk Propensity (n = 862)			Model without Risk Propensity (n = 1021)		
	Wald χ^2	Odds ratio (OR)	95% CI[a] for OR	Wald χ^2	Odds ratio (OR)	95% CI[a] for OR
Age group (Years)						
18-29	0.22	1.85	(0.57-6.06)	1.87	2.90	(1.03-8.20)
30-45	4.96	2.48	(1.20-5.11)*	4.40	2.73	(1.42-5.25)*
46-64	1.57	1.19	(0.62-2.31)	3.29	1.30	(0.72-2.32)
65-95 (reference group)						
Gender						
Male	0.12	1.16	(0.52-2.60)	0.00	0.98	(0.47-2.05)
Female (reference group)						
Riding on Public Roads						
Yes	4.72	1.81	(1.06-3.08)*	4.67	1.74	(1.05-2.9)*
No (reference group)						
Carry Passengers						
Yes	3.58	1.56	(0.98-2.48)	5.78	1.70	(1.10-2.61)*
No (reference group)						
Hours Riding	5.45	1.01	(1.00-1.01)	6.02	1.01	(1.00-1.01)
Dangerous Risk Taking	7.52	1.09	(1.03-1.16)**	27.32	1.15	(1.09-1.21)***
Risk Propensity	12.12	1.07	(1.03-1.12)***	--	--	--

[a]Confidence Interval

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Hosmer and Lemeshow Goodness-of-Fit (χ^2= 10.84, df 8, p= 0.21) Hosmer and Lemeshow Goodness-of-Fit (χ^2= 4.10, df 8, p = 0.85)

Figure 4.1 Ecological Model to Predict ATV Injury Among Farmers



Adapted from: Bronfenbrenner, U. (1979). *The Ecology of Human Development: Experiments by Nature and Design.* Cambridge: Harvard University Press.

CHAPTER FIVE

Summary

Discussion and Conclusion

This dissertation presented three papers that explored ATV ownership, ridership, and injury risk factors among adult farmers. First, the literature was explored to determine the current state of knowledge about ATV injury risk factors and occupational use of ATVs on farms. Second, a study investigating factors that predicted ATV ownership and ridership in a sample of adult farmers was described. Third, findings of a nested case-control study investigating predictors of ATV injury risk in adult farmers whose household owned an ATV were discussed.

This dissertation specifically aimed to:

1. Critically analyze the state of the science on ATV-related injury risk factors and explore recreational and occupational use of ATVs on farms.
2. Describe individual characteristics and demographic factors that are associated with ATV ownership and ridership among adult farmers.
3. Describe individual characteristics and environmental factors that are associated with ATV injury on farms.
4. Test models for predicting ATV ownership, ATV ridership, and ATV injury risk factors among adult farmers.

Deaths and injuries from ATVs have increased over time (CPSC, 2010) and ATVs are becoming more popular for recreational and occupational use on the farm (Ruen, 2009). The literature review, presented in Chapter Two, identified the following injury risk factors in the general population of ATV riders: younger age, male gender, absence of helmet use, risky behaviors such as riding as a passenger or carrying passengers on the ATV, riding on pubic roadways, and larger ATV engine size. ATV crashes have produced serious injuries in every body system and death in all age groups (Rodgers & Adler, 2001; Bowman et al., 2009; Brown et al., 2002; Helmkamp, 2000; Lynch et al., 1998; Rodgers, 1990).

Due to the limitations of the ATV injury prevention literature it was very difficult to define the true scope of the problem and trends in ATV injuries given there was no

standard measure of injury incidence, making it difficult to compare results across studies. Some studies reported injury frequencies while others used estimated rates. The review revealed that many descriptive studies relied on small, non-random samples and failed to provide generalizable evidence about ATV use patterns or, rider characteristics such as behaviors, attitudes, and specific risk-taking that may contribute to injuries and death. There was a bias toward the most severely injured due to the lack of nationwide and statewide surveillance of ATV-related injury.

