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Age, medication use, and nonfatal agricultural injury

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AGE, MEDICATION USE, AND NONFATAL AGRICULTURAL INJURY

by

Michelle Lynn Umbarger-Mackey

An Abstract

Of a thesis submitted in partial fulfillment
of the requirements for the Doctor of
Philosophy degree in Nursing
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The University of Iowa

July 2012

Thesis Supervisor: Associate Professor Sue Moorhead

ABSTRACT

This descriptive and analytic study used a secondary data set to describe and compare medication use and agricultural injury experiences between younger (≤54 years old) and older (≥55 years old) farmers; and to examine the relationship between the use of specific classes of medication and reported agricultural injury. The study sample included a total of 316 farmers, age 26 to 80 years old; 103 older farmers (33%), and 210 younger farmers (66%). This cohort of farmers sustained a total of 318 nonfatal agricultural injuries.

No statistical difference was found in the mean number of injuries sustained by older and younger farmers. The injury rate for the whole cohort of farmers was 41.95 injuries/100 years; older farmers' injury rate was 38.35 injuries/100 person-years, while younger farmers' was 44.01 injuries/100 person-years. Older farmers were more likely to report taking a medication than the younger farmers (OR: 3.08; 95% CI: 1.94-4.92). Older farmers had statistically significant greater odds of reporting the use of several medication classes/subclasses than the younger farmers, including: hormones; cardiac medications such as: ACE inhibitors, blood pressure medications, alpha blockers, and beta blockers, and finally central nervous system medications such as pain medications. Older farmers were also found to report taking more medications than younger farmers.

Multiple logistic regression analysis using GEE was used to examine the association between using specific classes of medication and agricultural injury, taking into consideration a myriad of confounding factors. Agricultural work exposures associated with injury included noise (OR 1.39, 95% CI: 1.02-1.90), chemical/pesticide use (OR 1.88, 95% CI: 1.39-2.55), heavy lifting (1.55, 95% CI: 1.06-2.28) and raising livestock (OR 1.49, 95% CI: 1.08-2.06).

Medication classes significantly associated with an increased risk for agricultural injury included taking two different types of heart medications: beta blockers (OR 2.30, 95% CI: 1.07-4.97) and ACE inhibitors (OR 2.72, 95% CI: 1.15-6.46). Farmers taking a blood formation/coagulation medication were found to have less risk of injury (OR 0.50, 95% CI: 0.28-0.93) than those not on a blood formation/coagulation medication. When exploring the issue of polypharmacy, no medication interactions were found to be significant. Yet, the number of cardiac medications taken per quarter was found to be statistically significant. The odds of nonfatal agricultural injury were lower with the use of more than one cardiac medication (OR: 0.35, 95% CI: 0.13-.0.94) compared to a farmer taking no cardiac medications.

Health conditions related to agricultural injury included depression and several interaction terms between taking medication and general health status. Farmers reporting their depression level as medium had a lower risk for nonfatal agricultural injury (OR 0.71, 95% CI: 0.53-0.95) compared to farmers reporting their depression as being low. Finally, several interactions between taking medication and general health status were statistically significant. These interactions illuminate two trends: 1) farmers in excellent/very good/good health have lower odds of injury if they are not taking medication versus if they did take medication, and 2) farmers with poor health have decreased odds of injury if they took mediation versus if they did not take medication.

This research contributes to the limited knowledge base regarding medication use and agricultural injury by identifying classes and subclasses of medications that are associated with nonfatal agricultural injury, as well as identifying an important interaction between general health status and medication use in regards to nonfatal agricultural injury.

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Iowa City, Iowa

CERTIFICATE OF APPROVAL

PH.D. THESIS

This is to certify that the Ph.D. thesis of

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has been approved by the Examining Committee
for the thesis requirement for the Doctor of Philosophy
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Elizabeth Swanson

In memory of my grandfather, Peter Etringer, a wonderful father, grandfather and farmer. To my father-in-law, a dedicated farmer whose personal experience with farming while taking medications for cardiovascular disease was the inspiration for this work. To my family, for your unending support and love-I could not have done this without you all! And finally, to all farmers, especially those who participated in the CSF study- thank you for your continued hard work and dedication to feeding our nation.

"Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country and wedded to its liberty and interests by the most lasting bands."

Thomas Jefferson

Letter to John Jay, August 23, 1785.The Papers of Thomas Jefferson, ed. Julian P. Boyd, vol. 8, p. 426

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CHAPTER 1

INTRODUCTION

Throughout history, farming has been known for its long hours and physically demanding work. With the passing of each season, farmers work long hours completing a multitude of difficult and dangerous agricultural tasks. Daily farmers engage in tasks that put them at risk for nonfatal, as well as fatal injury. The safety of agricultural tasks can be affected by farmers' health status, physiological changes, as well as medications taken for the treatment of acute and chronic diseases. In addition, farmers continue to work on the farm past the traditional retirement age of persons in the public work sector increasing the potential for age-related physical changes, chronic illness and the risk for injury. Several factors such as age-related physical changes, chronic illness symptoms, and side effects of medications may increase farmers' risk for agricultural injury as they continue to farm through the decades.

Statement of the Problem

There has been a long-standing effort to explore, describe and understand all facets of agricultural injury dating back to the 1940s in North America (Donham & Thelin, 2006). The hazards of agriculture work are well established, making it one of the most dangerous occupations in the United States (U.S.) (Bureau of Labor and Statistics (BLS), 2010; Frank, McKnight, Kirkhorn, & Gunderson, 2004; McCurdy & Carroll, 2000; National Institute for Occupational Health and Safety (NIOSH), 2004). According to the National Safety Council (NSC), every year over 700 ranchers and farmers die in work-related accidents, and another 150,000 agricultural workers suffer disabling injuries from work-related accidents (National Safety Council (NSC), 2005). The NSC also found that farmers over the age of 75 were more than twice as likely to die while farming as younger farmers (NSC, 2003). In 2005, agriculture had the highest occupational fatality rate in the United States with 32.5 fatalities per 100,000 workers, which is a 23%

increase from 2004 (BLS, 2006). The Bureau of Labor and Statistics (BLS) reported that in 2008, agriculture had an incidence rate of nonfatal occupational injury and illness of 5.3 recordable cases per 100 full-time workers compared to the rate of 3.9 recordable cases in private industry (BLS, 2009). In 2009, the agricultural fatalities rate was 26 fatalities per 100,000 full-time equivalent workers, which was an 18% decrease from 2008. Even with this decrease, the agriculture sector still had the highest fatality rate of all occupational sectors (BLS, 2010).

The U.S. population is experiencing a significant demographic shift resulting in a larger proportion of older individuals in the population. In 2009, there were an estimated 39.6 million people age 65 and older (12.9% of the total population) (Administration on Aging (AoA), 2010). It is projected that by 2050, the number of older Americans (65+) will reach 88.5 million, more than double the projected population for 2010 of 40.2 million (Vincent & Velkoff, 2010). In fact, the 2010 projection held true. Based on the 2010 census, there were 40,267,984 adults aged 65 and older, representing 15.1% of the total U.S. population (Werner, 2011).

This noteworthy trend in aging has also been prominent in the agricultural sector in the U.S. The Bureau of Labor Statistics (BLS) stated that in 1998, farmers had the highest percentage (68.5%) of workers over the age of 45; this is more than twice the average percentage (33.7%) for all employees in the U.S. (BLS, 2000). In the 2007 Census of Agriculture by the National Agricultural Statistics Service (NASS), the average age of farmers increased from the 2002 census of 55.3 to 57.1 years old. NASS also reported that the fastest growing group of farm operators were those over the age of 65, and that the number of farmers over the age of 75 increased in 2007 by 20%, while farmers under the age of 25 had decreased by 30% since 2002 (National Agricultural Statistics Service (NASS), 2007a). The average age of farmers in the state of Iowa was 56.1 years, even higher than the national average (NASS, 2007b).

The graying of the agricultural sector in the U.S. can be attributed to several factors. Unlike other sectors of the workforce, farmers continue to work beyond retirement age and work well into their 70s and 80s. Farmers are less likely to retire at the conventional age of 65 like older workers in the private working sector. There are many reasons farmers continue to farm past retirement age, including: 1) improved health and longevity may reduce the exit rate of older farmers- they feel healthy so they continue to farm, 2) there are less young farmers going into farming and therefore there is a decreased succession of the family farm, 3) the farmers low income levels make it more difficult to stop farming as well as more difficult to save for retirement, 4) most farmers are self-employed and are less likely to be able to participate in an employer-sponsored retirement plan, and 5) they have emotional ties to their land (Foskey, 2005; Gale, 2002; Mishra, Durst, & El-Osta, 2005).

When any or all of the above mentioned factors become a reality to aging farmers, they believe that they must maintain farming. With continued farming, aging farmers need to adjust to age-related changes that will inevitably affect their bodies. Their ability to move around in their physical environment safely requires the coordination of many different parts of the body. Joints must be flexible, bones and muscles strong, and sensory systems (vision, eye sight, vestibular system, and peripheral sensory systems) must be intact. But there are changes that occur during the normal aging process which may make daily activities of living more difficult and often unsafe. As one ages, movement becomes less effective, more difficult, and more painful (Whitbourne, 2002). Muscles progressively atrophy, even with continued use. In addition to this muscle loss and weakness, aging adults experience decreased bone density, joint stiffness, as well as postural instability or balance disorders due to dizziness, vertigo, and deterioration or failure of peripheral sensory systems (Duthie, 1998; Whitbourne, 2002). Another key issue arises as individuals' age- the likelihood of being diagnosed with one or more chronic diseases increases. Medications that are commonly used in the treatment of these chronic diseases have side effects that may also alter the ability to safely complete daily activities including work, such as farming. Other age-related changes include alterations in hearing and vision, as well as a decrease in muscle strength, agility, and stamina.

Ultimately, age-related changes, chronic disease, and medication use can affect the aging farmers' ability to work safely on their farm (Blahey, 2002). However, research examining the relationship of medication usage to agricultural injury has been minimal. This deficiency in the literature necessitates additional research exploring the relationship of medication use and agricultural injury. In addition, more research is needed regarding how increasing age may influence the risk for agricultural injury.

Significance of Study

The limited amount of research regarding older farmers and medication use in relation to agricultural injury may hinder the ability of agricultural safety and health specialists and health care workers, such as nurses, to work with farmers. Without this knowledge, these professionals are limited in their ability to design appropriate injury prevention strategies and interventions specifically for older farmers and farmers who are using medications.

Empirical evidence illustrates that the risk for nonfatal agricultural injury decreases with age, but that older farmers have higher rates of fatal agricultural injury (Crawford et al., 1998; Hwang et al., 2001; Lewis et al., 1998; Myers, Layne, & Marsh, 2009; Myers et al., 1999). However, knowledge regarding how medication use affects the farmers' safety while farming is minimal.

A few studies have found regular medication use or current medication use as a risk factor for agricultural injury (Brison & Pickett, 1992; Browning, Truszczynska, Reed, & McKnight, 1998; Spengler, Browning, & Reed, 2004; Sprince et al., 2002; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003b; Sprince et al., 2003c; Sprince et al., 2007; Xiang, Stallones, & Chiu, 1999), however there have only been three studies that have examined the use of specific classes of medications as a risk factor for agricultural injury (Pickett, Chipman, Brison, & Holness, 1996; Spengler et al., 2004; Voaklander et al., 2006). Unfortunately, there has only been a modest amount of research examining how the aging process might affect the farmers' ability to continue to farm safely (Amshoff & Reed, 2005; Browning et al., 1998; Cole & Donovan, 2008; Fiedler et al., 1998; Lizer, 2002; Marcum, Browning, Reed, & Charnigo, 2011; Myers et al., 2009; Voaklander et al., 2006; Voaklander, Hartling, Pickett, Dimich Ward, & Brison, 1999; Xiang et al., 1999).

Medication consumption in the U.S. is extensive; 82% of the population takes at least one medication (prescription or over the counter (OTC)) and 25% takes more than 5 medications at any given time (Mitchell, Kaufman, & Rosenberg, 2006). Due to this level of medication consumption, there is a risk for adverse reactions and injury with medication use (Agostini & Tinetti, 2002; Agostini, Han, & Tinetti, 2004; Leipzig, Cumming, & Tinetti, 1999a; Leipzig, Cumming, & Tinetti, 1999b). There is limited research in the area of medication use and its relationship to agricultural injury, so more empirical research needs to be conducted. This increased knowledge will allow agricultural safety specialists and occupational health nurses working with farmers to design customized injury prevention interventions for this special sub-set of farmers.

Purpose, Study Aims and Research Questions

The overall purpose of this study is to describe and compare medication use and agricultural injury experiences between younger (≤54 years old) and older (≥55 years old) farmers; and to examine and measure the relationship between the use of specific classes of medication and agricultural injury. The specific aims and associated research questions of this study are as follows:

Specific Aims and Research Questions

Specific Aim 1: Describe the relationship between age and medication usage, as well as age and nonfatal agricultural injury

1. What types of medications are older and younger farmers taking?
2. Are older farmers taking more medications than the younger farmers?
3. What are the nonfatal injury rates for older and younger farmers?
4. In what months are older and younger farmers getting injured?
5. What are the types of nonfatal injury that older and younger farmers are sustaining?
6. What are the sources of nonfatal injury for older and younger farmers?
7. What body parts are the older and younger farmers injuring?

Specific Aim 2: Describe the relationship between using certain classes of medication and experiencing a nonfatal agricultural injury

8. How many nonfatal injuries occur with each medication class?
9. What types of nonfatal injuries occur with each medication class?
10. What are the sources of nonfatal injury that occur with each medication class?
11. What body parts are injured with each medication class?

Specific Aim 3: Measure the association between using certain classes of medication and experiencing a nonfatal agricultural injury

12. Does taking medication increase the risk for nonfatal agricultural injury?

Summary

As farmers age, they continue to actively work in one of the most dangerous occupations in the U.S. (National Institute for Occupational Health and Safety (NIOSH), 2004). As these aging farmers continue to work, they do so with the possibility of medication use. Minimal research has been completed exploring the association between the use of certain classes of medication and agricultural injury. The knowledge gained from this research will allow health care providers and agricultural health and safety experts to develop agricultural injury prevention interventions specifically tailored to farmers using medications within these classes of medications. The study findings can also inform primary health care providers' medication prescribing practices as a result of increased knowledge regarding the medication classes associated with a greater risk for agricultural injury.

The next chapter provides a literature review on the use of medication and agricultural injury. The theoretical framework guiding this review is based on Haddon's Matrix-an injury prevention model developed by Dr. William Haddon utilizing concepts from the traditional epidemiological triangle: host, agent, and environment (Christoffel & Gallagher, 2006; Haddon, Suchman, & Klein, 1964; Haddon, 1968; Haddon, 1980). The review is organized around the host and agent concepts of the Haddon's Matrix.

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter is organized around the framework for injury prevention developed by Dr. William Haddon. This framework utilizes concepts from the traditional epidemiological triangle of: host, agent, and environment (Christoffel & Gallagher, 2006; Haddon, 1968; Haddon, 1980). This framework was chosen due to its longstanding use in the research and prevention of injuries, as well as its ability to allow the researcher to structure and focus the literature review of farmers, their medication use, aging, and agricultural injury in a meaningful way. The purpose of this review is to explore the literature regarding farmers' risk factors for agricultural injury and more explicitly the risk factors of medication use.

The Conceptual Framework

Utilizing the theoretical underpinnings of Haddon's Matrix (Haddon, 1968; Haddon, 1980; Haddon, 1999; Runyan, 2003) (Table 1) and the causal model for injury discussed by Peek-Asa and Zwerling (Peek-Asa & Zwerling, 2003) (Figure 1), a conceptual model for medication use and agricultural injury was created (Figure 2). This chapter uses this adapted conceptual model as a guide for the literature review, addressing the literature on host and agents, as it pertains to the current state of the literature on older farmers, the use of medication, aging, and agricultural injury.

Table 1: Haddon's Matrix

Time	***Host***	***Vehicle***	***Physical Environment***	***Sociocultural Environment***
Pre-event/fall				
Event/fall				
Post-Event/fall				

Source: Haddon, W. (1980). Advances in the epidemiology of injuries as a basis for public policy. *Public Health Reports Hyattsville, 95*(5), p.417.

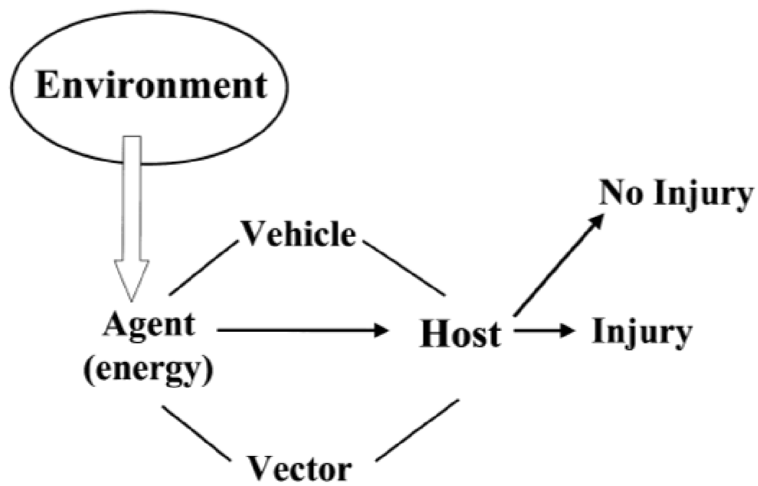

Figure 1: The causal model for injuries from Peek-Asa and Zwerling

Source: Peek-Asa, C., & Zwerling, C. (2003). Role of environmental interventions in injury control and prevention. *Epidemiologic Reviews, 25*(1), p.77.

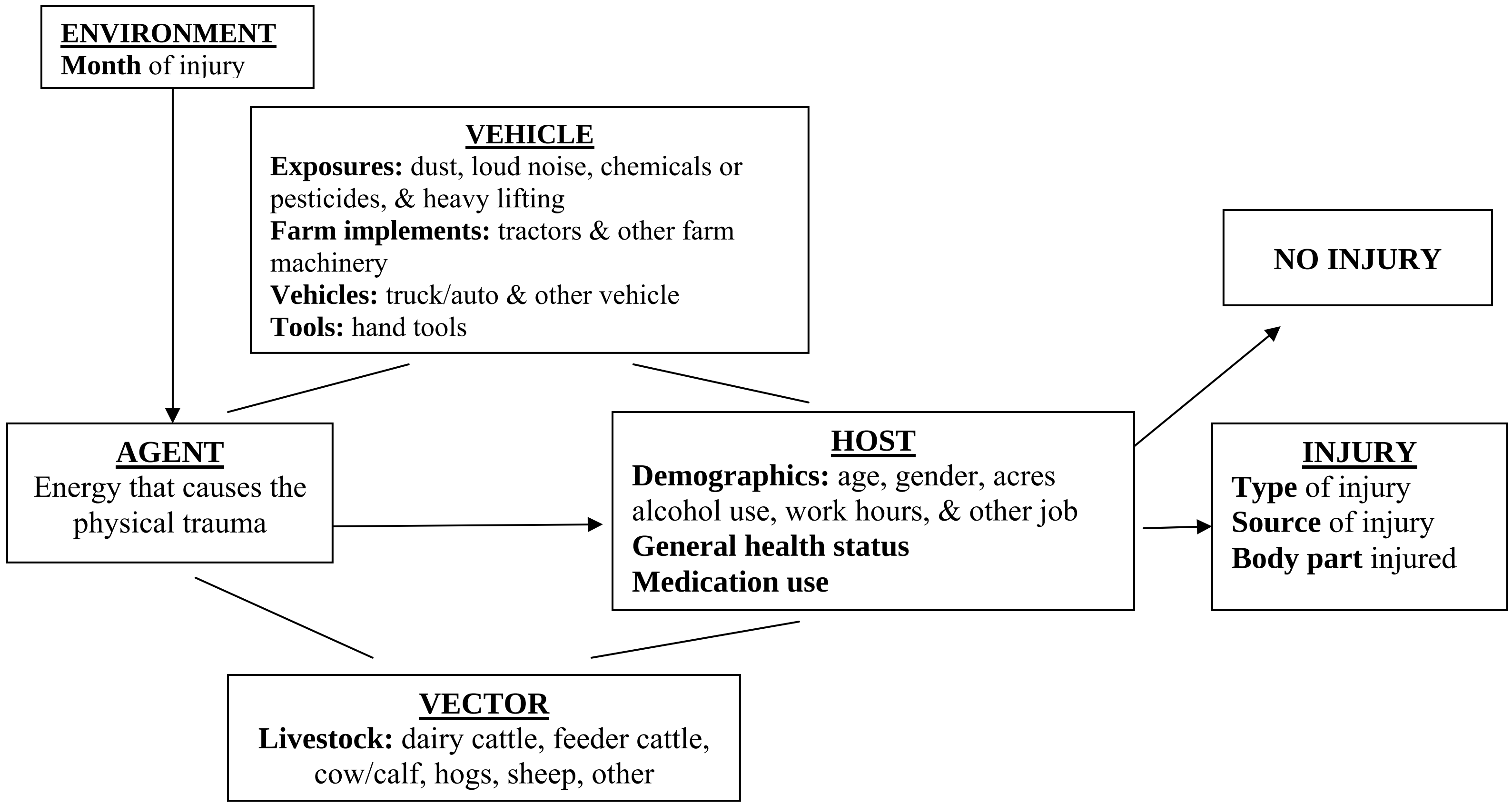

Figure 2: The proposed conceptual model for medication use and nonfatal agricultural injury

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Note: Adapted from Peek-Asa, C., & Zwerling, C. (2003). Role of environmental interventions in injury control and prevention. *Epidemiologic Reviews, 25*(1), p.77.