The research related to ATVs on farms consisted of five national studies, one regional, 10 state, and one local study. Eight of the 17 farm studies focused on children. The studies involved retrospective review, cross-sectional analyses, or prospective cohorts. Additional research using random samples of adult ATV riders on farms was recommended. Gaps identified in the literature included differentiating between recreational and occupational use of ATVs, how ATVs are used on farms, what the risk factors for injury are in adult farmers, and characteristics of ATV owners and riders on farms. There is also little to no evidence in the research literature about the efficacy of interventions to address prevention of ATV-related morbidity and mortality. This review provided a summary of the current literature on ATV risk factors and ATV use on farms and provides guidance for future research.

The study in Chapter Three described ATV use on farms, and examined associations between individual characteristics and behaviors and ATV ownership and ridership among a sample of farmers. The majority of ATVs on the farm were used for farming and recreation. Only 18% of the farm households with ATVs used them for farming all of the time. For farming, ATVs were used for monitoring property and livestock, hauling and transporting supplies, and using attachments to work the fields.

This study tested two predictive models, one of characteristics associated with ATV ownership and one related to ridership among farmers. Those who owned ATVs on their farm were more likely to be younger, male, and have fewer years of education. Significant predictors for ATV ridership were younger age, male gender, and dangerous risk-taking attitude. Fifty-three percent (1,208) of participants owned an ATV on their farm. Only one other study has examined ATV ownership on farms and it reported that approximately 643,348 farms in the United States owned ATVs (Goldcamp et al., 2006).

The estimated average ATV ownership was 519 (± 16) ATVs per 1,000 farms, with the highest rates in the west, and Midwest regions of the U.S. They estimated that 39% of all farms in operation in the United States had ATVs in 2001. It is likely that the prevalence of ATVs on farms increased over time from 2001 to the time data were collected for the current study. Goldcamp et al. (2006) found that ownership of ATVs was consistent across all types of farms. Our study supported this finding that farm type is not a significant predictor of ATV ownership. Our study is the first study to explore individual characteristics and behaviors of adult farmers as predictors of ATV ownership and ridership.

Chapter Four presented a nested-case control study to identify individual characteristics and behaviors and farm environment factors that predict ATV injury. The results supported Rodgers & Adler's study (2001) that identified younger age and higher monthly driving times as ATV injury risk factors. The participants were older in the dissertation study ($\bar{x}$ =57; SD ±12.4) compared to the national case-control study of the general population of ATV users (average age was not reported but 91.4% of cases and 82.3% of controls were ≤ 45). The incidence of helmet use and participating in formal ATV safety training was so low in the dissertation sample that these topics will have to be explored in future research. There are major implications for policy change based on the number of modifiable characteristics that predicted injury in our model. Riding on public roadways, carrying passengers, and high dangerous risk-taking attitude were predictors of ATV injury on farms.

Both of the studies presented in Chapters Three and Four were based on the same sample and had limitations. The investigator made the assumption that since the survey respondent was the head of household, he/ she was also the owner of the ATV(s) in cases where the farm household owned one or more ATVs. Recall and self-report bias are major limitations of survey studies. Respondents were asked to recall riding on an ATV or incurring an ATV injury in their lifetime. The sample was large and the size may have uncovered relationships with small effect sizes resulting in a Type 1 error. Finally, there are limitations inherent in using the odds ratio as the effect measure for higher prevalence outcomes.

Implications for Public Health Practice, Policy Change, and Research

The findings of this dissertation are valuable for public health practice and research. The research studies fill gaps in the literature about ATV use by adults on farms and by identify the characteristics that predict adult farmers who own and/or ride ATVs and summarize the risk factors for ATV injury in adults on farms. Public health practitioners need to be alert to the occupational hazards of farming and understand the farm culture including risk-taking and risk acceptance as guided by the Bronfenbrenner theoretical model (1979). There are multiple levels of influence that impact injury on the farm. This study identified individual characteristics and farm environment characteristics that influence ATV injury on the farm. Practitioners must examine the existing resources to determine the feasibility of adapting those with this new knowledge in mind. Practitioners must increase knowledge about safe use of ATVs on farms and increase awareness of the risk factors associated with ATV-related injury to farmers. This can be accomplished through media campaigns, sharing of information through Cooperative Extension Offices, farming organizations, and publishing information in popular farm magazines. The message should include importance of wearing a helmet, not carrying passengers or riding as a passenger, and avoiding public roadways.

Additionally, farmers need to understand that attitudes about safety and risk-taking affect decision-making and can result in injury. Educational strategies need to be developed for adult farmers and members of the farm household who use ATVs for occupational or recreational purposes on the farm. Statewide surveillance of ATV-related injuries and deaths is necessary to determine how the ATV was being used and whether the rider was using protective gear. The more information learned about the specific circumstances surrounding the injury event will inform the development of specific guidelines for safe ATV use.

Policies related to ATV use have been successful in reducing injuries and deaths (US GAO, 2010; Keenan & Bratton, 2004; Helmkamp, 2001). To prompt policy action, policy makers must be made aware of the burden to society related to ATVs: injuries, deaths, and cost of care for the injured and lost work time and productivity. It is time for comprehensive policy changes at the national and state levels. ATV users should be required to have their ATV registered and each rider should be required to be licensed

upon successful completion of mandatory rider training. Comprehensive ATV policy recommendations include helmet use, no passengers, and no riding on public roadways, and must include riders of all ages and not exclude based on occupational use. Additionally, policy should include specific provisions for supervision of minors by an adult including proximity of the rider to the adult supervising and consequences should be enforced for adults who do not require minors to follow the laws. Enforcement of laws on public and private property is necessary and education of law enforcement authorities is required for this to be successful.

Research about ATVs on farms is in its infancy. Future studies are recommended including: replication or adaptation of this study with other groups of farmers or by region; and descriptive studies to differentiate occupational and recreational use of ATVs on various types of farms. Prospective studies of ATV riders on farms are needed to study: (a) injury outcomes in adults; (b) barriers to helmet use while using ATVs on farms; (c) surveillance studies of livestock farms with ATVs to assess frequency and patterns of ATV use and determine specific tasks that require risky ATV behaviors; (d) evaluation of safety and training program effectiveness on changing knowledge, attitudes, and behaviors; and (e) effectiveness of policy implementation and enforcement.

UNIVERSITY OF KENTUCKY College of Nursing

UNIVERSITY OF KENTUCKY College of Public Health

Southeast Center for Agricultural Health and Injury Prevention

ATV Farm Safety Study

Please circle yes or no and fill in the blanks for ATVs and UTVs below.

An all-terrain vehicle (ATV or 3- or 4-wheeler) in this study means a motorized vehicle with one seat that can be straddled, large low pressure tires, and handlebar steering. An example of what these vehicles may look like is pictured here:

1. Does your farm household have an ATV?

   1. Yes 0. No

2. If yes, how many ATVs are used by the household? _____

A utility vehicle (UTV or rhino, gator, or mule) in this study means a motorized vehicle designed for more than one passenger with a steering wheel and smaller tires. An example of what these vehicles may look like is pictured here:

3. Does your household have a UTV?

   1. Yes 0. No

4. If yes, how many UTVs are used by the household? _____

The rest of the questions are about ATVs only. Please answer the remaining questions even if you don't have or ride ATVs. Your opinion is still important to us.

5. To what extent do you agree or disagree with the following statements? Circle your answer.

		Strongly disagree	*Somewhat disagree*	*Somewhat agree*	*Strongly agree*
a.	Helmets are <u>not</u> necessary when riding ATVs on the farm.	1	2	3	4
b.	A drivers license should be required to operate an ATV.	1	2	3	4
c.	ATVs should not be driven on highways except to cross the road.	1	2	3	4
d.	The state of Kentucky should adopt stricter guidelines for ATV operation.	1	2	3	4
e.	State laws relating to ATV use should not apply to farms.	1	2	3	4
f.	ATVs are dangerous and should be ridden with caution.	1	2	3	4
g.	Riding an ATV is part of living in Kentucky.	1	2	3	4
h.	ATV crashes are freak accidents in which the driver has no control.	1	2	3	4
i.	ATV operators of all ages should be required to attend formal safety training.	1	2	3	4
j.	ATVs should be registered through the state, similar to motorcycles or cars.	1	2	3	4
k.	Speed governors should be placed on ATVs for children under age 16 to control how fast they can drive the ATV.	1	2	3	4
l.	Wearing a helmet will decrease my risk of having a head injury if I am involved in an ATV crash.	1	2	3	4
m.	Carrying a passenger on an ATV increases the risk of being injured.	1	2	3	4