The conceptual model guiding this study is based on the framework for injury prevention developed by Dr. William Haddon over two decades ago. The Haddon Matrix uses concepts from the traditional epidemiological triangle: host, agent, and environment that occur within three time-phrases of injury: pre-event, event, and post-event (Christoffel & Gallagher, 2006; Haddon et al., 1964; Haddon, 1968; Haddon, 1980; Runyan, 2003).

The Haddon Matrix was chosen as a theoretical guide due to its longstanding use in the research and prevention of injuries. Its phase-factor approach allows for several points to identify strategies and interventions to prevent, respond to, or to mitigate injuries. Within the context of this framework, the *host* is the person or persons at risk for injury; the *agent* is the energy (mechanical, thermal, electrical) that is transmitted to the host via a *vehicle* (inanimate object) and/or *vector* (animate objects- person, animal, or organism). The *physical environment* includes all the characteristics in the setting in which the injury takes place (barn, field, tractor, etc.). The *social environment* refers to the social and legal norms and practices in the culture and society during the time surrounding the injury event (norms about using personal protective equipment, etc.) (Christoffel & Gallagher, 2006; Runyan, 2003). For the *agent* to result in an injury, the energy transmitted must be beyond the *host's* tolerance. This tolerance may be reduced through intrinsic factors in the *host* such as acute or chronic illness and medication use (Kraus, Peek-Asa, & Blander, 1997). Researchers have reported in the literature that certain disease/health-related factors and the use of medication are independent risk factors for agricultural injury (Pickett et al., 1996; Voaklander et al., 2006; Voaklander, Umbarger-Mackey, & Wilson, 2009).

The Haddon Matrix allows for intervening at several points using the aspect of time for injury prevention in the *pre-event*, *event*, and/or *post injury event* phases. *Pre-event* interventions are considered primary prevention and attempt to stop the injury event from occurring by acting on the causes of injury. The *injury event phase* interventions are secondary prevention that attempt to prevent the injury or reduce the seriousness of the injury by designing and implementing protective mechanisms. Finally, the *post-event phase* interventions are tertiary prevention and attempt to reduce the seriousness of the injury immediately after the event by providing timely adequate care, as well as long-term care or rehabilitation to restore the host to the highest level of physical and mental function possible (Christoffel & Gallagher, 2006; Runyan, 2003). For an example of the Haddon Matrix using concepts for medication use and agricultural injury, specifically a fall injury, see Table 2. This research is specifically interested in the intervention point of pre-event for the host where medication use is a point for potential intervention.

Table 2: Example of Haddon's Matrix: Medication use and an agricultural fall injury

Time	***Host***	***Vehicle***	***Physical Environment***	***Sociocultural Environment***
Pre-event/ fall	Age; age-related physiological changes-sensory changes in hearing, vision & balance; chronic illness; and ***medication use.*** **Potential interventions**: Teach farmers to: be aware of safety issues around the farm; be aware of medication side-effects;	Ground or surface fallen on or from. **Potential interventions**: clean up all spills; keep work area clean of trip hazards; keep walkways and equipment clean of mud and ice.	Uneven ground; slippery surfaces; poor lighting; obstacles in walkway; absence of railings or grab bars; unsafe stairways(around farm or on equipment); worn footwear (poor traction); seasonal weather conditions. **Potential interventions**: see pre-event vehicle.	**Potential interventions**: Foster social norms that encourage the use of personal protective equipment and safe agricultural work practices.
Event/ fall	Human tolerance to crash forces; osteoporosis; chronic health conditions; heart conditions; **Potential interventions**: Teach farmers potential methods to fall in ways that reduce injury or methods for rising after fall.	Height of the fall; surface fallen onto; contact with any objects during fall. **Potential interventions**: add safety cages to grain bin ladders;	Ability of farmer to call for EMS; availability of EMS; response time of EMS; distance to quality trauma care; **Potential interventions**: cleanliness of environment; first aid knowledge of family members possibly present.	**Potential interventions**: have farmers and family members learn to do safety checks of farm implements and farm work areas.
Post-Event/ fall	Farmer's general health status; fractures and other wounds; multiple injuries. **Potential interventions**: how to properly summon help; have cell phone on person.	**Potential interventions**: Avoid areas in which once can fall and not easily be rescued.	Financial status; insurance coverage; accessibility to rehabilitation centers. **Potential interventions**: Maintain driveways and fields for easy EMS access.	**Potential interventions**: Ensure funding for adequate emergency personnel appropriately equipped to deal with agricultural emergencies

Note: Adaptation of Haddon, W. (1980). Advances in the epidemiology of injuries as a basis for public policy. *Public Health Reports Hyattsville, 95*(5), p.417.

The findings of this literature review are critical as farmers continue to work beyond average retirement age and are at risk for occupational agricultural injury, disability, and even death. In order to develop nursing interventions explicitly for older farmers and farmers on medication, it is important to gain a comprehensive understanding of all the agricultural injury risk factors specific for older farmers, especially medication use.

Agricultural Injury Risks in Context of Haddon's Matrix: Host and Agent

Host: The Farmer

As farmers age and continue to farm, there are several *host* factors that increase their risk for agricultural injury. For the *agent* to result in an injury, the energy transmitted must be beyond the *host's* tolerance, which may be reduced through intrinsic factors in the *host* such as chronic illness and medication use (Kraus et al., 1997). Host factors that influence susceptibility to agricultural injury include but are not limited to: age, age-related physiological changes, chronic diseases and medication use.

Age

The demographic trend of aging farm operators has been noted since 1978, when the percentage of farm operators over the age of 65 began to consistently rise. In 1978, an average of one in six farmers were over the age of 65; in 2002, more than one in four or 26.2% of principal farm operators were over the age of 65 (Allen & Harris, 2005). NASS reported that the average age of principal farm operators in the U.S. in 2007 was 57.1 years, and 30% of the nation's principal farm operators were over the age of 65 (NASS, 2007a).

It is a well-known fact that in the process of working on their farms, older farmers sustain injuries and illnesses (Browning et al., 1998; Frank et al., 2004; Hwang et al., 2001; Myers et al., 2009; Myers et al., 1999). In general, agricultural injury research has shown a decreasing risk for nonfatal injury with increasing age (Crawford et al., 1998; Hwang et al., 2001; Lewis et al., 1998; Marcum et al., 2011; Myers et al., 2009; Myers et al., 1999; Zhou & Roseman, 1994), yet older farmers are more likely to be hospitalized for their injuries and also more likely to sustain more debilitating or fatal injuries (Crawford et al., 1998; Fiedler et al., 1998; Gelberg, Struttmann, & London, 1999; Hard, Myers, & Gerberich, 2002; Hwang et al., 2001; Lewis et al., 1998; Meyer, 2005; Mitchell, Franklin, Driscoll, & Fragar, 2002; Myers et al., 2009; Myers & Hard, 1995; Myers et al., 1999; Pickett, Hartling, Brison, & Guernsey, 1999; Pickett et al., 2001; Voaklander et al., 1999; Zhou & Roseman, 1994). It is posited that decreasing risk for nonfatal injury with increasing age may be due to older farmers working fewer hours (Browning et al., 1998; Marcum et al., 2011) and performing less risky farm tasks than their younger counterparts (Browning et al., 1998; Lewis et al., 1998; Marcum et al., 2011).

The most recent study looking into national agricultural injuries rates was conducted by Myers et al. (2009). The researchers used data from two national surveillance programs to derive more recent national injury rates for farmers in the U.S. Information for nonfatal injury rates came from the National Institute for Occupational Safety and Health's (NIOSH) Occupational Injury Surveillance of Production Agriculture (OISPA) surveys from 2001 to 2004. Fatality data were extracted from the Bureau of Labor's Census of Fatal Occupational Injuries (CFOI) for the years 1992 to 2004. The researchers found that older farmers (55 years and older) accounted for 32% of the nonfatal agricultural injuries and had a nonfatal injury rate of 4.5/100 workers/year. This rate was similar to their younger counterparts (aged 20-54) with a nonfatal injury rate of 4.6/100 workers/year. However, older farmers had a fatality rate (45.8/100,000 workers/year), which is 2.6 times greater than farmers aged 54 and younger. Although nonfatal injury rates were found to be similar in older and younger farmers, the older farmers' injuries tended to be more severe or disabling and resulted in more restricted work days and hospitalizations; hospitalization for 20% of injures for older farmers compared to 16% for younger farmers. Nearly half (47%) of the nonfatal injuries for the older farmers resulted in 14 or more restricted work days, versus the 32% for the younger farmers (t=4.787, p <0.001). Approximately one quarter (24%) of the older farmers were hospitalized for eight or more days for injuries compared to 8% of the younger workers (t=2.776, p =0.007) The older farmers who were hospitalized for their injuries were away from work for a longer time (Myers et al., 2009).

Another study exploring older farmers and injury in Kentucky and South Carolina found farmers over the age of 50 to have a crude injury rate of 9.3 injured farmers per 100 workers/year (Marcum et al., 2011). As seen in many previous studies, increasing age was found to be significantly associated with a decrease in the odds of agricultural injury; an increase of 10 years of age corresponded to a decrease in injury odds by 19%. The crude injury rate of this group of farmers was higher than that of the national sample found in Myers et al (2009) of 4.5/100 workers/year, but this may be due to differences in sampling such as differences in types of commodities farmed, farm experience, and other factors.

Age-related Physiological Changes

The individuals' ability to move around in their physical environment safely requires the coordination of many different parts of the body. There are several physiological changes that occur during the normal course of aging that can make daily activities of living and work tasks more difficult and potentially unsafe for older working adults. These changes can threaten the health and well-being of older adults by putting them at greater risk for injury. The effects of injury reach far into the lives of older adults by causing pain (temporary and chronic), a loss in mobility and independence, lost productivity, financial hardship, physical disability, and even death (National Center for

Injury Prevention and Control (NCIPC) & Centers for Disease Control and Prevention (CDC), 2006). Farmers tend to continue to work beyond what is considered in the public sector as retirement age, and age-related physiological changes can become serious risk factors for agricultural injury. Age-related sensory changes can include alterations in vision, hearing, balance, musculoskeletal capacity, reaction time, and sensitivity to cold and heat (Cole & Donovan, 2008).

Hearing Problems

A common age-related physiological change that affects older adults is hearing deficit or hearing loss. There is a strong association between reported hearing loss and increasing age in the U.S.; 18% of adults aged 45-64, 30% of adults aged 65-74 and 47% of adults 75 years and older report having a hearing impairment. Approximately 17 percent or 36 million adults in the U.S. report some degree of hearing loss (National Institute on Deafness and Other Communication Disorders (NIDCD), 2010). This loss poses a greater risk for farmers of all ages due to their exposure to loud noises. Farmers have work exposures that affect their hearing, such as exposure to loud noises from machinery, tractors, livestock, and shop maintenance activities. All of these can affect the farmers' ability to hear well and to become aware of potential hazards while farming.

Several studies have found an association between hearing problems, hearing aid use, and agricultural injury (Choi et al., 2005; Hwang et al., 2001; Lewis et al., 1998; Sprince et al., 2002; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003c; Sprince et al., 2007), while other studies identified hearing problems as a potential risk factor, but did not find a significant association (Browning et al., 1998; Crawford et al., 1998; Lewis et al., 1998; Marcum et al., 2011; Park et al., 2001; Xiang et al., 1999; Zwerling et al., 1995). Most of these studies utilized self-reported hearing measures which asked farmers about their subjective hearing status and the use of hearing aids. Self-reported data has the potential for misclassification bias and must be considered a limitation. Farmers may classify their hearing as better or worse than it truly is. A more objective measure of hearing loss, such as the standard hearing tests or audiometry, as used in the study by Choi (2005), may give a more accurate account of hearing deficits or loss and should be considered in future research.

Visual Problems

Another common age-related physiological change is visual acuity. The prevalence of visual impairment significantly increases with age (Burke & Laramie, 2004; National Eye Institute (NEI), 2004). It was estimated in 2009 that eight percent of the adult population experienced vision problems defined as trouble seeing, even with glasses or contact lenses (Pleis, Ward, & Lucas, 2010). Blindness or low vision affects 3.3 million adults in the U.S. over the age of 40 and is projected to increase to 5.5 million by 2020 (NEI, 2004). Age-related visual changes may require older farmers to use glasses or contacts to complete tasks of daily living and farm work.

There have been several studies that have examined visual changes or wearing glasses/contacts as a risk factor for farm injury, but none have found any significant positive association (Browning et al., 1998; Carruth, Skarke, Moffett, & Prestholdt, 2001; Lewis et al., 1998; Marcum et al., 2011; Sprince et al., 2002; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003c; Sprince et al., 2007; Voaklander et al., 2006; Voaklander et al., 2006; Zwerling et al., 1995). Six studies identified visual problems as a protective factor, but none of these findings were statistically significant (Lewis et al., 1998; Sprince et al., 2002; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003c; Sprince et al., 2007).

Visual problems may be protective in that farmers with poorer vision may self-select out of more dangerous tasks due to their lower visual acuity. As with the studies on hearing, several of these studies utilized self-report data of farmers rating their visual acuity or use of glasses/contacts. Again, a more objective measure of visual acuity, such as the Snellen chart, would increase the validity of the visual measure.

Chronic Diseases

Diseases of long duration and slow progression such as heart disease, stroke, cancer, and diabetes are considered chronic diseases. Throughout the world chronic diseases are by far the leading cause of mortality, representing 63% of all deaths (World Health Organization (WHO), 2012). Chronic diseases are often thought of as afflicting the old more so than the young. In 2008, 36 million people around the world died from chronic disease, and nine million were under the age of 60 (WHO, 2012).

The majority of older persons in the general population suffer from at least one chronic condition if not multiple conditions (AoA, 2010). The Administration on Aging (AoA) found that in the years 2006 to 2008, the most frequently occurring chronic conditions for adults 65 years of age and older included hypertension (38%), diagnosed arthritis (50%), all types of heart disease (32%), any cancer (22%), sinusitis (14%), and diabetes (18%) (AoA, 2010). Although chronic disease is more prevalent in older adults, farmers of any age may be diagnosed with a chronic disease and still continue to work on their farms.

Arthritis

Arthritis and other joint and musculoskeletal problems can afflict working farmers. According to the CDC, data from a national survey gathered from 2007 to 2009 suggest that approximately 22% (49.9 million) of adults aged≥18 years had self-reported doctor-diagnosed arthritis (Cheng, Hootman, Murphy, Langmaid, & Helmick, 2010). Of the approximately 50 million diagnosed with arthritis, 42.4% (21.1 million) report limitations in their usual daily activities due to their arthritis (Cheng et al., 2010). The prevalence of arthritis increases dramatically with age; 8% of adults aged 18 to 44 were diagnosed with arthritis compared to 54% of adults aged 75 years and older (Pleis et al., 2010). Arthritis can limit the farmers' physical mobility and make it difficult for them to adequately respond to hazardous situations such as moving machinery parts and live animals. Several studies have found a significant association between arthritis and agricultural injury (Marcum et al., 2011; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003c; Voaklander et al., 2006), while one study reported non-significant findings (Sprince et al., 2002). Several interventions could be implemented for farmers that suffer from arthritis such as modifying chores and tools/equipment to lessen joint pain during farm work.

Other Musculoskeletal Problems

Other musculoskeletal problems such as joint pain and back pain have been studied in association with agricultural injury (Carruth et al., 2001; Day et al., 2009; Hwang et al., 2001; Lewis et al., 1998; Marcum et al., 2011; Suutarinen, 2004; Xiang et al., 1999). In 2006, estimates derived from the National Health Interview Survey found that 30% of adults reported experiencing some type of joint pain during the last 30 days; knee pain was reported by 18% of respondents, shoulder pain (9%), finger pain (7%), and hip pain (7%) (CDC, 2008). Age is positively associated with the presence of chronic joint symptoms; 17% of adults aged 18-44 compared to 49% of adults 75 years and older (Pleis et al., 2010). Like arthritis, other joint and musculoskeletal problems like back or joint pain may make it difficult for farmers to effectively respond so that they avoid a dangerous situation.

Having back problems or pain has been found to be significantly associated with agricultural injury (Carruth et al., 2001; Hwang et al., 2001; Marcum et al., 2011; Suutarinen, 2004). However, there has been some research that has not found back pain or issues to be significantly associated to farm injury (Lewis et al., 1998; Marcum et al., 2011; Xiang et al., 1999) or has found it to be a protective factor (Day et al., 2009). The research on back pain and agricultural injury is inconclusive and more research is needed to better understand whether it is truly a risk factor or a protective factor. Hwang and colleagues (2001) found joint trouble to be a significant risk factor for farm injury and Suutarinen (2004) found musculoskeletal disorders to be risk factors.

Mental Health Issues

Mood disorders such as depression affect about 20.9 million or 9.5% of adults aged 18 and older in the U.S. (National Institutes of Health (NIH), 2010). Research linking depression and agricultural injury presents mixed findings. Several studies found a statistically significant association of agricultural injury with depression (Park et al., 2001; Sprince et al., 2003b; Sprince et al., 2003c; Sprince et al., 2007; Zwerling et al., 1995); whereas a few studies lacked significant findings (Sprince et al., 2002; Sprince et al., 2003a). It is not clear how depression or depressive symptoms may increase the farmers' risk for injury, but it may be due to cognitive changes, inattention, or side effects of medication (Zwerling et al., 1995).

Cardiovascular Disease

Cardiovascular disease (CVD) affects 26.8 million or 12% of adults aged 18 and older and is the number one cause of death in the U.S. (Pleis et al., 2010; Xu, Kochanek, Murphy, & Tejada-Vera, 2010). Age-related changes in the cardiovascular system such as structural changes in the heart, valves, and conduction system can cause cardiovascular problems such as hypertension, chronic heart failure, valvular dysfunction, decreased cardiac output, cardiac arrhythmias or conduction problems. Increased incidence of orthostatic hypotension is seen in older adults due to the aforementioned age-related cardiovascular changes. Orthostatic hypotension can cause an abnormally low blood pressure or symptoms such as light-headedness, dizziness or syncope, which can put an older adult at risk for injuries such as falls (Burke & Laramie, 2004).

Age-related cardiovascular changes combined with potential side effects from the medications taken for CVD can put older farmers at greater risk for injury, yet the research exploring this potential risk factor is sparse. Although CVD is prevalent in the U.S., there have only been a handful of studies exploring the association between CVD and agricultural injury. Four studies did not find CVD to be a risk factor for agricultural injury (Marcum et al., 2011; Sprince et al., 2003a; Sprince et al., 2003c; Sprince et al., 2007), and four studies found CVD to be a protective factor but the findings were not significant (Park, Sprince, Jensen, Whitten, & Zwerling, 2002; Sprince et al., 2002; Sprince et al., 2003b; Voaklander et al., 2006; Xiang et al., 1999).

In addition, little research has been completed on hypertension. The findings are inconclusive as only one study had significant findings for hypertension and several had non-significant findings. Xiang et al. (1999) found that older farmers with hypertension had a significantly lower injury risk (OR: 0.20; 90% CI: 0.06-0.69) compared to the older farmers who did not report having hypertension. There were two studies with non-significant findings for hypertension as a risk factor (Carruth et al., 2001; Marcum et al., 2011) and one study with non-significant findings as a protective factor (Voaklander et al., 2006). Due to the prevalence of CVD and hypertension, it is crucial that future research explore how these diseases, as well as treatments such as medications, may affect the older farmers' ability to continue to farm safely.