6.	Circle whether you agree or disagree with each statement.	*Agree*	*Disagree*
a.	Farming is more dangerous than jobs in industry or manufacturing.	1	0
b.	Accidents are just one of the occupational hazards of farming that must be accepted if you are going to be in the business.	1	0
c.	Compared to other farmers I'm very conscientious about avoiding accidents.	1	0
d.	During a normal work week, it's common for me, while doing farm work, to experience a number of "close calls" that under different circumstances might have resulted in personal injury or property loss.	1	0
e.	To make a profit, most farmers take farming risks that might endanger their health.	1	0

7.	Circle yes or no for each of the following:	*Yes*	*No*	
a.	Do you personally know of anyone who has been seriously injured (required medical attention) while riding an ATV?	1	0	
b.	Do you personally know of anyone who died due to an ATV crash?	1	0	
c.	Have you changed the way you ride on ATVs based on something that has happened to you or to someone you know? *If you do not ride on ATVs, circle 9.*	1	0	9
d.	Has anyone else in your immediate family ever taken an ATV safety course?	1	0	
e.	Have you ever taken an ATV safety course?	1	0	
f.	Are you a member of an ATV riding club/organization?	1	0	
g.	Do your children have different household rules for riding an ATV compared to adults in your household? *If no ATV or children, circle 9*	1	0	9
h.	If there are children under 16 in your household riding the ATV, do all the children wear helmets*? If no ATV or no children, circle 9*	1	0	9
i.	Do you think children under 16 years old are more at risk on an ATV than an adult?	1	0	

Listed below are different categories of risk some people take over their lifetimes. Please circle a number for how often you face any of the following risk categories now and also how often you faced any of these in your adult past, since you turned 18. *Circle a number for both now and past.*

8.	How often do/did you take:		*Never*	*Rarely*	*Often*	*Quite often*	*Very often*
a.	Recreational risks (e.g. rock climbing, scuba diving)	Now	1	2	3	4	5
		Past	1	2	3	4	5
b.	Health risks (e.g. smoking, poor diet, high alcohol consumption)	Now	1	2	3	4	5
		Past	1	2	3	4	5
c.	Career risks (e.g. quitting a job without another to go to)	Now	1	2	3	4	5
		Past	1	2	3	4	5
d.	Financial risks (e.g. gambling, risky investments)	Now	1	2	3	4	5
		Past	1	2	3	4	5
e.	Safety risks (e.g. fast driving, city cycling without a helmet)	Now	1	2	3	4	5
		Past	1	2	3	4	5
f.	Social risks (e.g. standing for election, publicly challenging a rule or decision)	Now	1	2	3	4	5
		Past	1	2	3	4	5

9. How strongly do you agree or disagree with the following statements?

		Strongly disagree	*Disagree*	*Un-decided*	*Agree*	*Strongly agree*
a.	I would rather take risks than be overly cautious.	1	2	3	4	5
b.	In the past month, I have done some exciting things that other people think are dangerous.	1	2	3	4	5
c.	I love to take risks even when there is a small chance I could get hurt.	1	2	3	4	5
d.	Sometimes people get on my nerves when they tell me how to act "more safely."	1	2	3	4	5
e.	I value having fun more than being safe.	1	2	3	4	5

The following questions relate to your personal experiences.

10. How many <u>days a month</u> are you exposed to or engaged in the following items/activities on your farm? *Your best guess is fine. Enter 0 if none. If every day, enter 30. Please enter a number for each item.*

		Days per month			Days per month
a.	Large animals	/___/___/	d.	Operate a tractor	/___/___/
b.	Farm chemicals	/___/___/	e.	Ride tractor as passenger	/___/___/
c.	Machinery such as balers/augers	/___/___/			

11. Have you ever ridden an ATV either as a driver or a passenger?

1. Yes-continue 0. No – *skip to question 22 on pg. 7.*

12. At what age did you first ride an ATV either as a driver or a passenger? *Your best guess is fine.*

    /___/___/ Age first road ATV

13. In the past 3 months, in your household have you been the person who rides an ATV the most?

    1. Yes 0. No

14. In an average month on the farm, how many days do you ride an ATV*? Your best guess is fine.*

    /___/___/ # days ride ATV in average month

15. On these days that you ride, on average about how many hours do you spend on an ATV each day? *Your best guess is fine.*

    /___/___/ # hours per day ride ATV on days that ride

16. Thinking about all the time you personally use an ATV, for every 10 hours of ATV use about how many hours would you say you carry a passenger and ride as a passenger? *Your best guess is fine. All the time =10; None of the time = 0. Please enter a number for both hours carry and ride.*

    /___/___/ # hours carry a passenger on ATV. Enter number. If all the time = 10; None = 0.

    /___/___/ # hours ride as passenger on ATV. Enter number. If all the time = 10; None = 0.

17. Next, thinking about your personal helmet use, for every 10 hours you use an ATV, about how many hours do you personally wear a helmet? *Enter the # of hours. Your best guess is fine. All the time =10; None of the time = 0.*

    _____ # hours you personally wear a helmet on ATV. *Enter number. If all the time =10; None = 0.*

18. How often do you personally ride ATVs: *Circle one number for each item.*

		Never	*Sometimes*	*Often*	*Always*
a.	On paved roads	0	1	2	3
b.	On unpaved roads	0	1	2	3
c.	On public roads	0	1	2	3
d.	On cultivated fields	0	1	2	3
e.	On pastures or ranges	0	1	2	3
f.	In forests or woods	0	1	2	3
g.	Across paved roads	0	1	2	3
h.	Over yards or lawns	0	1	2	3
i.	Over creeks, streams or swamps	0	1	2	3
j.	Over ditches	0	1	2	3
k.	Up hills, mountains, other steep terrain	0	1	2	3
l.	Do maneuvers like wheelies or jumping on an ATV?	0	1	2	3
m.	Engage in organized ATV trail rides?	0	1	2	3
n.	Compete in organized ATV racing or race informally with others?	0	1	2	3

The next series of questions is about injuries.

19. For the following questions, getting hurt or injured means an injury that kept you from doing your usual activities for at least 4 hours. In your lifetime, have you ever gotten hurt while operating an ATV?

1. Yes 0. No – *skip to Question 22 on the next page.*

20. How many times have you been injured due to an ATV? /___/___/ # times injured due to ATV

		Yes	No
a.	In the past 3 years, have you been hurt on an ATV?	1	0
b.	In the past 3 years, have you had to go to the hospital or doctor when you got hurt on an ATV?	1	0
c.	Have you gotten hurt while riding an ATV in the last month?	1	0

21. On a scale of 1 to 10 where 1 is not at all likely and 10 is extremely likely, how likely do you think you are to personally be injured while riding an ATV? *Circle one number.*

1	2	3	4	5	6	7	8	9	10

➔➔➔ Start here if you skipped the previous section because you have never ridden an ATV or were never hurt on an ATV.

22. In your lifetime, have you ever gotten hurt while operating any machinery besides an ATV on the farm?

1. Yes 0. No

23. How many other members of your household have gotten hurt on an ATV in the past? Getting hurt or injured means an injury that kept them from doing their usual activities for at least 4 hours.

/___/___/ # other household members hurt on ATV. *Enter 0 if none*.

STOP AND CHECK:

24. Have you or anyone else in your household been hurt riding on an ATV on your farm within the past 3 years?

1. Yes – continue **0. No – *skip to Q26 on Page 10.***

The next 2 pages ask about specific times when someone in your household was injured on an ATV.