Only a few studies have explored diabetes as a risk factor for agricultural injury, but there have been no significant findings either as a risk factor (Voaklander et al., 2006), or as a protective factor (Carruth et al., 2001). Other chronic health problems such as urinary problems (Voaklander et al., 2006), neurological disorders (Crawford et al., 1998; Park et al., 2001), and osteoporosis (Voaklander et al., 2006) have been briefly addressed in the research on risk factors for agricultural injury.

Appendix A summarizes the current research on the agricultural injury risk factors for the host of age-related physiological changes and chronic illness. Table A1 in Appendix A has been adapted from the work of Voaklander, Umbarger-Mackey and Wilson (2009).

Medication Use

Medication Use in the United States

Consumption of medications, both prescription and over-the-counter (OTC), throughout the U.S. is extensive, with a majority (82%) of the population taking at least one medication in 2006 (Mitchell et al., 2006). The Slone Epidemiological Center has been collecting medication use data via phone survey from 1998 through April of 2007 and provides comprehensive evaluation of medication use in the U.S. The 2006 annual report (n=2529 adults) denotes that that older adults (65+ years old) continue to be the largest consumers of medications with 17 to 19% taking at least ten medications in a given week. Although the prevalence of overall medication use has not changed significantly since the survey's inception in 1998, polypharmacy, the use of five or more medications, has increased from 23% in 1998 to 29% in 2000 (Mitchell et al., 2006).

In 2006,the Slone Epidemiological Center found the following medications to be the top ten most commonly used prescription and OTC medications (not including vitamin/minerals or herbal/natural supplements) taken by adults 18+ years old (in order from 1 to 10 most used): acetaminophen (19%), aspirin (18%), ibuprofen (17%), atorvastatin (6.7%), hydrochlorothiazide (5.9%), levothyroxine (5.5%), lisinopril (5.0%), simvastatin (4.8%), naproxen (4.7%), and pseudoephedrine (4.5%). Vitamins were used by 41% of adults in the Slone survey in 2006. The above noted medications fall into the following American Hospital Formulary Service's (AHFS) classification schema: acetaminophen (Central nervous system (CNS) agents), aspirin (Central nervous system (CNS) agents; Blood formation, coagulation, and thrombosis), ibuprofen (Central nervous system (CNS) agents), atorvastatin (Cardiovascular drugs), hydrochlorothiazide (Blood pressure (BP) medications), levothyroxine (Hormones and Synthetic substitutes), lisinopril (Cardiovascular drugs; ACE inhibitors; BP medications), simvastatin (Cardiovascular drugs), naproxen (Central nervous system (CNS) agents), and pseudoephedrine (Autonomic drugs) (American Hospital Formulary Service (AFHS), 2011; Mitchell et al., 2006).

The ten most commonly reported reasons for medication use in this sample included, in order from most common: hypertension (13%), pain (7.7%), cholesterol (7.4%), heart (6.9%), headache/migraine (5.6%), diabetes (4.5%), anticoagulation (3.9%), allergy (3.9%), arthritis/joint problems (3.9%), and depression (3.1%). The Slone survey participants are generally similar to the general U.S. population, but the Slone survey participants had a higher mean age and had a somewhat higher proportion of females. To adjust for this, the overall prevalence estimates were standardized to the 2006 U.S. Census Population Projections (Mitchell et al., 2006).

Another study on the prevalence of prescription and OTC medication use sampled community-residing older adults aged 57 to 85 years of age from July 2005 through March 2006 (Qato et al., 2008). Qato et al. (2008) took a nationally representative probability sample (n=3005) of community-dwelling adults to establish population estimates of the prevalence of medication use, concurrent use (use of two or more medications at least daily or weekly), and potential drug interactions. They found that 91% (95% CI 90.0-92.5%) of older adults (corresponding to 50.5 million adults aged 57-85 years age) regularly used at least one medication with prescription medication use being the most prevalent at 81% (95% CI, 79.4-83.5%) corresponding to approximately 44.9 million older adults. The most commonly used medications, prescribed and OTC, in this sample of older adults were cardiovascular agents. They included, in order from most used: aspirin (28%), hydrochlorothiazide (15.6%), atorvastatin (13.4%), levothyroxine (12.4%), lisinopril (12.2), metoprolol (10.9%), simvastatin (9.6%), atenolol (8.7%), amlodipine (8.3%), and metformin (8.2%). Polypharmacy or concurrent use of medications was also explored in this study and the researchers found that more than half of the older adults in their sample used five or more medications, with 68% (95%CI, 64.8-71.1%) concurrently using OTCs, dietary supplements, or both (Qato et al., 2008).

Specifically, 29 % (95% CI, 26.6-30.6%) of the older adults concurrently used prescription medications, while only three respondents concurrently used five or more OTCs, however nearly one in eight older adults concurrently used five or more dietary supplements. The prevalence of prescription medication use increased steadily with age for both men and women. Finally, at least one in 25 older adults in this sample used a medication regimen that posed a risk of a major drug-drug interaction, of which half of these interactions included the use of a non-prescription medication. The two most prevalent interactions included 1) the use of lisinopril and potassium; increasing the potential risk for hyperkalemia, and 2) the interaction between non-prescription aspirin and prescription warfarin; increasing the risk of bleeding (Qato et al., 2008).

Medication Use and Aging

There are many challenges to providing safe and effective drug therapy to the elderly population. The way the body manages medications is altered over the years and the elderly are usually on multi-drug regimens due to multiple diseases (ElDesoky, 2007). Changes in pharmacokinetics and pharmacodynamics affect how the body absorbs, metabolizes, and excretes different medications. Pharmacokinetics is best described as what the body does to the drug, including the time course of its absorption, bioavailability, distribution, metabolism and excretion (Ruscin, 2009). As we age, the body's ability to metabolize and excrete medications decreases, allowing for a potentially toxic build-up of a medication (Ruscin, 2009; Zwicker & Fulmer, 2008). These pharmacokinetic alterations may be due to changes in body composition (increased fat mass and decreased total body water) and the functioning of the organs that eliminate the drugs such as the liver and kidneys (Hines & Murphy, 2011). Pharmacodynamics is the response of the body to a medication, including receptor binding, postreceptor effects and chemical interactions which in turn can contribute to drug interaction susceptibility

(Hines & Murphy, 2011; Ruscin, 2009; Zwicker & Fulmer, 2008). Next, the issues surrounding multi-drug regimens or polypharmacy will be discussed.

Polypharmacy

Polypharmacy has been defined in the literature in different ways with no standard definition being used. Polypharmacy is most often defined either by the number of medications taken, by the use of medications without indication, or just simply by the use of multiple medications (Aparasu & Mort, 2004; Fulton & Allen, 2005; Hajjar, Cafiero, & Hanlon, 2007). In addition, polypharmacy has a multifactorial etiology. There are physical and pathophysiological changes that occur due to aging, as well as the onset of chronic health conditions that can necessitate the use of multiple medications. Over-the-counter (OTC), complementary, and/or alternative medications may also be used to self-treat minor ailments. For example, farmers may be diagnosed with diabetes, heart disease, hypertension and dyslipidemia and will be on multiple medications to treat these health problems. Not only will the farmers be on several medications, but they may also have several providers prescribing these medications without coordination among them. This can lead to the use of multiple medications that are contraindicated due to interactions and an increased risk of adverse effects.

With advancing age, the body responds differently to medications. Pharmacokinetics is defined as the way a body absorbs, metabolizes, distributes, and eliminates a medication (Zwicker & Fulmer, 2008). Polypharmacy can alter pharmacokinetics which results in an interaction between medications. One medication can alter the absorption, distribution, metabolism, or excretion of another medication causing these subsequent drug-drug interactions. This response is formally referred to as a pharmacodynamic interaction, and occurs when one medication actually potentiates or inhibits another medication (Fulton & Allen, 2005).

Drug-drug interaction in adults may cause serious adverse effects. The elderly are more susceptible to drug-drug interactions due to age-related physiological changes that affect pharmacokinetics and pharmacodynamics (Hines & Murphy, 2011). Commonly known drug-drug interactions and their adverse effects have been discussed in the book, *Evidenced-Based Geriatric Nursing Protocols for Best Practice* (Zwicker & Fulmer, 2008) and are shown in Appendix B, Table B1.

The American Hospital Formulary System (AHFS) Medication Classes

The AHFS is a comprehensive evidence-based drug compendium used in medical and paramedical communities as a foundation for safe and effective drug therapy (AHFS, 2009). It is used in the current research to classify all medications taken by the cohort of farmers. Table 3 presents the AHFS classes and subclasses used in the current study along with examples of medications and common side effects for each class/subclass. The side effects in the following table are not an exhaustive list of all the potential side effects for all medications within the AHFS classification schema, but rather a sample of potential side effects.

Table 3: The American Hospital Formulary System (AHFS) Classification Schema

AHFS Classes	AHFS Subclasses	Side Effects
Antihistamine Drugs	• **First Generation Antihistamines**: Diphenhydramine; treat allergies • **Second Generation Antihistamines**: Loratadine; to treat allergies	• **(CNS) effects:** depression, sedation, dizziness, disturbed coordination, muscular weakness, and lassitude (fatigue). Some individuals may experience other CNS effects such as paradoxical excitement characterized by restlessness, insomnia, euphoria, tremors, nervousness, palpitations, seizures; • **Gastrointestinal (GI) effects:** nausea, constipation, diarrhea, anorexia, • **Hepatic effects:** hepatic failure, jaundice, and abnormal hepatic functioning, cholestasis, hepatitis; • **Cardiovascular effects:** are uncommon and usually occur with overdose; cardiovascular effects include: hypotension, hypertension, tachycardia, palpitation, ECG changes (e.g., widened QRS), arrhythmias (e.g., extrasystole, heart block); • **Anticholinergic effects**: dry mouth, nose and throat; impotence, vertigo, visual disturbances, dysuria; urinary retention; headaches; parathesias; toxic psychosis; nervousness; irritability.
Anti-infective Agents	• **Anthelmintics:** ivermectin; to treat worm infestations; • **Antimycobacterials:** isoniazid to treat tuberculosis; • **Antibacterials:** gentamicin, cephalexin, erythromycin, and penicillins; • **Antifungals:** fluconazole; • **Urinary anti-infectives:** trimethoprim; • **Antiprotozoals:** chloroquine to treat	• **CNS effects**: dizziness, fatigue, somnolence, fatigue, headache, insomnia, malaise, cognitive changes, syncope, vertigo, nervousness, depression, anxiety, parathesia, seizures; • **GI effects**: nausea, constipation, diarrhea, vomiting, abdominal pain, anorexia, dyspepsia, heartburn, dry mouth; • **Cardiovascular effects**: tachycardia, peripheral edema, orthostatic hypotension, hypertension, edema; • **Occular effects:** abnormal sensation in the eye, eyelid edema; • **Musculoskeletal effects**: tendonitits, tendon rupture, transient arthralgia, myalgia; • **Other effects:** rash, neutropenia, tinnitus.

Table 3 continued

AHFS Classes	AHFS Subclasses	Side Effects
Anti-infective Agents, cont.	malaria; and • **Antivirals** such as atazanavi	
Autonomic Drugs	• **Parasympathomimetic (cholinergic) agents:** neostigmine to treat myasthenia gravis; • **anticholinergic agents:** such as atropine; • **sympathomimetic (adrenergic) agents:** dopamine and psuedoephedrine; • **skeletal muscle relaxants:** baclofen; and • **Other miscellaneous autonomic drugs:** nicotine.	• **Parasympathetic stimulation and muscarinic effects**: nausea, vomiting, diarrhea, miosis, increased bronchial secretions, abdominal cramps, bradycardia, bronchospasm, weakness, muscle cramps, hypotension; • **Antimuscarinic effects**: dry mouth, dry skin, blurred vision, urinary hesitancy and retention, tachycardia, palpitations, constipation, headache, nervousness, drowsiness, weakness, dizziness, flushing, insomnia, mental confusion; • **CNS effects**: vertigo, disorientation, delirium, hallucinations, confusion, irritability, dilated pupils.
Blood Formation, Coagulation, and Thrombosis drugs	• **Antianemia drugs** : iron preperations; • **antithrombotic agents:** warfarin, heparin, and aspirin ; • **hematopoietic agent**s: epoetin alfa; • **hemorrheologic agents:** pentoxifylline; and • **antihemorrhagic agents:** protamine sulfate and thrombin.	• **Cardiovascular effects**: chest pain, tachycardia, bradycardia, peripheral edema, orthostatic hypotension, hypertension, edema, cardiac arrest, pulmonary embolus, arrhythmias; • **CNS effects**: headache, transient parathesia, weakness, dizziness, faintness, syncope, disorientation, numbness, malaise, seizures, confusion; • **GI effects**: dyspepsia, nausea, constipation, diarrhea, vomiting, abdominal pain; • **Other effects:** hemorrhage, necrosis, epistaxis, purpura.

Table 3 continued

AHFS Classes	AHFS Subclasses	Side Effects
Cardiovascular Drugs	• **cardiac drugs:** digoxin • **Antiarrhythmic agents:** amiodarone • **Antilipemic agents:** simvistatin; • **Hypotensive agents:** atenolol and agiotensin-converting enzyme (ACE) inhibitors; • **Vasodilating agents:** nitates and nitrites (nitroglycerin); • **Sclerosing agents:** morrhuate sodium to treat varicose veins; • **A-adrenergic blocking agents (alpha blockers):** carvediol; • **B-adrenergic blocking agents (beta blockers):** atenolol and propanolol; • **Calcium-channel blocking agents:** amlodipine and verapamil; and • **Renin-angiotensin-aldosterone system inhibitors**: lisinopril.	• **Anticholinergic effects**: dry mouth, constipation, paralytic ileus, blurred vision, urinary retention; • **Cardiovascular effects**: hypotension, syncope, dyspnea, bradycardia, heart block, arrhythmias, tachycardia, hypertension, heart rate disturbances, edema, peripheral ischemia, chest pain, heart failure; • **GI effects:** nausea, vomiting, diarrhea, bloating, pain, gas, anorexia, hypoglycemia, constipation, hemorrhoids, dyspepsia, heartburn, biliary colic, steatorrhea, indigestion, epigastric distress, thirst; • **CNS effects:** drowsiness, sedation, headache, fatigue, weakness, lethargy, insomnia, behavioral changes, restlessness, anxiety, agitation, irritability, mental depression, visual and auditory hallucinations, dizziness, syncope, disorientation, confusion, lightheadedness, psychosis, nervousness, apprehension, agitation, euphoria, tinnitus, visual disturbances, parathesias, numbness, difficulty swallowing, dyspnea, slurred speech, muscle twitching, tremors, seizures, unconsciousness, respiratory depression, ataxia; • **Musculoskeletal effects.** Arthralgia/arthritis, muscle weakness, myalgia, muscle cramps; • **Other effects:** weight gain, rash, pruitis, leg cramps, rhinitis, pallor, polyuria, weight loss, hypokalemia, gynecomastia, lymphadenopathy, conjunctivitis, eye pain, increased risk for type 2 diabetes mellitus, hypoglycemia, back or joint pain, persistent cough, angioedema.

Table 3 continued

AHFS Classes	AHFS Subclasses	Side Effects
Central Nervous System (CNS) Agents	• **General anesthestics**: barbituates • **Analgesics and antipyretics:** nonsteroidal anti-inflammatory agents (NSAIDS) like ibuprofen, cyclooxygenase-2 (COX2) inhibitors, salicylates, • **Opiate agonists:** such as hydrocodone; • **Anticonvulsants:** phenobarbital and clonazepam; • **psychotherapeutic agents:** antidepressants and antipsychotics; • **Anorexigenic agents and respiratory and cerebral stimulants:** amphetamines; • **Anxiolytics, sedatives, and hypnotics:** barbiturates and benzodiazepines; • **Antimanic agents**: lithium salts; • **Animigraine agents:** almotriptan malate; • **Antiparkinsonian agents:** levodopa	• **CNS effects:** sedation, headache, dizziness, insomnia, anxiety, asthenia, depression, hypertonia, migraine, nervousness, neuralgia, neuropathy, parathesias, somnolence, vertigo, mental depression, apathy, inability to concentrate, sleepiness, irritability, drowsiness, somnolence, fatigue, ataxia, restlessness, nystagmus, blurred vision, diplopia, paradoxical excitement, hyperactivity, suicidal ideation/behavior, sleep disturbances, weakness, tremors, myoclonic movements, hyperflexia, confusion, disorientation, memory loss, euphoria, agitation, manic symptoms, increased motor activity, severe CNS depression, delirium, complex sleep-related behaviors, decreased concentration, dulled senses, hallucinations, psychosis, abnormal thinking, amnesia, hyperkinesias, slurred speech, delusions, aggressive behavior, paranoid reaction, manic reaction, gait abnormalities, euphoria, coma, stupor, lingual facial dyskinesias, personality changes, paranoia; • **Extrapyramidal symptoms:** acute dystonic reaction- muscle rigidity, eyes fixed in deviated position; akathisia; akinesia; psuedoparkinsonism; perioral tremor; • **Tardive dyskinesia:** involuntary movements, especially in the face, lips, and tongue; • **Anticholinergic effects**: dry mouth, constipation, blurred vision, dizziness, sedation, urinary retention; • **Cardiovascular effects:** hypertension, hypotension, ventricular tachycardia, dyspnea, pulmonary edema, orthostatic hypotension, hypertensive crisis, bradycardia, chest pain, valulopathy, pulmonary hypertension, arrhythmias, cardiomyopathy, myocardial infarction, myocardial ischemia, coronary vasospasm; • **GI effects:** dyspepsia, diarrhea, abdominal pain, nausea, vomiting, flatulence, gastritis, constipation, upper GI ulceration, bleeding,

Table 3 continued

AHFS Classes	AHFS Subclasses	Side Effects
Central Nervous System (CNS) Agents, cont.		gastric distress, dysphagia, constipation, anorexia,weight loss • **Renal effects:** hypertension, peripheral edema, renal calculus; • **Other effects:** upper respiratory tract infections, sinusitis, rhinitis, bronchitis, coughing, dyspnea, rash, dermatitis, pruritis, uticaria, anemia, dysuria, tinnitus, fever, flu-like symptoms, hyperglycemia, hypokalemia, weight gain, liver disease, hepatitis, jaundice, hypocalcemia, photophobia, impotence, ejaculatory disturbances, anorgasmia, urinary frequency, urinary retention, urinary incontinence, hypermetabolic syndrome, pallor, flushing ,Tourette's syndrome, anaphylaxis, angioedema, emotional lability, stroke, anaphylaxis, thrombocytopenic purpura, psychomotor retardation, **n**ephrogenic diabetes insipidus, goiters, hypothyroidism, leukocytosis, peripheral vascular ischemia, transient ischemic attack, serotonin syndrome, photosensitization.
Gastrointestinal (GI)Drugs	• **Antacids and absorbants**: aluminum carbonate, calcium carbonate, and activated charcoal; • **Antidiarrheal agents :** loperamide; • **Antiflatulents:** simethicone; • **Cathartics and laxatives:** bisacodyl and stool softeners; • **Choleitholtic agents:** ursodiol for gallstone dissolution; • **Digestants:** pancreatin and pancrelipase; • **Emetics:** ipecac; • **Antiemetics:** ondansetron;	• **CNS effects:** confusion, headache, neurotoxicity, headache, lethargy, dizziness, irritability, hyperactivity, drowsiness, paradoxical CNS stimulation, blurred vision, incoordination, restlessness, lightheadedness, insomnia, ataxia, akathisia, seizures, reversible confusional states (e.g., mental confusion, agitation, psychosis, paranoia, depression, anxiety, hallucinations, hostility, delirium, disorientation), myalgia, fatigue, mood swings, depression, insomnia,, personality changes to frank psychoses; • **Cardiovascular effects:** palpitations, hypotension, electrocardiogram changes, cardiac arrhythmias, unspecified chest pain, bradycardia; • **GI effects:** diarrhea, constipation, decreased bowel motility, hemorrhoids, fissures, fecal impaction, belching, flatulence, nausea, vomiting, fluid and electrolyte depletion, bowel or esophageal obstruction, GI discomfort, irritation, burning or griping, cramping,