25a. Please complete the following chart for the **most serious** ATV-related injury event that has occurred within the past 3 years either to you or a family member on your farm.

a. What was the injured person's position on the ATV?	Operator Passenger			
b. How many wheels did the ATV have?	3 wheels 4 wheels			
c. What was the engine size of the ATV that crashed?	70 cc or less 71-90 cc more than 90 cc			
d. Was the person doing farm work at the time of injury?	Yes No Don't Know			
e. Was the person riding for fun at the time of injury?	Yes No Don't Know			
f. How many people were on the ATV when it crashed?	/___/___/			
g. How many people were injured?	/___/___/			
If more than 1 person was injured in this incident, please answer the rest of the questions for the person with the most serious injury.				
h. Was this person male or female?	Male Female			
i. How old was this person?	/___/___/_age when injured			
j. Was a doctor or health care professional consulted?	Yes No Don't Know			
k. How many days did the person have to stay in the hospital? Your best guess is fine.	/___/___/___/ Enter 0 if none.			
l. How many days of usual activity were missed?	/___/___/___/ days missed from injury			
m. Did the person fully recover from the injury?	Yes No Don't Know			
n. Parts of the body most affected?				
o. Number of surgeries to repair injuries?	_____# surgeries. Enter 0 if none.			
p. Has this person ever had a serious injury from other machines on the farm?	Yes No Don't Know			
q. What was the main type of training/education the injured person completed prior to riding ATVs?	None	Parent	Safety course	Other _____
r. What kind of crash caused the injury?	Rollover	Collision	Ejection	Other_____
s. Was the injured person wearing a helmet?	Yes No Don't Know			

25b. Now we'd like information on the **next most serious** ATV-related injury event that has occurred within the past 3 years either to you or a family member on your farm.

a. What was the injured person's position on the ATV?	Operator Passenger			
b. How many wheels did the ATV have?	3 wheels 4 wheels			
c. What was the engine size of the ATV that crashed?	70 cc or less 71-90 cc more than 90 cc			
d. Was the person doing farm work at the time of injury?	Yes No Don't Know			
e. Was the person riding for fun at the time of injury?	Yes No Don't Know			
f. How many people were on the ATV when it crashed?	/___/___/			
g. How many people were injured?	/___/___/			
If more than 1 person was injured in this incident, please answer the rest of the questions for the person with the most serious injury.				
h. Was this person male or female?	Male Female			
i. How old was this person?	/___/___/_age when injured			
j. Was a doctor or health care professional consulted?	Yes No Don't Know			
k. How many days did the person have to stay in the hospital? Your best guess is fine.	/___/___/___/ Enter 0 if none.			
l. How many days of usual activity were missed?	/___/___/___/ days missed from injury			
m. Did the person fully recover from the injury?	Yes No Don't Know			
n. Parts of the body most affected?				
o. Number of surgeries to repair injuries?	_____# surgeries. Enter 0 if none.			
p. Has this person ever had a serious injury from other machines on the farm?	Yes No Don't Know			
q. What was the main type of training/education the injured person completed prior to riding ATVs?	None	Parent	Safety course	Other _____
r. What kind of crash caused the injury?	Rollover	Collision	Ejection	Other_____
s. Was the injured person wearing a helmet?	Yes No Don't Know			

➔➔➔ **Start here if you skipped the previous section.** These are some questions about ATVs on your farm. *If you have no ATVS on your farm go to Q31, page 11.*

26. What is your single-seat ATV used for on your farm? *Circle all that apply.*

a. Hauling & transporting supplies/equipment
b. Monitoring property/livestock
c. Use attachments to work fields/property
d. Fun/recreation/riding/hunting
e. Do not have single-seat ATVs on my farm

27. What percentage of the time are the ATVs on your farm: *Enter 0 if none of the time.*

a. Operated on public land/roads. Enter 0 if none. /___/___/___/
b. Operated on private property/roads. Enter 0 if none. /___/___/___/

28. What percentage of the time are the ATVs on your farm: *Enter 0 if none of the time.*

a. Driven for work on the farm. Enter 0 if none. /___/___/___/
b. Driven for leisure/non-work activities. Enter 0 if none. /___/___/___/

NOTE: Items 28 a & b should total to 100% 100%

29. For the 5 ATVs used the most in your household, please provide the following information:

				When you got it, was it new or used?		*Got it from an ATV dealer or previous owner?*	
ATV	*# of wheels*	*Engine size (cc)*	*Model year*	*New*	*Used*	*Dealer*	*Owner*
1				1	2	1	2
2				1	2	1	2
3				1	2	1	2
4				1	2	1	2
5				1	2	1	2

30. Please provide information for up to 5 people that <u>live</u> in the household and operate one or more of the ATVs listed in Q29. We do not need names.