Table 3 continued

AHFS Classes	AHFS Subclasses	Side Effects
Gastrointestinal (GI)Drugs, cont.	• **Antiulcer agents and acid suppressants:** cimetidine and omeprazole; • **Prokinetic agents:** metoclopramide; • **Anti-inflammatory agents:** balsalazide to treat ulcerative colitis.	pain, tenesmus, abdominal distention, bloating, malabsorption, irritation of mucosa, ulceration, stomatitis, protracted vomiting, anorexia, gastritis, dyspepsia, gastroenteritis, stool abnormalities, GI hemorrhage; • **Other effects:** renal impairment, hepatic impairment, hypokalemia, dehydration, uticaria, rhinoconjunctivitis, acute bronchospasm, anaphylaxis, muscle weakness, **e**lectrolyte abnormalities (e.g., hyperphosphatemia, hypernatremia, hypocalcemia, hypokalemia), allergic reactions, myopathy, fever, diaphoresis, tinnitus, dry mouth, abnormal taste, pruritus, rash, transient blurred vision, fever, urinary retention, rhinitis; parathesias, toxic psychosis, nervousness, irritability.
Hormones and Synthetic Substitutes	• **Adrenals:** corticosteroids; • **Androgens:** testosterone; contraceptives such as estrogen-progestin combinations; estrogen • **Estrogen agonists:** estradiol for treatment of menopause and tamoxifen for the treatment of breast cancer; • **Gonadotropins:** lutropin to treat infertility; • **Antidiabetic agents**: metformin and insulin; • **Antihypoglycemic agents**: glucagon; • **Parathyroid agents:** teriparatide to	• **CNS effects:** headache, vertigo, insomnia, restlessness, increased motor activity, ischemic neuropathy, electroencephalogram (EEG) abnormalities, seizures, aseptic meningitis, mental depression, dizziness, migraine headache, vertigo; • **Cardiovascular effects:** hypercholesterolemia, atherosclerosis, thrombosis, thromboembolism, fat embolism, and thrombophlebitis, hypertension, thrombophlebitic events, congestive heart failure, tachycardia, increased pulse and blood pressures, angina pectoris, cardiac arrhythmias, chest pain, palpitations; • **Endocrine effects:** amenorrhea or other menstrual difficulties, decrease glucose tolerance, produce hyperglycemia, and aggravate or precipitate diabetes mellitus, decreased breast size, voice changes (e.g., deepening, hoarseness, instability), sore throat, acne, increased oiliness of skin or hair, hair loss, weight gain, edema, and, rarely, clitoral hypertrophy or testicular atrophy, increased serum triglyceride concentrations, hypoglycemia;

Table 3 continued

AHFS Classes	AHFS Subclasses	Side Effects
Hormones and Synthetic Substitutes, cont.	• treat osteoporosis; • **Pituitary agents:** vasopressin to treat diabetes insipidus; • **Somatotropin agonists and antagonists:** pegvisoment for the treatment of acromegaly; • **Progestins:** hydroxyprogesterone for the treatment of amenorrhea or abnormal uterine bleeding; • **Thyroid and antithyroid agents:** levothyroxine to treat hypothyroidism and methimazole used to treat hyperthyroidism	• **GI effects:** nausea, vomiting, anorexia, weight loss, increased appetite, weight gain, diarrhea or constipation, abdominal distention, pancreatitis, gastric irritation, ulcerative esophagitis, indigestion, ulcers, abdominal cramps, abdominal pain, bloating, diarrhea, constipation. gingivitis, dry socket; • **Musculoskeletal effects**: muscle wasting, muscle pain or weakness, delayed wound healing, osteoporosis; • **Other effects:** increased susceptibility to infection, fluid and electrolyte disturbances, bronchospasm, cough, urticaria, angioedema, rash, jaundice, allergic reactions, rash, chloasma, melasma, liver function changes, amenorrhea, dysmenorrhea, premenstrual-like syndrome, breast changes (tenderness, enlargement, and secretion), facial erythema, petechiae, ecchymoses, edema, elevations in serum aminotransferase (transaminase) concentrations (i.e., AST [SGOT], ALT [SGPT]).
Vitamins	• **Single vitamin preparations:** vitamins A, B complex, C, D, E, K, as well as • **Multivitamin preparations**.	• **CNS effects:** dizziness, weakness, headache, somnolence, sweating, parathesias, somnolence, altered sleep patterns, difficulty concentrating, irritability, overactivity, excitement, mental depression, confusion, impaired judgment; • **GI effects:** nausea, vomiting, GI upset, diarrhea, flatulence, abdominal pain, dyspepsia, intestinal cramps; • **Other effects:** facial dermatitis, dry mucous membranes, conjunctivitis, palmoplantar peeling, yellowing (palms, hands, feet, and face from bet-carotene), joint pain, unusual bleeding or bruising, dry mouth, constipation, muscle pain, bone pain, metallic taste, allergic reactions, feeling of warmth, pruitis, rash, urticaria, very yellow urine, temporary flushing, itching, tingling.

Sources: AHFS. *AHFS DRUG INFORMATION 2009* (1st ed.). Bethesda, MD: American Society of Health-System Pharmacists®.

Facts, A. C. (Ed.). (2011). *Drug facts and comparisons*. St. Louis: Facts and Comparisons; Wolters Kluwer Health.

Meiner, S. E., & Lueckenotte, A. (2005). *Gerontologic nursing*. St. Louis: Mosby.

Note: Medications and side effects listed are not an exhaustive account of all medications and side effects for the AHFS classes, but rather they are a sample of the potential medications and side effects within each class.

Many of the side effects from medications in the AHFS classes and subclasses can affect several of the tasks farmers complete during the day. Some of the most common side effects that are of concern include:1) central nervous system (CNS) effects such as dizziness, syncope, sedation, delirium, disturbed coordination, and gait difficulties, 2) cardiovascular effects such as hypotension, dyspnea, and bradycardia; and 3) musculoskeletal effects such as muscular weakness and fatigue. These side effects can make working on the farm very dangerous.

The above noted side effects from medication use can lead to an adverse drug event. An adverse drug event is an adverse outcome that occurs when taking medication in any of the following situations: normal use of medicine, poor adherence, self-medication, inappropriate use, inappropriate or suboptimum prescribing, or medication error (Zwicker & Fulmer, 2008). These adverse events are responsible for approximately 700,000 emergency department visits and 120,000 hospitalizations annually (Budnitz et al., 2006). During the years 2004-2005, adults 65 years of age and older visited the emergency department due to adverse drug event an estimated 177,504 times annually (Budnitz, Shehab, Kegler, & Richards, 2007).

One adverse drug event is injury. Many side effects may impair the ability to perform hazardous activities requiring mental alertness and physical coordination such as operating machinery or working with livestock. Side effects such as sedation, dizziness, muscular weakness, and fatigue can make working with cattle very dangerous. Cattle are very large unpredictable animals and the aforementioned side effects can decrease the ability of farmers to safely and effectively react to a potentially dangerous situation. CNS side effects along with the potential visual disturbances can make working with or driving farm implements very dangerous. Misjudgments can be made that may lead to a tractor over-turn, an entanglement in an implement, or a fall from a grain bin. One adverse event that can occur after taking medication that has been thoroughly studied is falls. Falls and medication use are discussed next.

Falls and Medication Use

Among older adults in the U. S., falls are the most common cause of injuries and hospital trauma, as well as the leading cause of injury-related deaths. One in three persons, 65 years of age and older fall each year (CDC, 2006a). In 2004, more than 1.8 million seniors aged 65 and older were treated in emergency departments for fall-related injuries, and over 433,000 were hospitalized (CDC, 2006b). In 2007, the age-adjusted crude fatal fall rate for adults age 65 and older was 48.32 per 100,000(CDC, 2009a). In 2008, the crude nonfatal injury rate for adults age 65 and older was 5,438.97 per 100,000 (CDC, 2009b).

The Centers for Disease Control and Prevention (CDC) and the National Center for Injury and Prevention and Control (NCIPC) created a web-based injury statistics query and reporting system (WISQARS) that catalogues national injury data. In their online fact-sheet for falls among older adults they state that one in three persons 65 years of age and older fall each year. In 2009, older adults were treated in emergency departments for more than 2.2 million nonfatal fall-related injuries, and over 582,000 were hospitalized (Centers for Disease Control and Prevention & National Center for Injury Prevention and Control, 2010).

Several studies have found that injuries from falls (falls from elevations; slips/trips/falls) are one of the most common injuries that farmers sustain (Browning et al., 1998; Rautiainen, Lange, Hodne, Schneiders, & Donham, 2004; Sprince et al., 2003c; Voaklander et al., 2006; Zhou & Roseman, 1994). Therefore it is important to explore the literature for what medications may put persons at risk for falls.

Authors Leipzig, Cumming, & Tinetti (1999a, b) used articles published between 1966 and 1996 to complete two systematic reviews/meta-analyses to critically evaluate evidence linking certain classes of medications to falls in older adults. The authors used a fixed-effects approach using the Mantel-Haenszel method of pooling data for the analysis.

Part one exclusively evaluated psychotropic drugs and their association with falls and part two evaluated cardiac and analgesics drugs and their association with falls. In part one, evaluating psychotropic drugs, the authors used a fixed-effects meta-analysis approach to evaluate 40 studies of adults 60 years of age and older. The authors found that there was an association between the use of specific psychotropic drugs and falls (Leipzig, Cumming, & Tinetti, 1999a).

The results from the meta-analysis are reported as pooled odds ratios (ORs). An odds ratio is a measure of effect size that describes the strength of the association between two variables; specifically it is the ratio of the odds of development of the outcome of interest in exposed persons over the development of said outcome in non-exposed persons (Gordis, 2000). In the case of a meta-analysis, the data from several studies have been combined so the ORs are expressed as pooled ORs, as data has been 'pooled' together to get the ORs. The results for the pooled odds ratios (ORs) are as follows for the moderate associations: any psychotropic drug use (OR: 1.73; 95% CI: 1.52-1.97); neuroleptic use (OR: 1.50; 95% CI: 1.25-1.79); sedative/hypnotic use (OR: 1.54; 95% CI: 1.40-1.70); any antidepressant use (OR: 1.66; 95% CI: 1.41-1.95); and finally for tricyclic antidepressant (TCA) use (OR: 1.51; 95% CI: 1.14-2.00) (Leipzig et al., 1999a).

In part two, evaluating cardiac and analgesic drugs, again a fixed-effect meta-analysis approach was used to evaluate 29 studies of adults aged 60 and older. In this meta-analysis digoxin (OR: 1.22; 95% CI: 1.05-1.42), type 1a antiarrhythmic (OR: 1.59; 95% CI: 1.02-2.48), and diuretic use (OR: 1.08; 95% CI: 1.02-1.16) were found to be weakly associated with falls in older adults (Leipzig et al., 1999b). Limitations in this meta-analysis include the use of observational data only; none of the studies were randomized control trials; and they used a fixed-effects approach rather than the random-effects approach. When a researcher is using data from several studies where it is unlikely that all the studies are functionally equivalent (i.e., subjects recruited in the same way on the same population, same interventions used, and same study design) using a fixed-effects method of meta-analysis would not properly account for the between study variability. Unless the studies for meta-analysis fit this very narrow functional equivalency, using a fixed-effect model would be inappropriate and should be reanalyzed using a random-effects model (Schmidt, Oh, & Hayes, 2009).

Addressing this deficiency, a more recent meta-analysis of the impact of medication use on falls in the elderly was published in 2009 (Woolcott et al., 2009). But before Woolcott et al. (2009) completed their updated random-effects meta-analysis, Hartikainen, Lonnroos, and Louhivuori (2007) completed a systematic review describing studies published from1996 to 2004, which examined medication use and falls. The authors of this review found the main medication risk factor for falls and fractures in older people was Benzodiazepines, with antidepressants and antipsychotics also being associated to falls. Antiepileptics and cardiovascular drugs that lower blood pressure were found to be weakly associated to falls in older adults. These findings give a good summary of what has been published in the literature from 1996-2004, yet the authors failed to complete a meta-analysis or use any formal statistical techniques to pool these data which would have proven more valuable (Hartikainen, Lonnroos, & Louhivuori, 2007; Woolcott, 2009).

Attending to the deficiencies of the meta-analysis and review mentioned previously, the most recent meta-analysis of the impact of medication use on falls in the elderly was published in 2009 by Woollcott, et al. These authors completed a meta-analysis using Bayesian random-effects methods incorporating the results of Leipzig et al. (Leipzig et al., 1999a; Leipzig et al., 1999b) along with new study data. Woollcott and colleagues searched literature published between 1996 and August 2007 and considered a study eligible if the study presented original data of a case-control, cross-sectional, randomized control trial (RCT), or cohort designs and assessed the association between medication use and falls in persons aged 60 years and older. Utilizing 22 studies, the meta-analysis included 79,081 participants and nine unique classes of medications and found a strong significant association with falls when using the following medication classes (Baysesian unadjusted OR estimates): sedatives and hypnotics (OR: 1.47; 95% CI: 1.35-1.62), antidepressants (OR: 1.68; 95% CI: 1.47-1.91), and benzodiazepines (OR: 1.57; 95% CI: 1.43-1.72). A very weak association was found for the following classes (Baysesian unadjusted OR estimates): antihypertensive agents (OR: 1.24; 95% CI: 1.01-1.50), diuretics (OR: 1.07; 95% CI: 1.01-1.14), and non-steroidal anti-inflammatory drugs (OR: 1.21; 95% CI: 1.01-1.44). The following medication classes were not found to significantly increase the risk of falling: narcotics (OR: 0.96; 95% CI: 0.78-1.18) and beta-blockers (OR: 1.01; 95% CI: 0.86-1.17).

Woolcott and colleagues (2009) then completed an updated Bayseian analysis which only included the studies in which other confounders such as age, gender, and comorbidities could be adjusted. The updated Bayesian posterior ORs included the following significant associations: antidepressants (OR: 1.36; 95% CI: 1.13-1.76), and benzodiazepines (OR: 1.41; 95%CI: 1.20-1.71). Although antipsychotics and neuroleptics (OR: 1.59; 95% CI: 1.37-1.83) and diuretics (OR: 1.07; 95% CI: 1.01-1.14) were associated with falling in the unadjusted meta-analysis, after the adjustment they were no longer statistically associated with falling. In conclusion, the researchers confirmed the use of sedatives and hypnotics, antidepressants, and benzodiazepines were significantly associated with falls in the elderly.

Farmers and Medication Usage

The literature on farmers and medication use is limited. There have been a modest number of studies that have reported medication use as a risk factor for agricultural injury. The majority of these studies were based on farmers' self-report of *any medication use*, and did not identify any specific medications or classes of medications as risk factors. Five of these studies found that taking any medication was significantly associated with agricultural injury (Brison & Pickett, 1992; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003c; Xiang et al., 1999), while four studies did not have statistically significant findings (Browning et al., 1998; Marcum et al., 2011; Sprince et al., 2002; Sprince et al., 2007). There have only been three studies looking at how specific classes of medication are associated with agricultural injury. The medications found to be associated with agricultural injury include: stomach remedies or laxatives, circulatory medications, sleep medications, NSAIDS, and sedatives (Pickett et al., 1996; Spengler et al., 2004; Voaklander et al., 2006). The most common medication class found in the literature to be studied in relation to agricultural injury was sleep medications; it was addressed specifically in three studies (Pickett et al., 1996; Spengler et al., 2004; Voaklander et al., 2006). The studies exploring medication use, but not any specific medication or classes of medications will be discussed first.

Brison and Pickett's (1992) Canadian cohort study of 547 farmers in Ontario found the use of prescription drugs by farm owners (n=17) to be significantly associated with increased risk for injury (relative risk (RR):2.7; p=0.07). Although, when using the complete population of the study (n=547), the use of prescription drug use was not found to be statistically significant in the logistic regression models. Limitations to this study include the lack of controlling for comorbidities, and the low participation rate which limits the generalizability of the findings.

The cross-sectional study by Browning et al. (1998) specifically exploring agricultural injures in older farmers in Kentucky found that farmers that reported current use of medication had a 24% higher injury rate than those who did not report prescription medication use. Yet, current use of a prescription medication was not found to be statistically significant in either the univariate (OR: 1.24; 95% CI: 0.75-2.05) or multiple logistic regression analyses (Browning et al., 1998). An obvious limitation to the study was the recall bias introduced due to the one year period for recalling injuries. This extended recall period would lead farmers to recall severe injuries best and potentially forget the more minor injuries, which may have led to an underestimation of the injury rate.

Xiang et al. (1999) explored nonfatal agricultural injuries among a cohort of older farmers in Colorado and found that older male farmers that suffered an injury were more likely to be taking at least one prescription medication than those not injured (adjusted OR: 3.02; 90% CI: 1.05- 8.61, p=0.29) (Xiang et al., 1999). The researchers did include comorbidities such as heart disease, high blood pressure, arthritis, and cancer in the regression analysis as confounders. A limitation to this study was the recall period for injuries and risk factors. The farmers were asked about injuries and risk factors that were experienced in the previous 12 months. Again, this long recall period can introduce bias and underestimate the true injury rate.

Several case-control studies were conducted by Sprince et al (2002, 2003b, 2003c, and 2007). The first study assessed risk factors for machinery-related agricultural injury in a group of farmers from the Agricultural Health Study. They did not find a statistically significant association between taking medication and machinery-related injury (OR: 1.19; 95% CI: 0.83-1.72) (Sprince et al., 2002). There were several studies published in 2003 by Sprince et al., all case-control designs nested within the Agricultural Health Study. In the first study (2003a), the researchers specifically explored animal-related injury among Iowa farmers and found that the use of any medication increased a farmers risk for animal-related injury (OR: 2.07; 95% CI: 1.29-3.33) (Sprince et al., 2003a). The next study Sprince and colleagues(2003b) study assessed risk factors for agricultural injury found a statistically significant association between farm work-related injury and regular medication use (OR: 1.44; 95% CI: 1.04- 1.96) (Sprince et al., 2003b). The next study looked specifically at fall injuries among Iowa farmers and found that taking medications regularly increased the farmers risk of falls (OR: 1.80; 95% CI: 1.02-3.18) (Sprince et al., 2003c).

Finally, the last study by Sprince et al. (2007) explored risk factors for low back injury in a case-control group of farmers, again from the Agricultural Health Study. The findings related to any medication use were not statistically significant (OR: 1.63; 95% CI: 0.85-3.11). The recall time in these studies was 12 months, introducing bias to the results as farmers may not have correctly recalled all injuries due to the long recall period. The researchers also noted that the farmers in their studies were younger, worked on larger farms, and applied pesticides more frequently than Iowa farmers in general. Therefore, generalizing the results to all Iowa farmers should be done with caution.

The last study to look at non-specific medication use and agricultural injury is a study of farmers 50 years and older in Kentucky and South Carolina (Marcum et al., 2011). Self-reported data on medication use, other risk factors and injury were collected in four waves. The recall time for injuries and risk factors were for the previous year or since the last survey. Several co-morbid health conditions were included in the analysis. In univariate regression analysis, daily prescription use was not found to be statistically significant (OR: 1.00: 95% CI: 0.75-1.32) and therefore was not included in the multivariate regression analysis (Marcum et al., 2011).

A limitation to all the previously discussed studies is that the injury and risk factor data were all self-report, therefore introducing potential bias due to improper or non-complete recall of injuries and potential exposures. Another limitation is that the studies did not explore specific types or classes of medications, rather only inquired about the current use of medication or regular medication use.

There have been only a few studies that have explored the associations between agricultural injury and farmers taking specific classes of medication. The Canadian case-control study completed by Pickett et al. (1996) explored the use of several classes of medication and agricultural injury. The farmers were asked in a mailed survey about several classes of medication: narcotic analgesics, non-narcotic analgesics, heart or circulatory medications, stomach remedies or laxatives, tranquilizers or sleeping pills, and antidepressants. The researchers found that 28% of the controls and 31% of the cases took at least one medication. Only 0.4% of controls and none of the cases were taking antidepressants. The most common class of medication taken in the study was non-narcotic analgesics with 21.5% of controls and 18.5% of cases taking them. In the bivariate analysis, the only medication found to be significantly associated with farm injury was the use of stomach remedies or laxatives taken alone (OR: 2.88; 95% CI: 1.20-6.90). In the multivariable analysis, the researchers found statistically significant increases in risk of farm injury with the regular use of stomach remedies or laxatives by males (OR: 2.8; 95% CI: 1.0-7.7) and heart and circulatory medications by men over the age of 45 (OR: 4.2; 95% CI: 1.2-14.7). This study did not completely control for chronic health conditions for which the medications were taken. They used *number of co-morbid conditions* as a confounder to attempt to address the potential correlation between medication use and the diseases for which the medications were taken. This lack of controlling for co-morbidities may have created bias due to confounding by indication.

Confounding by indication is a term used to describe the confounding role of disease prognosis or severity and the medications used to treat the disease (Salas, Hotman, & Stricker, 1999). Therefore, to avoid this confounding it is important to distinguish if a chronic disease puts the subject at risk for injury, if it is the medication they take for that disease, or if it is the combination of the disease and the medication that puts them at risk. The best way to deal with confounding by indication is to explore the interactions between the disease and the specific medications taken for the disease.

A cross-sectional study by Spengler and colleagues (2004) explored the impact of self-reported sleep habits and sleep problems on injury risk in a group of Kentucky farmers. They included the use of sleep medications in the multiple logistic regression as well as sleep apnea, and average daily hours of sleep. In bivariate analysis, farmers that used sleep medications were twice as likely to have had an injury within the last 12 months as farmers who did not use any sleep medications. In the multivariate logistic regression analysis, sleep medication remained significantly associated with an increased risk for agricultural injury (OR: 2.11; 95% CI: 1.01-4.40) (Spengler et al., 2004). Again, the 12 month recall for self-reported injury and risk factor data may introduce bias into the study. This 12 month recall time frame also creates the inability to establish a temporal relationship between use of the sleeping medication and the actual injury.

A Canadian case-control study by Voaklander et al. (2006) on farmers over the age of 66 explored the use of several classes of medication with agricultural injury. Several classes of medications were excluded from the multiple logistic regression analysis due to having less than 16 farmers having purchased the medications. The classes not included were: anti-histamines, anti-convulsants, anti-depressants, anti-psychotics, anti-Parkinsonian agents, visual impairment agents, sex hormones, thyroid agents, and anti-hypertensives. Their findings indicated a greater risk for injury for those farmers who had stopped taking narcotic analgesics (OR: 9.37; 95% CI: 4.95-17.72) and non-steroidal anti-inflammatories (NSAIDS) (OR: 2.40; 95% CI: 1.43, 4.03) 30 days prior to the date of injury. These researchers also found that farmers taking sedatives up until the date of injury were also at risk for agricultural injury (OR: 3.01; 95% CI: 1.39, 6.52) compared to those not taking sedatives. No statistical association was found with the following classes: anti-hypertensive medications, anti-coagulants, diabetes medications, corticosteroids, anti-ulcer agents, and electrolytic/caloric/water balance medications (Voaklander et al., 2006)

This is the first study to use data that was not survey or interview based, but rather taken from several governmental databases. Co-morbidities were controlled for in this study, but only injuries related to emergency and hospital treatment were used in this study. This lack of inclusion of less severe injuries or fatal injuries may dilute or underestimate the associations found in this study. Finally, the medication information was not truly about medications taken but rather a proxy indicator for medications taken. This proxy was established from a database of medications purchased. A farmer may have purchased, but not actually used the medications, leading to potentially biased results (Voaklander et al., 2006).

In summary, the literature regarding medication use and agricultural injury includes five studies that found that taking any medication was significantly associated with agricultural injury (Brison & Pickett, 1992; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003c; Xiang et al., 1999), while four studies did not have statistically significant findings (Browning et al., 1998; Marcum et al., 2011; Sprince et al., 2002; Sprince et al., 2007). The only specific classes or types of medications that have been found to increase the farmers' risk for injury were sleep medications (Spengler et al., 2004), regular use of stomach remedies or laxatives by males, heart and circulatory medications by men over the age of 45 (Pickett et al., 1996), anxiolytics, sedatives, and hypnotics (Voaklander et al., 2006), and finally cessation of use of non-steroidal anti-inflammatory medications, narcotic pain killers 30 days prior to an injury (Voaklander et al., 2006).

This review on the use of medication as a risk factor for agricultural injury has revealed several concerns about the research conducted regarding medication use as a risk factor for injury. First, all but one of the studies relied on self-report data which may introduce bias due to limitations in recall. Secondly and most importantly, the majority of the studies lacked the ability to establish a true temporal relationship between taking a medication and experiencing an injury, as most of the studies relied on a recall time of 12 months for both injuries and exposures. Therefore, it is not known if the medication use in these studies could truly be part of the causal pathway leading to an injury. Third, many of these studies did not include co-morbid health problems and therefore were confounded by indication. This lack of controlling for co-morbidities can lead to confusion as to whether the disease itself or the medication use increased the risk for injury. Finally, only three studies explored classes or types of medications and their relationship to agricultural injury. More research is needed using medical and pharmacy records that temporally link the use of different types or classes of medications to an agricultural injury, and that greatly decreases the confounding by indication through thorough assessment of doctor-diagnosed medical conditions established by medical records data.

Appendix A summarizes the current research on the medication use as a host risk factor for agricultural injury. Table A2 in Appendix A has been adapted from the work of Voaklander, Umbarger-Mackey and Wilson (2009).

Agents of Agricultural Injury

An *agent* is the actual energy (mechanical, thermal, electrical) that is transmitted to the host via a *vehicle* (inanimate object) and *vector* (animate objects). For the *agent* or energy to result in an injury, the energy transmitted must be beyond the *host's* tolerance. As farmers continue to work throughout the decades, their tolerance is affected by many age-related factors as discussed previously (Kraus et al., 1997). This section will discuss the agents, vectors and vehicles, which have been found in the literature to contribute to injuries in older farmers.

<u>Vehicles: Farm Implements, Tools, and Agrichemicals</u>

Tractors are a mainstay of farming in the U. S. With the operation of tractors come potential hazards that can result in injury and even death. Tractor overturns are the number one cause of fatality in older farmers (Donham & Thelin, 2006; Gelberg et al., 1999; Meyer, 2005; Mitchell et al., 2002; Myers et al., 2009; Myers et al., 1999; Pickett et al., 1999; Voaklander et al., 1999). It has been noted by many in the field of agricultural safety and health that older farmers are more likely than younger farmers to operate older tractors that do not have roll over protection (ROPs) (Gelberg et al., 1999; Voaklander et al., 1999).

In a recent national study by Myers (2009), researchers found that the most common mechanisms of frequent nonfatal injuries for the older farmers included contact with objects and falls. Contact injuries included being struck by swinging or slipping objects and being struck by falling objects. Other common nonfatal injuries included off-road non-collisions, and over-exertion. The most common fatal injury to older farmers was due to tractors (46% of all fatal injuries to older farmer), compared to 27% in younger farmers (Myers et al., 2009).

Vectors: Animals

Several studies have found that having livestock can put the older farmer at greater risk for injury (Brison & Pickett, 1992; Browning et al., 1998; Sprince et al., 2003a; Xiang et al., 1999). This could be that older farmers' balance, stamina, and reaction time may be diminished due to the normal process of aging. These age-related changes may make it difficult for older farmers to respond quickly and agilely to a dangerous animal-related hazard. A study on injury and older farmers in Kentucky conducted by Browning et al (1998) found that 75% of all the injuries in the study occurred on farms that had beef cattle alone or beef cattle and tobacco. They also found a statistically significant increase in risk of injury if the older farmer worked on a single-livestock (cattle) farm (OR: 1.90; 95% CI: 1.02-3.55) or a farm with cattle and tobacco (OR: 2.15; 95% CI: 1.00-4.59) versus those with that worked on a farm with just tobacco. The beef cattle farms in this study accounted for 85% of the animal-related injuries. Eighty-three percent of all the animal-related injuries were the result of being kicked by cattle (Browning et al., 1998).

In a study of older farmers in Colorado, Xiang et al. (1999) found that the leading cause of agricultural injuries for older farmers was livestock (44.5%). In a case-control study by Sprince et al. (2003a), researchers assessed risk factors for animal-related injuries in a group of large-livestock Iowa farmers. Their findings noted an increased risk for injury from animals for the following: use of hearing aids (OR: 5.4; 95% CI: 1.6-18.0), doctor-diagnosed arthritis or rheumatism (OR: 3.0; 95% CI: 1.7-5.2), and educational level beyond high school (OR: 1.8; 95% CI: 1.1-2.8). These findings make sense as having a hearing aid and having arthritis or rheumatism may make it more difficult to respond rapidly to animal cues and avoid dangerous situations posed by large animals.

Myers et al (2009) found in their national sample of farmers that animal-related incidents accounted for approximately 10% of the nonfatal injuries. Those farmers having livestock operations sustained the most agricultural injuries (53,341) and had the highest injury rate of 5.9/100 workers/year. Younger farmers (aged 20 to 54 years old) had a slightly higher nonfatal injury rate (5.8/100 workers/year) on livestock operations than older farmers (5.3/100 workers/year) (Myers et al., 2009).

Falls

Falls are multi-factorial, as there are many contributing factors. Rather than trying to discuss falls as caused by vectors (fall due to an animal) or vehicles (fall from a tractor) or due to environmental conditions (icy sidewalk), they will be discussed in their entirety in this next section. As noted earlier, falls are the most common cause of injuries and hospital trauma, as well as the leading cause of injury related deaths for adults over the age of 65 (CDC, 2006a; CDD< 2006b; CDC, 2009a, CDC, 2009b).

Falls are also a concern in the farming population. Several studies have found that injuries from falls (falls from elevations; slips/trips/falls) are one of the most common injuries that farmers sustain (Browning et al., 1998; Rautiainen et al., 2004; Sprince et al., 2003c; Voaklander et al., 2006; Zhou & Roseman, 1994). A study on injury and older farmers in Kentucky conducted by Browning et al (1998) found that the leading cause of farm injury was falls at 24.9%, with 93% of those farmers reporting a fall requiring medical services and 56% missing more than four hours of farm work. The three most prevalent types of falls were: falls from machinery (35%), falls from slipping on ice (17%), and falls while hanging/taking down tobacco (17%) (Browning et al., 1998).

A case-control study by Sprince et al. (2003c) explored agricultural fall injury in a group of Iowa farmers (average age=50 years old). In this study, there were 79 farmers and they reported 85 falls. Nineteen of those farmers (24%) required hospitalization due to the fall injury. Fifty-three percent of the falls occurred during the three month period of autumn from September through November. This period includes harvest season and the increase in falls may be due to the increased tasks and time constraints of harvest season as well as the potential environmental conditions related to this time of year (Sprince et al., 2003c). Types of falls included falls: 1) from a moving vehicle (28 injuries; 32.9%), 2) to floor, walkway, or other surface (21 injuries; 24.7%), 3) off a ladder (10 injuries; 11.8%), 4) to lower level (6 injuries; 7.1%), and finally 5) other or unspecified (20 injuries; 23.5%). The researchers found that fall-related farm injuries were significantly associated with middle-age (40-64 years), regular use of medications, doctor-diagnosed arthritis/rheumatism, and difficulty hearing normal conversation (even in the case of using a hearing aid) (Sprince et al., 2003c).

Finally, the study by Myers et al. (2009) of a national sample of farmers found that 30% of the nonfatal agricultural injuries to older farmers resulted from falls (Myers et al., 2009). These fall injuries included falls on the same level (15%) and falls from an elevation (14%). As falls are very common in older adults in general, it is not surprising falls are prevalent in older farmers as well.

Summary

While there have been numerous studies exploring risk factors for agricultural injury, there have been a limited number of studies specifically looking at risk factors for older farmers (Blahey, 2002; Browning et al., 1998; Myers et al., 2009; Myers et al., 1999; Whitman & Field, 1995; Whitman, 2002; Xiang et al., 1999) and even fewer exploring current/regular medication use and farm injury (Pickett et al., 1996; Spengler et al., 2004; Sprince et al., 2003b; Sprince et al., 2003c; Xiang et al., 1999). There is even a larger gap in knowledge about how specific medications may affect the older farmers' safety while farming as there have only been three studies that have examined the use of specific classes of medications as a risk factor for agricultural injury (Pickett et al., 1996; Tiesman et al., 2006; Voaklander et al., 2006).

CHAPTER 3
RESEARCH METHODS

This chapter outlines the research methods used to address the specific aims and research questions posited in chapter one. As this research is a secondary data analysis, a description of the original parent study, Certified Safe Farm, is included. The current study design, data collection procedures, measurement of variables and plan for data analysis are also detailed in this chapter.

Secondary Data Set: The Certified Safe Farm Study

Analysis of already existing data is cost-effective, allows researchers to gain a more extensive understanding of particular phenomena and to publish new findings (Clarke & Cossette, 2000; Coyer & Gallo, 2005). In most research studies, participants invest a tremendous amount of time and energy; completing a secondary data analysis has the ability to obtain more research answers for the same time and money invested as doing the original study. Analysis of secondary data can also be used as a pilot study in which researchers initially explore their research questions. This analysis approach can also be used to provide a baseline in which future primary data collection of medication and agricultural injury results may be compared (Clarke & Cossette, 2000; Coyer & Gallo, 2005).

The current research is a retrospective review of data from the intervention study, Certified Safe Farm. In 1996, Iowa's Center for Agricultural Safety and Health developed the Certified Safe Farm (CSF), an innovative financially-based incentive intervention program to reduce farm-related injuries, illness, and fatalities. The CSF is a comprehensive intervention program designed to: 1) detect work-related health problems at an early stage and refer farmers to appropriate care, 2) identify and remove hazards on the farm, 3) educate farmers about safe working methods and personal protective equipment use, and 4) share the cost savings from reduced injuries and illness among farmers and their business partners (Rautiainen et al., 2004). The CSF intervention study has expanded with programs being currently evaluated in Iowa, Nebraska, North Carolina, Wisconsin, and New York.

The CSF study has three main components that contribute to its success: 1) preventive health screening, 2) an on-site farm safety review, and 3) agricultural safety and health education. Farmers that successfully complete all three intervention components, including receiving a passing score (85%) on the farm review, are eligible for financial incentives which in the future may include a reduction in their insurance rates (Rautiainen et al., 2004).

With permission from the original CSF research team, the current study used CSF data to explore the use of medication as a risk factor for agricultural injury, which has not previously been addressed by CSF researchers. Please see Appendix C for the letter from CSF primary investigator, Kelley Donham, allowing use of the CSF data.

Human Subjects Protection

The research proposal for this study was submitted to the Institutional Review Board at the University of Iowa Human Subjects Office and was approved (Appendix D). This study was a retrospective analysis of data retrieved from the Certified Safe Farm database. Due to the nature of a retrospective review of data, no contact with subjects occurred; therefore there was no direct benefit to the farmers. This study did not pose any harm or discomfort (physical, psychological, financial, social, and legal) to the farmers.

Data retrieved for use in this study included farmer sensitive demographic and health information such as age, gender, marital status, medications used, health issues, as well as information regarding agricultural practices. Due to the sensitivity of this information, steps were taken to insure privacy and confidentiality of the data. All of the farmers were given a farmer ID number that was linked to their information rather than using names or social security numbers. All data were saved in password protected computers and stored in the principal investigator's password protected personal computer.

Design

A descriptive and analytic secondary data analysis was completed on data from a prospective cohort study to expand the knowledge regarding medication use and agricultural injury experiences of younger (≤54 years old) and older (≥55 years old) farmers in Iowa, as well as the association between medication use and agricultural injury in the whole cohort of farmers.

Setting and Sampling

The secondary data analysis used data from the Certified Safe Farm (CSF) intervention study (Rautiainen et al., 2004). The parent study used a randomized controlled trial design and sampled farmers from a nine county area in northwestern Iowa. All principal farm operators who met the USDA farm criteria of having a minimum agricultural production of $1,000 in sales of agricultural products per year were eligible (Rautiainen et al., 2004; USDA, 2011). An introductory mailing was sent to 5,287 active farms that were identified from the Iowa Office of the National Agricultural Statistics Service (NASS). Farmers that returned a postage-paid card were then interviewed via telephone until a total of 300 farmers were recruited.

The CSF team had previously done a power analysis to achieve 0.80 (80%) power, alpha 0.05, sample size 125 (intervention) +125 (control), and an injury rate of 0.78 injuries per farm in 5 years. To achieve this power, the authors interviewed willing participants until they reached the sample size of n=150 in the intervention group and n=150 in the control group. Additional farmers were added in 2000 to maintain at least 125 subjects in both groups (control and intervention). The final sample included 316 farmers that were followed quarterly and annually from 1999 to 2000 to document exposures and injury/illness outcomes. See Appendix E for a flowchart from the original CSF study on the identification of the sample, study procedures, and collection of data (Figure E1).

Reliability and Validity of the Data

To validate the accuracy of the data coding, the CSF research team implemented the following quality control measures: 1) the use of computer-aided telephone interviews (CATI) in which the interviewers were well trained; 2) CATI questions were structured so that questions had a response, including 'not applicable', and 'refused to answer'; 3) good oversight of the CATI data collection; research team members addressed unclear entries with follow-up phone calls to farmers for clarification; and 4) data programming was set up to eliminate entries that were out of range. The data used for the current study were retrieved from files the research team maintained as well as from an Access database stored on the College of Public Health's SQL server.

Data Collection

In the original parent study, there were four primary data collection systems used: 1) quarterly phone calls, 2) a yearly occupational health history, 3) clinic health screenings, and 4) a farm safety review. For the current study analysis, demographic data, agricultural practices, and health/medication data from the annual occupational health history form were used along with injury and exposure data from the quarterly phone calls. The following are descriptions of the two data collection instruments used as the basis for the current secondary data analysis.

Quarterly phone calls were completed from September 1999 to August 2003 using computer-aided telephone interviews (CATI). Ten rounds of telephone data consisted of participants' recall of work-related exposures, injuries and illnesses during each follow-up period. Farmers were given a CSF calendar each year to assist them in recording their injuries to better answer questions in the quarterly calls. The occupational health history form was completed annually from 1999 to 2003 and consisted of questions regarding demographic and farm production variables, safety behaviors, use of personal protective equipment, health outcomes, and medication use. See Appendix F for a timeline regarding data collection for the parent study.

For a prospective assessment from exposure to the outcome of agricultural injury, yearly occupational health history medication variables were linked with the reported injury experiences of the following observational periods until the next occupational health history form was completed by the farmer (Figure 3).

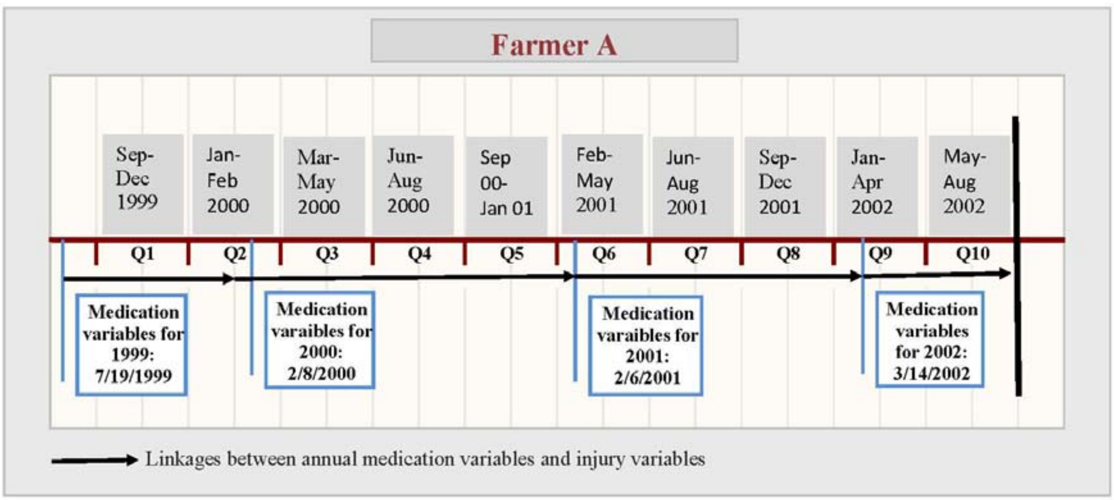

Figure 3: Research timeline for the study of medication use in Iowa farmers.

Note: Q1-Q10: quarterly observational period (10 quarters) for following injury experience (2-5 months each quarter)

Conceptual and Operational Definitions

The conceptual and operational definitions of the variables used in the current study will be presented next. The variables will be organized around the concepts of the

Haddon Matrix for injury prevention-host, agent (vectors and vehicles,) and environment. The main outcome for this study is agricultural injury and will be defined prior to the other matrix concepts.

Outcomes: Nonfatal Agricultural Injury

The main focus of Haddon's Matrix is the event of injury. In this study, nonfatal agricultural injury was the main outcome variable. The event of an agricultural injury is defined as "A sudden, unexpected, unintentional incident which has an external cause and which leads to some form of bodily harm such as a bruise, burn, cut, crush, fracture, puncture, sprain, strain, poisoning, loss of consciousness, or other bodily injury. Injuries if they cause any of the following: cessation of work/activity for any length of time, reduced working ability for any length of time, medical attention, self-treatment, or considerable pain or discomfort." (Rautiainen et al., 2004). This definition was included in a calendar given to the participant farmers to help them keep track of injuries throughout the study. The injury question on the quarterly call data was: 'Did you experience any farm work-related injuries between [*first month*] and [*last month*]? (Rautiainen et al., 2004). For the current research, only nonfatal injuries were included in the analysis. One fatal injury occurred during the original study, but it was not included in the analysis.