Rider	*Age*	*Gender*	*Ever injured on ATV?*		*How long have they been riding ATVs? Enter # years, months or weeks*			*Do they operate, ride as a passenger, or both? (Circle one)*		
	Years	*Circle*	*Circle*		*# years*	*# months*	*# weeks*	*Operate only*	*Passenger only*	*Both*
1		M/F	Yes	No				1	2	3
2		M/F	Yes	No				1	2	3
3		M/F	Yes	No				1	2	3
4		M/F	Yes	No				1	2	3
5		M/F	Yes	No				1	2	3

➔➔➔ **Start here if you skipped the previous section.**

Finally the last few questions are about you.

31. Are you the head of your household? 1. Yes 0. No

32. On a scale of 1 to 10 where 1 is not stressful at all and 10 is extremely stressful, how would you describe your life? *Circle one number.*

1	2	3	4	5	6	7	8	9	10

33. Which of the following below best describes your type of farm? *Circle one.*

1. Livestock 3. Dairy 5. Other (specify) _____
2. Crop 4. Hobby

34. Please enter your farm size in acres /___/___/___/___/___/ acres

35. What is your current age? /___/___/ Current age

36. Gender (Circle one) 1. Male 2. Female

37. Please circle the race/ethnicity that comes closest to you.

1. Caucasian/White
2. African-American
3. Asian
4. Other (specify) _____

38. Are you of Hispanic origin or descent? 1. Yes 0. No

39. How many years of formal education have you completed? /___/___/ Years of formal education

40. On average how many hours do you: *Enter 0 if none.* *# hours /week*

a. Work on the farm each week? /___/___/ *Enter 0 if none*

b. Work employed outside the farm each week? /___/___/ *Enter 0 if none*

41. Please enter your county of residence. _____ County of residence

42. Including yourself, how many adults and children live in your household? /___/___/

43. Please circle the number that best describes your total annual household income.

1. $10,000 or less
2. $10,001 to $20,000
3. $20,001 to $40,000
4. $40,001 to $60,000
5. $60,001 to $80,000
6. Over $80,000

44. Finally, are you a registered voter? 1. Yes 0. No

Those are all the questions! Thank you so much for participating in this study. Your responses will help us know more about ATV use on farms. The results of this study may be published but your name will not be connected with the study or used in any way. Please fold your survey and put it in the business reply envelope included to: Jessica Wilson, University of Kentucky, 416 College of Nursing Building, Lexington, KY 40536-0232.

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Place of Birth Lexington, KY

Educational Background

Year	Degree	Institution
1994, June	ADN	Midway College
1996, June	BSN	Midway College
2000, December	MSN	Spalding University

Professional Positions Held

Year	Employer	Title
August 2004 - present	University of Kentucky College of Nursing, Lexington, KY	Lecturer
January 2003 - May 2004	Midway College, Midway and Danville, KY	Nursing Faculty
November 2000 - January 2003	University of Kentucky Chandler Medical Center, Lexington, KY	Neurosurgery Nurse Practitioner, College of Medicine
May 1997 - June 1998	University of Kentucky Chandler Medical Center, Lexington, KY	Research Nurse Coordinator, Department of Neurosurgery
June 1994 - April 1997	University of Kentucky Chandler Medical Center, Lexington, KY	Charge Nurse/Staff Nurse

Scholastic and professional honors

Year	Honors
2012	Louise J. Zegeer Excellence in Undergraduate Teaching Award
2001	Sigma Theta Tau International Research Award
2000	Coleman Award for Outstanding Student Research in Nursing
1999	Sigma Theta Tau International Scholarship Award
1996	University of Kentucky Clinical Excellence Award
1996	Midway College Art and Science Nursing Award

Publications

Rice, J.L., "Nurses Need to Place Emphasis on ATV-related Injury Prevention," *NurseLife*, January (2004).

****Rice, J.L***., "Non-prescription Medication Alert: The Nurse's Role," *Kentucky Nurse*, 45(4), 24-25. (1997).

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