Agricultural injury was further defined operationally in the following injury variables: agricultural injury (yes/no), quarterly injury, total number of injuries, source of injury, month injury occurred, type of injury, and body part injured. These injury variables were taken from the quarterly calls data that were collected every quarter for a total of 10 quarters. Please see Table 4 for complete definitions of all injury variables.

Table 4: Agricultural injury variables

AGRICULTURAL INJURY VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Agricultural injury	A sudden, unexpected, unintentional incident which has an external cause and which leads to some form of bodily harm such as a bruise, burn, cut, crush, fracture, puncture, sprain, strain, poisoning, loss of consciousness, or other bodily injury. Please include injuries if they cause any of the following: cessation of work/activity for any length of time, reduced working ability for any length of time, medical attention, self-treatment, or considerable pain or discomfort.	Did you experience any farm-work related injuries between (dates of each quarter)? This is a binary variable. They were able to answer to having more than one injury per quarter.	Injury= 1, No injury=0
Quarterly Injury	Please see above for injury definition.	Did you experience any farm-work related injuries between (dates of each quarter)? Total number of injuries experienced in the quarter. Integer; in this data set it is between 1-3, as no one had more than 3 injuries per quarter.	1-3
Total number of injuries	Please see above for injury definition.	Did you experience any farm-work related injuries between (dates of each quarter)? Total number of injuries experienced in the study period. Integer; in this data set it is between 1-10, as no one had more than 10 injuries in the three year follow-up period.	1-10

Table 4 continued

AGRICULTURAL INJURY VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Injury month	A measurement of the time of year that the farmer's injury occurred.	What month did the injury occur? Using a 12 month calendar year.	January=1, February=2, March=3, April=4, May=5, June=6, July=7, August=8, September=9, October=10, November=11, December=12
Type of injury	Describes what type of injury occurred to the farmer while working.	What type of injury occurred? Types of injuries include: bruise, burn, cut, crush, fracture, puncture, sprain/strain, or other.	Bruise=1, Burn=2, Cut=3, Crush=4, Fracture=5, Puncture=6, Sprain/strain=7, or Other=8.
Source of injury	Describes the vehicle or vector that transfers energy and causes injury to the farmer.	What was the main source or cause of the injury? Categorical variable describing the vectors and vehicles of injury: tractor, other machinery, livestock, hand tool, pesticide/chemical, plant/tree, working surface, truck/auto, other vehicle, human error, other, and NA.	Tractor=1, Other machinery=2, Livestock=3, Hand tool=4, Pesticide/chemical=5, Plant /tree= 6, Working surface=7, Truck/auto=8, Other vehicle=9, Human error=10, or Other =11, 12=NA
Body part injured	Place on the farmer's body where the injury occurred.	What parts of the body were injured? Categorical variable describing body parts injured: head/neck, eye(s), chest/trunk, back, arms/shoulder, finger, hand/wrist, leg/knee/hip, foot, and other.	Head/neck=1, Eye(s)=2, Chest/trunk=3, Back=4, arms/shoulder=5, Finger=6, Hand/wrist=7, Leg/knee/hip=8, Foot= 9, Other=10.

Host Concepts

Within the context of the Haddon Matrix, the *host* is the person at risk for injury (Christoffel & Gallagher, 2006). The host in this study was conceptually defined as an Iowa farmer who farmed in a targeted nine county area of northwest Iowa and made a minimum agricultural production of $1,000 in sales of agricultural products per year. To explore the age differences within this cohort of farmers, the farmers were divided into two groups- *older farmers* and *younger farmers*. *Older farmer* was operationally defined as a farmer aged 55 and older. *Younger farmer* was operationally defined as a farmer aged 54 and younger. Partitioning the cohort based on age allowed the researcher to explore and describe differences and similarities in agricultural work practices and injury experiences between *older* and *younger* farmers as the literature on older farmers is limited.

The Department of Health and Human Services' Administration on Aging (AoA) has defined the older population in the U.S. as persons 65 years or older (AoA, 2010). Several potential age cut points were explored for the current research. When 65 years old was explored as the cut point for age division, it resulted in a very small *older farmer* group (n=41, 13%) and a large *younger farmer* group (n=272, 89%). Therefore, the age cut-off of 60 years old was explored, and again it resulted in a very small group of *older farmers* (n=68, 22%) and a large *younger farmer* group (n=245, 78%). Consequently, the age of 55 years old and older was explored and resulted in 103 (33%) *older farmers* and 210 (66%) *younger farmers.* Finally, 50 years old and older as a division point was explored and resulted in 144 (46%) older farmers and 169 (54%) younger farmers, by far the most even distribution. The age division of 55 and older was chosen as it resulted in two groups that was the best compromise between even distribution and matching the AoA's definition of older adults. Furthermore, there is a sizeable amount of literature using 55 and older to describe older farmers (Lizer & Petrea, 2007; Lizer & Petrea, 2008;

Myers et al., 2009; Myers et al., 1999; Voaklander, Dosman, Hagel, Warsh, & Pickett, 2010) which allows for easy and valid comparison of findings. Many host variables were originally gathered in the parent research study including demographic, health, and medication use variables.

Demographic variables

Demographic variables are conceptually defined as the personal attributes of farmers within the agricultural setting that describe the cohort of Iowa farmers and/or are predicted to affect injury outcomes. In this study, several farmer characteristic variables were available and theoretically influence agricultural injury outcomes: birth year, gender, education level, marital status, other job, smoking status, alcohol use, stress, hours a week (farm work), hours a week (off farm work), and livestock. These demographic variables were taken from the annual occupational health forms that were collected annually throughout this study. The data were transformed into quarterly variables by taking the annual data and repeating it for each quarter until the new occupational health form was received. If the data changed, then the new data would be used quarterly until the next year's form was received. This continued until the study was complete. Please see Table 5 for complete definitions and coding of the host's demographic variables and Figure 3 (p.56) for a visualization of this process.

Table 5: Host demographic variables

HOST DEMOGRAPHIC VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Date of birth	Measurement of when the farmer was born based on the year.	What year were you born? Categorical variable describing the year the farmer was born based on the following categories: 1919-1939, 1940-1949, 1950-1959, or 1960-1973.	1919-1929=1, 1930-1939=2, 1940-1949=3, 1950-1959=4 1960-1973=5
Age Category	Measurement of age based on the farmer being an *older farmer*-aged 55 or older, or being a *younger farmer* -aged 54 and younger.	Based on the year the farmer was born, age was calculated by taking the first year of the study (1999) and subtracting the year the farmer was born , farmers were defined as either old (≥55) or young (≤54) based on their age in 1999.	55 or older= old 54 or younger=young
Gender	The self-reported characteristic used to distinguish between males and females; refers to the physiology of non-human animals, without any implication of social gender roles.	What is your gender: male or female? Dichotomous variable: M or F.	Male gender=M Female gender=F
Educational level	The self-reported highest grade of formal, structured education completed by the farmer to date of starting the study.	Highest grade completed? Categorical variable based on the following categories: high school or less, some college, and Bachelor's degree.	High school or less=HS, Some college=SC, Bachelor's degree=BA.
Marital status	The self-reported status regarding the state of being united to a person as husband or wife in a consensual and contractual relationship recognized by law.	Marital status: married or not married. Dichotomous variable: yes or no	Married=1 Not married=2

Table 5 continued

HOST DEMOGRAPHIC VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Other job	Self-reported post of employment, full-time or part-time, that is held outside the farm.	Did you work off the farm during the past three months? Dichotomous variable: yes or no.	Yes=1 No=2
Smoking status	Self-reported status on Smoking-the inhalation of the smoke of burning tobacco encased in cigarettes, pipes, and cigars.	Do you smoke cigarettes, pipe, or cigars? Dichotomous variable: yes or no.	Yes=1 No=2
Alcohol use	Self-reported amount of alcohol consumed within a specified amount of time.	On average, how frequently do you drink alcoholic beverages?	3 or more a week=1, 2 or less a week=2, None=3.
Stress	Self-reported amount of stress experienced. MedlinePlus says this about stress, ‘We all have stress sometimes. For some people, it happens before having to speak in public. For other people, it might be before a first date. What causes stress for you may not be stressful for someone else. Sometimes stress is helpful - it can encourage you to meet a deadline or get things done. But long-term stress can increase the risk of diseases like depression, heart disease and a variety of other problems” (MedlinePlus, 2010b).	What is your level of stress: Original data was: 1) very low, 2) low, 3) average, 4) high, and 5) very high. Due to small counts in levels 4 and 5, the stress variable was condensed to three levels.	1= very low/low 2= average 3= high/very high

Table 5 continued

HOST DEMOGRAPHIC VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Hours a week (on farm)	Self-reported average number of hours the farmer works on the farm per week.	Average number of hours you work on your farm per week? In the logistic regression analysis, *hours per week* was a continuous variable.	0-9.9=1, 10-19.9=2, 20-29.9=3, 30-39.9=4, 40-49.9=5, and 50+=6
Hours a week (off farm)	Self-reported average number of hours the farmer works off the farm per week.	Average number of hours you work off your farm per week? In the logistic regression analysis, *hours per week* was a continuous variable.	0-9.9=1, 10-19.9=2, 20-29.9=3, 30-39.9=4, 40-49.9=5, and 50+=6
Farm Acres	Self-reported number of acres the farmer owns and rents	Indicate the number of acres you farmed during the past 12 months.	0-40=1, 41-160=2, 161-320=3, 321-640=4, 641-99=5, 1000+=6.
Livestock	Self-reported status on whether or not the farmer raised/work with livestock including: dairy, feeder cattle, cow/calf, hogs, poultry, and other.	Do you currently raise livestock? Dichotomous variable: yes or no.	Yes=1 No=2

Chronic health variables

Chronic health variables were conceptually defined as the health attributes of the farmers that may affect injury outcomes. There were several chronic disease variables that could theoretically influence agricultural injury outcomes. These health variables included general health status and several chronic disease variables such as depression, asthma, emphysema, hay fever, allergies, lung cancer, heart disease, hypertension, stroke, diabetes, kidney disease, liver disease, cancer, and arthritis. These chronic variables were taken from the occupational health forms that were collected annually throughout this study. The question was, "Have you experienced any of the following", and listed each of the aforementioned diseases. The farmers were allowed to answer yes or no.

The data were transformed from annual variables into quarterly variables by the following process on each farmer: first, to properly match the occupational health data to the correct corresponding quarter, the date of the first occupational health history form was noted and subsequently matched with the corresponding quarter by date; then dichotomous chronic health variable(s) were then added to that quarter. These health variables were then added to subsequent quarters until the date of the next annual occupational health form and its corresponding quarter. At the time of the updated occupational health form, changes in health history were assessed and new chronic disease variables were added. Again, the new chronic health variables were then carried forward until the next annual occupational health form was completed. This process was reiterated until all 10 quarters were populated with the new quarterly chronic health variables. This process was manually completed by the researcher until all farmers had quarterly chronic health variables. See Table 6 for the definitions and coding of the host's chronic health variables.

Table 6: Host chronic health variables

HOST CHRONIC HEALTH VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
General health status	Self-reported status on the farmer's health**-** "the condition of an organism or one of its parts in which it performs its vital functions normally or properly**:** the state of being sound in body or mind; *especially***:** freedom from physical disease and pain; the condition of an organism with respect to the performance of its vital functions especially as evaluated subjectively or nonprofessionally" (MedlinePlus, 2010b).	In general, how would you rate your health, as compared to others your age? Categorical variables based on the following categories: excellent, very good, good, and fair/poor.	Excellent=1, Very good=2, Good=3, Fair/poor=4
Depression	Self-reported amount of depression experienced. Depression is defined as 'a serious medical illness that involves the brain. It's more than just a feeling of being "down in the dumps" or "blue" for a few days…the feelings do not go away. They persist and interfere with your everyday life. Symptoms can include: sadness, loss of interest or pleasure in activities you used to enjoy, change in weight, difficulty sleeping or oversleeping, energy loss, feelings of worthlessness, thoughts of death or suicide" (MedlinePlus, 2010b).	What is your level of depression: Original data was: 1) very low, 2) low, 3) average, 4) high, and 5) very high. Due to small counts in levels 4 and 5, the depression variable was condensed to three levels.	1= very low/low 2= average 3= high/very high
Asthma	Self-reported experience with Asthma, "a chronic lung disorder that is marked by recurring episodes of airway obstruction (as from bronchospasm) manifested by labored breathing accompanied especially by wheezing and coughing and by a sense of constriction in the chest, and that is triggered by hyperactivity to various stimuli (as allergens or rapid change in air temperature)"(MedlinePlus, 2010b).	Have you experienced asthma? Dichotomous variable: yes or no.	Yes=1 No=2

Table 6 continued

HOST CHRONIC HEALTH VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Emphysema	Self-reported experience with emphysema, "a condition characterized by air-filled expansions in interstitial or subcutaneous tissues; *specifically***:** a condition of the lung that is marked by distension and eventual rupture of the alveoli with progressive loss of pulmonary elasticity, that is accompanied by shortness of breath with or without cough, and that may lead to impairment of heart action" (MedlinePlus, 2010b).	Have you experienced emphysema? Dichotomous variable: yes or no.	Yes=1 No=2
Hay Fever	Self-reported experience with hay fever; hay fever is "an acute allergic reaction to pollen that is usually seasonal and is marked by sneezing, nasal discharge and congestion, and itching and watering of the eyes" (MedlinePlus, 2010b).	Have you experienced hay fever? Dichotomous variable: yes or no.	Yes=1 No=2
Allergies	Self-reported experience with allergies; "exaggerated or pathological reaction (as by sneezing, respiratory embarrassment, itching, or skin rashes) to substances, situations, or physical states that are without comparable effect on the average individual" (MedlinePlus, 2010b).	Have you experienced allergies? Dichotomous variable: yes or no.	Yes=1 No=2
Lung Cancer	Self-reported experience with lung cancer. Either non-small lung cancer, "any carcinoma (as an adenocarcinoma or squamous cell carcinoma) of the lungs that is not a small-cell lung cancer." or small-cell-"cancer of a highly malignant form that affects the lungs, tends to metastasize to other parts of the body and is characterized by small round or oval cells resembling oat grains and having a high ratio of nuclear protoplasm to cytoplasm" (MedlinePlus, 2010b).	Have you experienced lung cancer? Dichotomous variable: yes or no.	Yes=1 No=2

Table 6 continued

HOST CHRONIC HEALTH VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Heart Disease	Self-reported experience with heart disease, "an abnormal organic condition of the heart or of the heart and circulation" (MedlinePlus, 2010b).	Have you experienced heart disease? Dichotomous variable: yes or no.	Yes=1 No=2
Hypertension	Self-reported experience with hypertension, " abnormally high arterial blood pressure that is usually indicated by an adult systolic blood pressure of 140 mm Hg or greater or a diastolic blood pressure of 90 mm Hg or greater, is chiefly of unknown cause but may be attributable to a preexisting condition (as a renal or endocrine disorder), that typically results in a thickening and inelasticity of arterial walls and hypertrophy of the left heart ventricle, and that is a risk factor for various pathological conditions or events" (MedlinePlus, 2010b).	Have you experienced hypertension? Dichotomous variable: yes or no.	Yes=1 No=2
Stroke	Self-reported experience with stroke, "sudden diminution or loss of consciousness, sensation, and voluntary motion caused by rupture or obstruction (as by a clot) of a blood vessel of the brain" (MedlinePlus, 2010b).	Have you experienced stroke? Dichotomous variable: yes or no.	Yes=1 No=2
Diabetes	Self-reported experience with diabetes; diabetes mellitus, "a variable disorder of carbohydrate metabolism caused by a combination of hereditary and environmental factors and usually characterized by inadequate secretion or utilization of insulin, by excessive urine production, by excessive amounts of sugar in the blood and urine, and by thirst, hunger, and loss of weight" (MedlinePlus, 2010b).	Have you experienced diabetes? Dichotomous variable: yes or no.	Yes=1 No=2

Table 6 continued

HOST CHRONIC HEALTH VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Kidney Disease	Self-reported experience with kidney disease- "Damage to the nephrons results in kidney disease. This damage may leave kidneys unable to remove wastes. Usually the damage occurs slowly over years" (MedlinePlus, 2010a).	Have you experienced kidney disease? Dichotomous variable: yes or no.	Yes=1 No=2
Liver Disease	Self-reported experience with liver disease, "There are many kinds of liver diseases. Viruses cause some of them, like hepatitis A, hepatitis B and hepatitis C. Others can be the result of drugs, poisons or drinking too much alcohol. If the liver forms scar tissue because of an illness, it's called cirrhosis. Jaundice, or yellowing of the skin, can be one sign of liver disease" (MedlinePlus, 2010a).	Have you experienced liver disease? Dichotomous variable: yes or no.	Yes=1 No=2
Cancer	Self-reported experience with cancer, "a malignant tumor of potentially unlimited growth that expands locally by invasion and systemically by metastasis" (MedlinePlus, 2010b).	Have you experienced cancer? Dichotomous variable: yes or no.	Yes=1 No=2
Arthritis	Self-reported experience with arthritis, "inflammation of joints due to infectious, metabolic, or constitutional causes" (MedlinePlus, 2010b).	Have you experienced arthritis? Dichotomous variable: yes or no.	Yes=1 No=2

<u>Medication variables</u>

Medication variables were conceptually defined as the prescription or over the counter medications the farmers were currently taking daily or when needed, that could theoretically influence agricultural injury outcomes. Data on medication were taken from the annual occupational health history and were used to construct new predictor or explanatory variables. Participant farmers were asked about their medication use on the annual occupational health history form. The question was: "Please list any prescription medications/or over the counter medications you currently take daily or when needed: name of the medication, dosage, length of time taken, and reason" (Rautiainen et al., 2004). The farmers could answer the medication question with up to four medications.

Annual occupational health history forms were used to identify information about medication use. To determine the longitudinal association of medication use and agricultural injury, it was imperative to establish the exposures and risk factors of interest, namely the use of medications, which preceded the occurrence of an agricultural injury. To establish temporality, it must be clear that the medication was used before the injury occurred.

Using annual medication data, new quarterly medication variables were constructed. The data were transformed from annual variables into quarterly variables by the following process on each farmer: first, to establish which quarter the farmer started using the listed medications, the date of the first occupational health history form was noted and subsequently matched with the corresponding quarter by date; the dichotomous medication variable(s) were then added to that quarter. These medication variables were then added to subsequent quarters until the date of the next annual occupational health form and its corresponding quarter. At the time of the updated occupational health form, changes in medication usage were assessed and new medication variables were assigned; either by adding newly listed medications and/or removing medications no longer listed.

Again, the new medication variables were then carried forward until the next annual occupational health form was completed.

This process was iterated until all 10 quarters were populated with the new quarterly medication variables. If anytime during this process the farmer stated that (s)he had been on a medication for a certain number of years, then that medication variable was added to all preceding quarters up to the number of years mentioned. This process was manually completed by the researcher until all farmers had quarterly medication variables. Again, a visualization of this process is presented in figure 3, p. 56. With the above mentioned process, it was possible for a farmer to then be on more than the previously mentioned four medications.

Finally, using the quarterly medication variables, new medication class variables were created. To establish if the farmer took any medication in a specified quarter, a dichotomous variable for *currently taking medication* was created. If a farmer had any medication listed in a quarter, then the *currently taking medication* variable was coded yes, if not, then no. Medication class variables were created in accordance with the American Hospital Formulary Service's (AHFS) classification schema (AFHS, 2011). These medication variables included a new dichotomous variable (yes/no) for each of the following major AHFS medication classes: antihistamine drugs (Class4), anti-infective agents (class8), autonomic drugs (class12), blood formation, coagulation, and thrombosis medications (class20), cardiac drugs (class24), central nervous system (CNS) agents (class28), gastrointestinal (GI) drugs (class56), hormones and synthetic substitutes (class68), vitamins (class88), and finally and 'other medications'. See Appendix G for a full list of AHFS medication classes.

Using STAT!Ref (STAT!Ref & Teton Data Systems, 2007), all medications taken by the farmers were then classified under a major AHFS classification number and name. After which, the farmers were assessed as to whether or not they had taken any medications classified into that class during each quarter. Some medications were classified under multiple AHFS classes: by indication, mechanism of action or route of administration. Aspirin is an example; aspirin falls into the *CNS* class as well as the *blood formation/coagulation* class. Therefore, for the purpose of this analysis, aspirin was counted under each of these classes. More specific dichotomous sub-class variables were created due to a high use of cardiac and CNS medications in this cohort of farmers. These subclasses include the following CNS sub-classes: *Pain meds* and *Antidepressants*; and the Cardiac subclasses: *BP meds, Alpha Blockers, Beta Blockers,* and *ACE Inhibitors.* Please see Table 7 for the (AHFS) medication classification schema for the classes and subclasses used in this research.

Table 7: American Hospital Formulary Service (AHFS) classification schema

AHFS MAIN CLASSES	**AHFS SUBCLASS 1**	**AHFS SUBCLASS 2**
04:00 Antihistamine Drugs		
08:00 Anti-infective Agents		
12:00 Autonomic Drugs		
20:00 Blood Formation, Coagulation, and Thrombosis drugs		
24:00 Cardiovascular Drugs	24.08 Hypotensive Agents' 24:24 - β-Adrenergic Blocking Agent	24:08.04 – α-Adrenergic Blocking Agents 24:08.08 - β-Adrenergic Blocking Agents 24.32.04 -Angiotensin-Converting Enzyme Inhibitors (ACE Inhibitors)
28:00 Central Nervous System (CNS) Agents		28.08 Analgesics and Antipyretics 28.16.04 Antidepressants
56: 00 Gastrointestinal (GI)Drugs		
68:00 Hormones and Synthetic Substitutes		
88:00 Vitamins		

Note: Medication classes based on American Hospital Formulary Service (AFHS). (2011). *AHFS pharmacologic-therapeutic classification system.*

In the parent CSF study, the farmers were given the opportunity to provide information for up to four medications. Several variables were created to establish the exact number of certain medications farmers were taking per quarter. *Number of medications taken per quarter* imparts the total number of medications the farmers stated they were on in a specific quarter. *Number of CNS medications taken per quarter* describes the total number of central nervous system (CNS) medications the farmers stated they were on each quarter. Finally, *number of cardiac medication taken per quarter* described if farmers stated they took none, one or more than one cardiac medication each quarter. See Table 8 for complete definitions of the host's medication use variables.

Table 8: Host medication use variables

HOST MEDICATION USE VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Current medication use	Self-reported current use of any type of prescription or over the counter medication.	Did the farmer state using at least one medication on the annual occupational health history form?	Yes=1 No=2
Antihistamine drugs (class4)	Self-reported use of an antihistamine medication- "any of various compounds that oppose the actions of histamine and are used especially for treating allergic reactions (as hay fever), cold symptoms, and motion sickness" (MedlinePlus, 2010b).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking an antihistamine drug. Any drug classified as a 4:00 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2
Anti-infective agents (class8)	Self-reported use of an anti-infective medication- Something capable of acting against infection, by inhibiting the spread of an infectious agent or by killing the infectious agent outright. Anti-infective is a general term that encompasses antibacterials, antibiotics, antifungals, antiprotozoans and antivirals" (MedicineNet.com).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking an anti-infective drug. Any drug classified as a 8:00 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2
Autonomic drugs (class12)s	Self-reported use of autonomic medications such as anticholinergic agents, cholinergic agents, adrenergic agents, and skeletal muscle relaxants (American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking an autonomic drug. Any drug classified as a 12:00 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2
Blood formation, coagulation and thrombosis drugs (class20)	Self-reported use of blood formation, coagulation and thrombosis medication, including anti-anemic agents, antithrombotic agents (heparin, Coumadin, etc.), hematopoietic agents, hemmorheologic agents, and anti-hemorrhagic agents (American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a blood formation/coagulation and thrombosis drug. Any drug classified as a 20:00 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2

Table 8 continued

HOST MEDICATION USE VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Cardiovascular drugs (class24)	Self-reported use of cardiovascular drugs such as antilipidemic agents, hypotensive agents, vasodilating agents, etc. (American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a cardiovascular drug. Any drug classified as a 4:00 in the AHFS).	Yes=1 No=2
Alpha blockers	Self-reported use of alpha blockers-"any of a group of drugs (as phenoxybenzamine and phentolamine) that combine with and block the activity of an alpha-receptor and that are used especially to treat hypertension" (MedlinePlus , 2010b).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking an alpha blocker. Any drug classified as a 24:20 in the AHFS). Alpha blockers are a subclass of cardiac medications.	Yes=1 No=2
Beta blockers	Self-reported use of beta blockers-" any of a group of drugs (as propranolol) that combine with and block the activity of a beta-receptor to decrease the heart rate and force of contractions and lower high blood pressure and that are used especially to treat hypertension, angina pectoris, and ventricular and supraventricular arrhythmias" (MedlinePlus , 2010b).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a beta blocker. Any drug classified as a 24:24 in the AHFS). Beta blockers are a subclass of cardiac medications.	Yes=1 No=2
ACE inhibitors	Self-reported use of ACE inhibitors-"any of a group of antihypertensive drugs (as captopril) that relax arteries and promote renal excretion of salt and water by inhibiting the activity of an angiotensin converting enzyme" (MedlinePlus , 2010b).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking an ACE inhibitor. Any drug classified as a 24:32.04 in the AHFS).	Yes=1 No=2

Table 8 continued

HOST MEDICATION USE VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Blood pressure (BP) medication	Self-reported use of BP medication- medications often used to treat hypertension include: diuretics, calcium channel blockers, beta-blockers, ACE inhibitors, angiotensin II receptor blockers, alpha-blockers, centrally acting drugs, vasodilators and rennin inhibitors (MedlinePlus , 2010a). A drug classified as a 24:08 in the AHFS system such as alpha blockers, beta blockers, calcium channel blockers, central alpha agonists, diuretics, etc. (American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a BP medication. Any drug classified as a 24:08 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2
Central nervous system (CNS) agents (class28)	Self-reported use of CNS medications such as analgesics and antipyretics, opiate antagonists, anticonvulsants, psychotherapeutic agents, anxiolytics, sedatives, and hypnotics, antimigraine agents, antiparkinsonian agents, etc. (American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a CNS drug. Any drug classified as a 28:00 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2
Pain medication	Self-reported use of pain medication-including analgesics like-nonsteroidal anti-inflammatory agents, opiate agonists, and some antipyretics like acetaminophen. etc. Drugs classified in the AHFS system as a 28:08 analgesic and antipyretic-NSAIDS, COX2 inhibitors, salicylates, opiate agonists, etc. (American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a pain medication. Any drug classified as a 28:08 in the AHFS pharmacologic-therapeutic classification system). Pain medications are a subclass of CNS medications.	Yes=1 No=2

Table 8 continued

HOST MEDICATION USE VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Antidepressant	Self-reported use of antidepressants- "Antidepressants are medicines that treat depression." Selective serotonin reuptake inhibitors, Tricyclic antidepressants" (MedlinePlus, 2010a). A drug that falls into the antidepressants class for AHFS , class 28:16.04 such as monoamine oxidase inhibitors, selective serotonin and norepinephrine reuptake inhibitors, selective serotonin inhibitors, tricyclics and othe norepinephrine inhibitors, etc.(American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking an antidepressant. Any drug classified as a 28:16.04 in the AHFS pharmacologic-therapeutic classification system). Antidepressants are a subclass of CNS medications.	Yes=1 No=2
Gastrointestinal (GI) drugs (class56)	Self-reported use of GI medication such as antacids, antidiarrhea agents, antiflatulents, cathartics, laxatives, digestants, emetics, anti-emetics, antiulcer agents, etc. (American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a GI drug. Any drug classified as a 56:00 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2
Hormone and synthetic substitutes (class68)	Self-reported use of hormones including:adrenals, androgens, contraceptives, estrogens and anti-estrogens,gonadotropins, anti-diabetic agents (insulin, etc.), antihypoglycemic agents, thyroid and antithyroid agents, etc. (American Hospital Formulary Service (AFHS), 2011).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a hormone or synthetic substitute drug. Any drug classified as a 68:00 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2

Table 8 continued

HOST MEDICATION USE VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Vitamins (class88)	Self-reported use of dietary supplements or vitamins, "any of various organic substances that are essential in minute quantities to the nutrition of most animals and some plants, act especially as coenzymes and precursors of coenzymes in the regulation of metabolic processes but do not provide energy or serve as building units, and are present in natural foodstuffs or are sometimes produced within the body" (MedlinePlus, 2010b).	Based on the medications the farmer filled out on the occupational health history form, is he/she taking a vitamin. Any drug classified as a 88:00 in the AHFS pharmacologic-therapeutic classification system).	Yes=1 No=2
Number of medications per quarter	The total quantity or number of self-reported medication, prescribed and over the counter, the farmer is currently taking.	The number of medications the farmer has listed on the occupational health history form. Continuous variable.	#
Number of CNS medications	The total quantity or number of self-reported CNS medication the farmer is currently taking.	Based on the medications the farmer filled out on the occupational health history form, how many CNS medications is he/she taking? Any drug classified as a 28:16.04 in the AHFS pharmacologic-therapeutic classification system).	#
Cardiac medication category	The total quantity or number of self-reported cardiac medication the farmer is currently taking.	Based on the medications the farmer filled out on the occupational health history form, how many CNS medications is he/she taking. Any drug classified as a 24:00 in the AHFS pharmacologic-therapeutic classification system).	None; One; More than one

Agent, Vehicle and Vector Concepts

Within the context of the Haddon Matrix, the *agent* is the energy (mechanical, thermal, electrical) that is transmitted to the host via a *vehicle* (inanimate object) or *vector* (animate objects) (Christoffel & Gallagher, 2006; Haddon, 1980). Vehicle variables included farm implements, tools and agrichemicals; vectors in this study include animals. No data were collected on the actual agent or energy that was transmitted to the host.

<u>Vehicle variables</u>

Vehicle variables are conceptually defined as the inanimate objects that are the mechanisms for the transfer of energy to the host resulting in injury. In this study, the vehicle variables that theoretically influence agricultural injury outcomes were as follows: dust, loud noises, pesticide/chemical use, heavy lifting, and injury source. The injury variable, *source of injury*, contains several potential vehicles (which are in bold under coding in Table 9 such as: tractor, other machinery, hand tool, pesticide/chemical, plant/tree, working surface, truck/auto, and other vehicle). See Table 9 for vehicle variables.

Table 9: Vehicle variables

VEHICLE VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Source of injury	Describes the vehicle or vector that transfers energy and causes injury to the farmer.	What was the main source or cause of the injury? Categorical variable describing the vectors and vehicles of injury: tractor, other machinery, livestock, hand tool, pesticide/chemical, plant/tree, working surface, truck/auto, other vehicle, human error, or other	***Tractor=1***, ***Other machinery=2,*** Livestock=3, ***Hand tool=4, Pesticide/chemical=5,*** Plant /tree= 6, ***Working surface=7***, ***Truck/auto=8,*** Other ***vehicle=9,*** Human error=10, or Other =11.
Dust exposure	Self-report of exposure to high levels of dust; farm (examples of dust exposure: handling grain, working in animal confinement, or cleaning up buildings).	In the period between (insert specific dates for each quarter) were you exposed to high levels of dust; farm (examples of dust exposure: handling grain, working in animal confinement, or cleaning up buildings?	Yes=1 No=2
Loud noise exposure	Self-report of exposure to loud noise (noise is loud (>85) when you would have to raise your voice to be heard (examples of loud noises include the following: tractors, machines, grain dryers, and hogs).	Were you exposed to loud noise (noise is loud (>85) when you would have to raise your voice to be heard. Examples of loud noises include the following: tractors, machines, grain dryers, hogs).	Yes=1 No=2
Pesticide /chemical exposure	Self-report of exposure pesticides or other chemicals (such as detergents, cleaners, disinfectants, fuels or oils, organic solvents, paints, and acids or bases).	Were you exposed to pesticides or other chemicals (such as detergents, cleaners, disinfectants, fuels or oils, organic solvents, paints, and acids or bases)?	Yes=1 No=2
Heavy lifting exposure	Self-report of exposure to lifting heavy objects.	Were you exposed to heavy lifting?	Yes=1 No=2

Vector variables

Vector variables were conceptually defined as the animate objects that are the mechanisms for the transfer of energy to the host resulting in injury and were predicted to affect injury outcomes. In this study, the vector variables that theoretically influence agricultural injury outcomes were identified as the following variables: livestock, and source of injury. The injury variable, *source of injury*, contains the potential vector of livestock, which is in bold under coding in Table 10. See Table 10 for all vector variables.

Table 10: Vector variables

VECTOR VARIABLES			
Variable	**Conceptual Definition**	**Operational Definition**	**Coding**
Livestock	Self-reported status on whether or not the farmer raised/work with livestock including: dairy, feeder cattle, cow/calf, hogs, poultry, or other.	Do you currently raise livestock? Dichotomous variable: yes or no.	Yes=1 No=2
Source of injury	Describes the vehicle or vector that transfers energy and causes injury to the farmer.	What was the main source or cause of the injury? Categorical variable describing the vectors and vehicles of injury: tractor, other machinery, livestock, hand tool, pesticide/chemical, plant/tree, working surface, truck/auto, other vehicle, human error, or other	*Tractor=1, Other machinery=2*, **Livestock**=3, *Hand tool=4, Pesticide/chemical=5*, Plant /tree= 6, Working *surface=7, Truck/auto=8,* Other *vehicle=9*, Human error=10, or Other =11.

Environmental Concepts

Physical Environmental variables

The farmers were asked to list the month of the year that their injury occurred. Using this variable of *injury month* it was assessed what time of year or what season the injury occurred. *Injury month* was an environmental factor that notes the time of year that the injury occurred and may give clues to potential weather conditions; spring planting and fall harvest are times of the year where intensive labor activities occur and may predispose farmers to injury. Please see Table 4 page 59 for the definition of the *injury month* variable.

Socio-cultural variables

No socio-cultural variables were collected at the time of the farmers' injury. Therefore no socio-cultural variables are used in this study.

Data Analysis

The data analyses were performed with the use of SAS 9.3 (SAS Institute, 2011) Descriptive analysis of demographic data was completed to summarize demographics, such as characteristics of farmers, and characteristics of other variables. Cross tabulation was completed to describe patterns of agricultural injury and medication use for both the older and younger farmers. Multiple logistic regression analysis was utilized to examine and measure the relationship between the use of medication and nonfatal agricultural injury. Detailed statistical procedures are identified in relation to the specific aims. Table 11 presents the data analysis for each research question.

Table 11: Research questions with corresponding data analysis

Research Question	Analysis
1. What types of medications are older and younger farmers taking?	Descriptive statistics Cross tabulations Chi-square- categorical variable
2. Are older farmers taking more medications than the younger farmers?	Descriptive statistics Cross tabulations T-tests- continuous variables
3. What are the nonfatal injury rates for older and younger farmers?	Calculate injury rates for older and younger farmers
4. In what months are older and younger farmers getting injured?	Descriptive statistics Cross tabulations Chi-square- categorical variables
5. What are the types of nonfatal injury older and younger farmers sustaining?	Descriptive statistics Cross tabulations Chi-square- categorical variable
6. What are the sources of nonfatal injury for older and younger farmers?	Descriptive statistics Cross tabulations Chi-square- categorical variables
7. What body parts are the older and younger farmers injuring?	Descriptive statistics Cross tabulations Chi-square- categorical variables
8. How many nonfatal injuries occur with each medication class?	Descriptive statistics Cross tabulations T-tests- continuous variables
9. What types of nonfatal injury that occurs with each medication class?	Descriptive statistics Cross tabulations Chi-square- categorical variables
10. What are the sources of nonfatal injury for each of the medication classes?	Descriptive statistics Cross tabulations T-tests- continuous variables
11. What body parts are injured with each medication class?	Descriptive statistics Cross tabulations T-tests- continuous variables
12. Does taking medication increase the risk of agricultural injury?	Multiple logistic regression using generalized estimation equations *includes several confounding variables

Specific Aims and Corresponding Data Analysis

Specific Aim 1: Describe the relationship of age and medication usage and nonfatal agricultural injury

Descriptive analysis was conducted to summarize and describe medication usage and injury variables in relation to each age group. Frequencies, means, standard deviations, and percentages were calculated when appropriate. Cross tabulation was used to describe differences in the two age groups of farmers, younger (≤54) and older (≥ 55). Chi-square tests were completed to compare the categorical data; Fisher's exact test was used when any cell was less than five. Two sample t-tests were used in the analysis of the continuous data. All tests were two-tailed and a p-value of <0.05 was deemed to be statistically significant. Bivariate logistic regression using GEE was completed to measure the association between using medication and age. Bivariate odds ratios (ORs) and associated 95% confidence intervals (CI) were computed for each variable using the SAS PROC GENMOD procedure.

Specific Aim 2: Describe the relationship between using certain classes of medication and experiencing a nonfatal agricultural injury

Descriptive analysis was conducted to summarize and describe the characteristics of agricultural injury in relation to medication use. For each class of medication, frequencies and percentages were calculated for source and type of injury, body part injured. Chi-square tests were completed to compare the categorical data; Fisher's exact test was used when any cell was less than five. Two sample t-tests were used in the analysis of the continuous data. All tests were two-tailed and a p-value of <0.05 was deemed to be statistically significant.

Specific Aim 3: Measure the association between using certain classes of medication and experiencing a nonfatal agricultural injury

Bivariate regression analysis

Bivariate regression analysis using GEE was completed first to explore the relationship between individual variables and the outcome of agricultural injury. Bivariate odds ratios (ORs) and associated 95% confidence intervals (CI) were computed for each variable using the SAS PROC GENMOD procedure.

Finally, multiple logistic regression analysis using GEE was used to examine the association between using specific classes of medication and agricultural injury taking into consideration a myriad of confounding factors. The specifics of model building and the longitudinal multiple logistic regression analysis are described in detail in the next section.

Multiple logistic regression analysis

Multiple logistic regression is a statistical method that is utilized to evaluate several explanatory variables or covariates (X_1, X_2, ... X_p) in order to predict a dichotomous outcome (Y). This statistical method is widely used to describe the relationship between a binary outcome variable and a set of covariate (Fitzmaurice, Laird, & Ware, 2004). In logistic regression, the outcome or dependent variable is usually denoted as binary or dichotomous, with Y= 1 or Y= 0; in this case Y = 0 for no injury, and Y= 1 for injury.

The data collected for this study was longitudinal in which the predictor and outcome variables were repeatedly measured on 10 occasions (10 quarterly calls). With these repeated measures, correlation among predictors and correlation among outcomes, (within subject correlation) need to be properly be accounted for to make valid scientific inferences. To accomplish this, the generalized estimating equations (GEE) method was used. The GEE method is based on the concept of 'estimating equations' and provides an appropriate approach for analyzing correlated responses (discreet or continuous) such as with longitudinal repeated measures data (Fitzmaurice et al., 2004) . Generally, GEE generalizes and extends the usual likelihood equations for a generalized linear model by incorporating the covariance matrix of the vector of responses (Fitzmaurice et al., 2004).

The CSF researchers collected a myriad of potential confounding risk factors including personal, demographic, environmental and occupational characteristics. The following variables were considered as potential confounders as they have been found in the agricultural injury literature to be significantly associated with agricultural injury: age, education, farm size (acres), raising livestock, farm working hours, dust exposure, noise exposure, chemical/pesticide exposure, exposure to heavy lifting, general health status and depression.

In the original CSF study, the researchers found that group affiliation, also known as CSF status (control vs. intervention), had no significant effect on the outcome of injury. To verify that it had no effect on the outcome analyzed in this study, it was included as a variable in model selection. Thus, the candidate pool of variables used in the model selection process included the following 32 variables: date of birth; education; livestock; hours of work on farm per week; exposure to dust, noise, chemicals and heavy lifting; depression; currently taking: medications, antihistamines, anti-infective medications, autonomic medications, blood thinners/coagulators, cardiac medications, central nervous system medications (CNS), gastrointestinal (GI) medications, hormones, dietary supplements/vitamins, other medications, alpha blockers, beta blockers, ACE inhibitors, pain medications, blood pressure (BP) medications, and antidepressants; number of medications taken per quarter: all medications, CNS medications, cardiac mediations; general health; stress and CSF status. Please see Table 12 on for more information about the variables in the candidate pool.

Table 12: Candidate pool of variables for the logistic regression analysis

VARIABLE	TYPE
Date of birth	Categorical
Education level	Categorical
Livestock	Categorical, binary
Hours of work on farm per week	Continuous
Dust exposure	Categorical, binary
Noise exposure	Categorical, binary
Chemical and pesticide exposure	Categorical, binary
Exposure to heavy lifting	Categorical, binary
Currently taking any medications	Categorical, binary
Currently taking any antihistamines	Categorical, binary
Currently taking any anti-infective agents	Categorical, binary
Currently taking any autonomic medications	Categorical, binary
Currently taking any blood thinners/coagulators	Categorical, binary
Currently taking any cardiac medications	Categorical, binary
Currently taking any central nervous system (CNS) medications	Categorical, binary
Currently taking any gastrointestinal (GI) medications	Categorical, binary
Currently taking any hormones	Categorical, binary
Currently taking any vitamins	Categorical, binary
Currently taking any alpha blockers	Categorical, binary
Currently taking any beta blockers	Categorical, binary
Currently taking any ACE inhibitors	Categorical, binary
Currently taking any pain medications	Categorical, binary
Currently taking any blood pressure (BP) medications	Categorical, binary
Currently taking any antidepressant medications	Categorical, binary
Number of medications taken per quarter	Continuous
Number of CNS medications taken per quarter	Continuous
Cardiac med category	Categorical
General health status	Categorical
Stress	Categorical
Depression	Categorical
CSF status	Categorical, binary

To identify the best predictive model for the association between medication use and agricultural injury, longitudinal multiple logistic regression analysis was completed using the generalized estimating equations (GEE). GEE was chosen for analysis due to the longitudinal nature of the CSF data and the ability to appropriately account for the repeated measures data.

SAS 9.3 (SAS Institute, 2011) was used to determine ORs and confidence intervals (CIs) based on the GEE analysis. The initial model was fit using the full list of variables in the aforementioned candidate pool. A process of stepwise-variable removal was initiated, starting with the variable with the highest p-value from the model and continuing until the largest p-value for the remaining variables was below the chosen threshold of p=0.10. All candidate pool variable terms were initially entered into the model as main-effects terms. Once the final list of retained main-effects variables was determined, estimable interactions of the remaining variables were also explored.

Logistic regression using GEE was utilized to model the binary response variable of injury (yes/no). Due to the repeated measures collected over time (quarterly) on individual farmers, a first-order autoregressive correlation structure was used to model the dependence between observations within a farmer. The offset option (Months) was used to account for varying exposure between quarterly contacts with the farmers. When model selection was performed (using p-value criterion with a step-wise removal threshold of p=0.10 for retainment), a final model was achieved and included the subsequent variables: farm exposure variables-loud noise, chemical/pesticide use, heavy lifting and raising livestock; health variables: general health and depression; and finally medication variables-taking any medication, ACE inhibitors, beta blockers, number of cardiac medications, blood formation/coagulation medications, and hormones.

<u>Interaction effects</u>

Drug-disease interactions are important to explore for confounding by indication. Confounding by indication is a term used to describe the confounding role of disease prognosis or severity and the medications used to treat the disease (Salas et al., 1999). Therefore, to avoid this confounding it was important to distinguish if a chronic disease puts the farmer at risk for an injury, if it is the medication they take for that disease, or if it is the combination of the disease and the medication. The best way to deal with confounding by indication was to explore the interactions between the disease and the medication taken for the disease. In cleaning and preparing the data for analysis, it was noted that on average 30% of the chronic health variables were missing. Due to these missing data, the chronic health variables were removed from the candidate pool of variables prior to the model selection process. To explore how the disease process may be associated with injury, a surrogate variable called *general health* that provided information on the self-reported health status of each farmer was included as a candidate variable in the multivariate analysis. The farmers rated their general health status as excellent, very good, good or fair/poor.

As mentioned earlier, the model-selection procedure considered only main-effects models due to the large number of variables being considered. As part of a follow-up to the model-selection process, interaction effects were tested by adding interaction terms to the final multiple logistic regression model. *Drug-disease* interactions were tested using the variables from the above noted final model, numerous interactions between *general health* (excellent, very good, good, fair/poor) and specific medication variables (each medication class) as well as the variable *currently taking medication* (yes/no) were investigated. *Drug-drug* interactions were also tested by using the variables from the above noted final model; numerous interactions between each of the classes of medications were investigated.

Summary

The research methods used to address the specific aims and research questions posited in chapter one have been outlined. The current study's design, data collection procedures, measurement of variables and data analysis has been described. The next chapter will present the results of this secondary analysis using the methods described in this chapter.

CHAPTER 4

RESULTS

Original data from the Certified Safe Farm (CSF) study were used for this secondary data analysis. There were 316 farmers reporting a total of 318 agricultural injuries. Differences in medication use and agricultural injury experiences of younger ($\leq$54 years old) and older ($\geq$55 years old) farmers were explored. The results of the multiple logistic regression analysis are provided to determine the measured association between taking certain medication classes and agricultural injury. A description of the demographic, agricultural injury and medication use characteristics of the entire cohort are presented first, followed by a presentation of results for each research question. Finally, the results of the multiple logistic regression analysis are presented.

Descriptive Statistics

Demographic characteristics of the farmers are summarized in Table 13 (categorical variables) and Table 14 (continuous variables). Table 15 presents demographics for the study population in comparison with all Iowa farmers. Table 16 presents the frequency distributions of injury variables and Table 17 presents the frequency distributions of medication variables.

The Farmers

There were a total of 316 farmers in this study. One hundred and three (33%) farmers were age 55 and older (older farmers), and 210 (66%) farmers were age 54 and younger (younger farmers); frequency missing (n=3). The age of the farmers ranged from 26 to 80 years with a mean age of 50 years old (SD = 11.4) (Figure 4). The median age for all farmers was 48 years old. The sub-group of older farmers had an age range from 55 to 80 years old with a mean age of 64 years old (SD= 6.28). The sub-group of younger farmers had an age range from 26 to 54 years old with a mean age of 43 (SD = 6.45) (Figure 5).

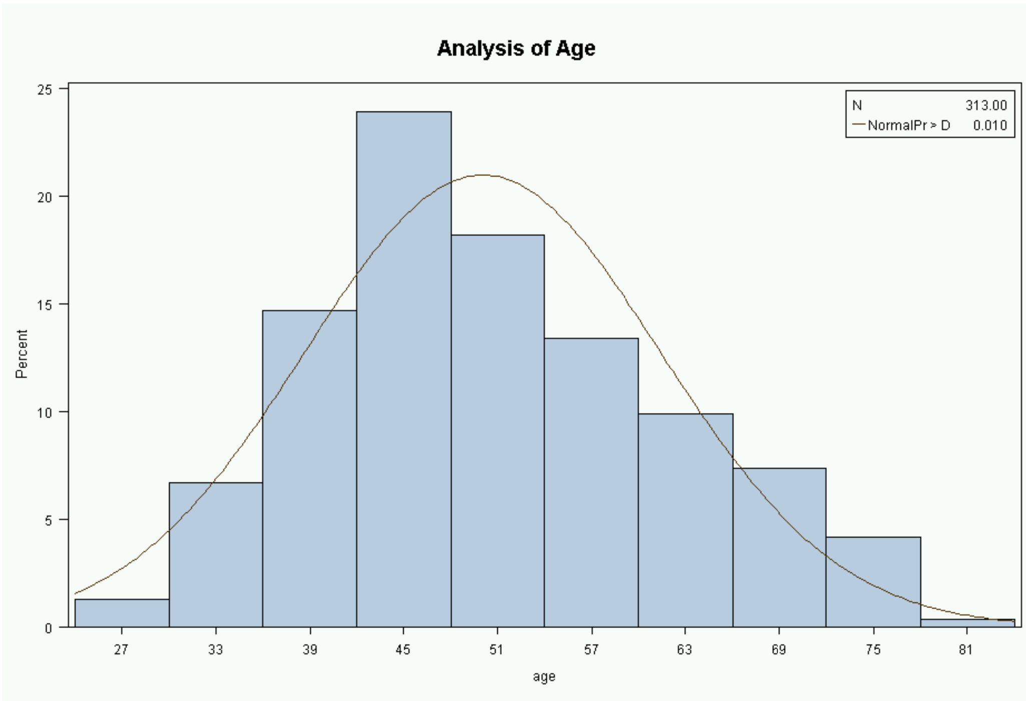

Figure 4: Age distribution for entire cohort

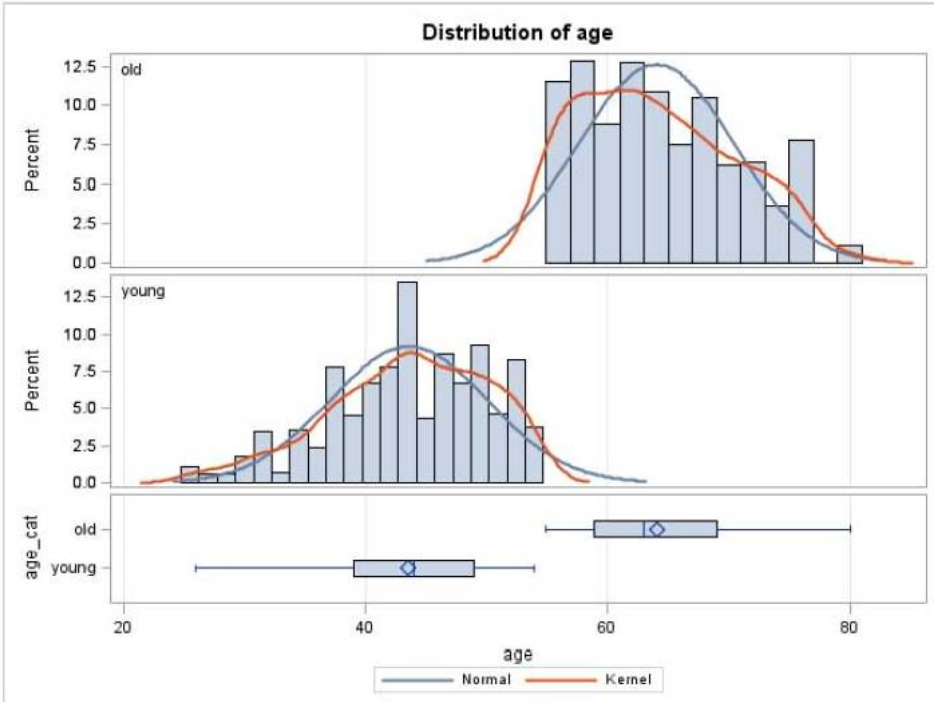

Figure 5: Age distribution of farmers: old and young

The farmers were primarily male (98%), married (93%), and non-smokers (93%). The educational level of this cohort included: high school or less (46%), some college (19%), and a bachelor's degree (35%). The majority of older farmers (58%) had a 'high school or less' educational level, whereas younger farmers tended to at least have some college (40%) or have received a bachelor's degree (22%). This difference in educational level between younger and older farmers was significant, $x^2(2, n = 289) = 8.79,\ p =$ 0.0123). The majority of older farmers (53%) reported that they did not drink any alcohol, whereas only 28% of younger farmers reported that they did not drink. There was a significant difference in reported alcohol intake between older and younger farmers $x^2(2, n = 303) = 18.83,\ p$ <0.0001). Approximately half (56%) of all the farmers had livestock, 45% of older farmers and 62% of younger farmers. Older farmers were less likely to have livestock on their farm, $x^2(1, n = 303) = 7.94,\ p = 0.0048$ (Table 13).

The majority of the farmers felt their health was either very good (45%) or excellent (21%), with only 13 (4%) farmers classifying their health as poor; five (5%) older farmers and 8 (4%) younger farmers. There was no statistical difference in the self-reported health status of older and younger farmers, $x^2(3, n = 303) = 2.17,\ p = 0.5377$. The farmers were also asked about stress and depression with the majority of farmers reporting a low level of depression (n=260, 83%). Older and younger farmers had similar experiences with depression; 81% of older farmers and 84% of younger farmers reported their depression was very low/low. Only three farmers (<1%) answered as having a high level of depression; all three farmers were younger farmers. There was no statistical age effect in self-reported depression levels, $x^2(2, n = 313) = 2.72,\ p = 0.2560$.

The majority of farmers (50%) reported their stress at a medium level, whereas 20% stated it was low, and 30% stated their stress level was high. The majority of younger (49%) and older farmers (52%) rated their stress at a medium level. Older and younger farmers differed on their experiences with low and high stress; 36% of younger farmers rated their stress level as high compared to 18% of older farmers, and 29% of older farmers rated their stress level as low as compared to 20% of younger farmers. This difference in stress levels was statistically significant, $x^2(2, n = 313) = 13.75$, $p = 0.0010$. A summary of the demographic characteristics can be found in Table 13.

Table 13: Frequency distribution of sample demographic variables

Variables	**N** (missing)	**No. (%) of Older Farmers**	**No. (%) of Younger Farmers**	**No. (%) of All Farmers**	**P value**
Date of Birth					
1919-1929 (70-80 yo)	313	22 (21)	0	22 (7)	
1930-1939 (60-69 yo)	(3)	46 (45)	0	46 (15)	-
1940-1949 (50-59 yo)		35 (34)	41 (20)	76 (24)	
1950-1959 (40-49 yo)		0	114 (54)	114 (36)	
1960-1973 (26-39 yo)		0	55 (26)	55 (18)	
Age category					-
Younger (>55)	313	0	210 (66)	210 (66)	
Older (≥ 55)	(3)	103 (33)	0	103 (33)	
Gender					
Male	312	99(96)	207 (99)	306(98)	†0.0949
Female	(3)	4 (4)	2 (<1)	6 (2)	
Married					
Yes	297	94(94)	181 (92)	275 (93)	0.5094
No	(19)	6(6)	16 (8)	22 (7)	
Education					
High school or less	289	56 (58)	77 (40)	133(46)	***0.0123**
Some college	(27)	14(15)	74 (40)	56(19)	
Bachelor's degree		26 (27)	42 (22)	100 (35)	
Any Smoking					
Yes	307	4 (4)	188 (91)	22 (7)	0.1601
No	(9)	97 (96)	18 (9)	285 (93)	
Alcohol- drinks/week					
None	303	53 (53)	56 (28)	109 (36)	***<0.0001**
1 to 2	(13)	30 (30)	91 (45)	121 (40)	
3 or more		17 (17)	56 (28)	73 (24)	
General health					
Excellent	303	20 (20)	45 (22)	65 (21)	0.5377
Very good	(13)	41 (41)	96 (32)	137 (45)	
Good		34 (34)	54 (18)	88 (29)	
Fair/Poor		5 (5)	8 (3)	13 (4)	
Depression					
Low	313	83 (81)	177 (84)	260 (83)	0.2560
Medium	(3)	20 (19)	30 (14)	50 (16)	
High		0	3 (1)	3 (<1)	

Table 13 continued

Variables	N (missing)	No. (%) of Older Farmers	No. (%) of Younger Farmers	No. (%) of All Farmers	P value
Stress					
Low	313	30 (29)	32 (15)	62 (20)	***0.0010**
Medium	(3)	54 (52)	103 (49)	157 (50)	
High		19 (18)	75 (36)	94 (30)	
Other Job off Farm					
Yes	303	31 (31)	99 (49)	130 (43)	***0.0033**
No	(13)	69 (69	104 (51)	173 (57)	
Livestock					
Yes	303	45 (45)	126 (62)	171 (56)	***0.0048**
No	(3)	55 (55)	77 (38)	132 (44)	
Farm Size (acres)					
Small (<161)	313	17 (17)	25 (12)	42 (13)	***0.0008**
Medium (161-639)	(3)	52 (50)	68 (32)	120 (38)	
Larger (>639)		34 (33)	117 (56)	151 (48)	

Notes: Chi-square tests were used to compare categorical data

†(F) Fisher's exact test was used when sample sizes were small.

All tests were two-tailed and a p-value of <0.05 was deemed to be statistically significant; *Significant results in **bold type**

All data were taken from farmers' first occupational health history.

The whole cohort of farmers worked an average of 20 hours per week on their farms, with older farmers working fewer hours (M=18.55, SD=18.89, range: 0-90) than the younger farmers (M=21.10, SD=21.10, range: 0-121). This difference was significant $t(2511) = -2.94, p = 0.0033$. Forty-three percent of the total cohort worked off-farm jobs as well. Thirty-one percent of older farmers as compared to 49% of younger farmers worked off the farm; the difference was statistically significant, $x^2(1, n = 303) = 8.63,\ p = 0.0033$. The younger farmers worked an average of 13.48 hours a week at another job off the farm, while older farmers only worked on average

7.43 hours off the farm. This age difference in hours worked off-farm was significant; $t(2511) = -8.15,\ p < 0.0001$ (Table 14).

Table 14: Descriptive statistics and normality of continuous demographic independent variables

Farmers	Age	Farm Acres	Farm Work Hours	Off Farm Work Hours
All Farmers				
Mean	50	750.84	20.22	11.50
Median	48	639	10	0
SD	11.40	561.82	20041	17.68
Range	26-80	0-3320	0-121	0-60
Skewness	0.37	1.35	1.36	1.20
Kurtosis	-0.49	2.16	1.04	-0.08
Older Farmers				
Mean	64	534.62	18.55	7.43
Median	63	440	9	0
SD	6.28	363.37	18.89	14.86
Range	55-80	0-1625	0-90	0-60
Skewness	0.51	0.89	1.30	1.89
Kurtosis	-0.69	0.30	0.61	2.21
Younger Farmers				
Mean	43	856.72	21.10	13.48
Median	44	720	10	0
SD	6.45	610.44	21.10	18.60
Range	26-45	0-3320	0-121	0-60
Skewness	-0.45	1.16	1.35	0.96
Kurtosis	-0.28	1.33	1.04	-0.62
P Values	**<0.0001**	**<0.0001**	**0.0033**	**<0.0001**

Notes: Independent sample t-tests were used in the analysis; all tests were two-tailed and a p-value of <0.05 was deemed to be statistically significant.

Farm work and off farm work are in hours per week

SD is standard deviation

The mean number of acres farmed by the whole cohort was 751 (Figure 6). Older farmers owned significantly less acres (M=534.6, SD=363.4, range= 0-1625) than the younger farmers (M=856.7, SD=610.4, range= 0-3320); this difference was significant t (2485) = -13.92, $p < 0.0001$ (Table 14 and Figure 7).

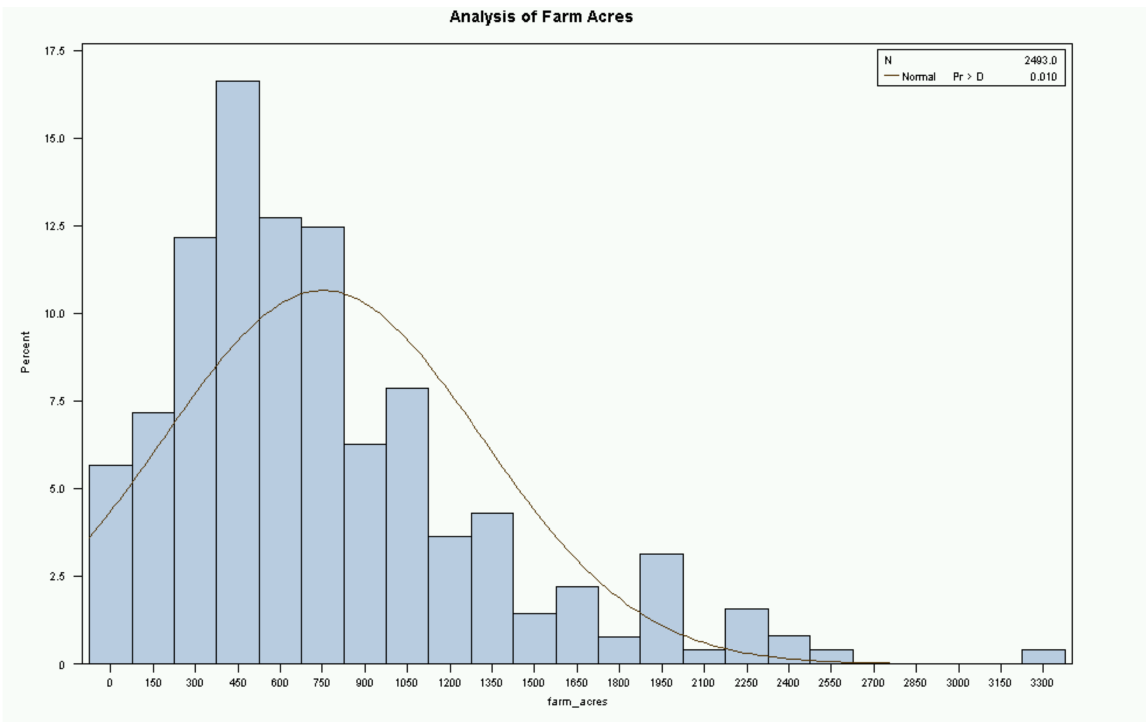

Figure 6: Distribution of farm acres for entire cohort

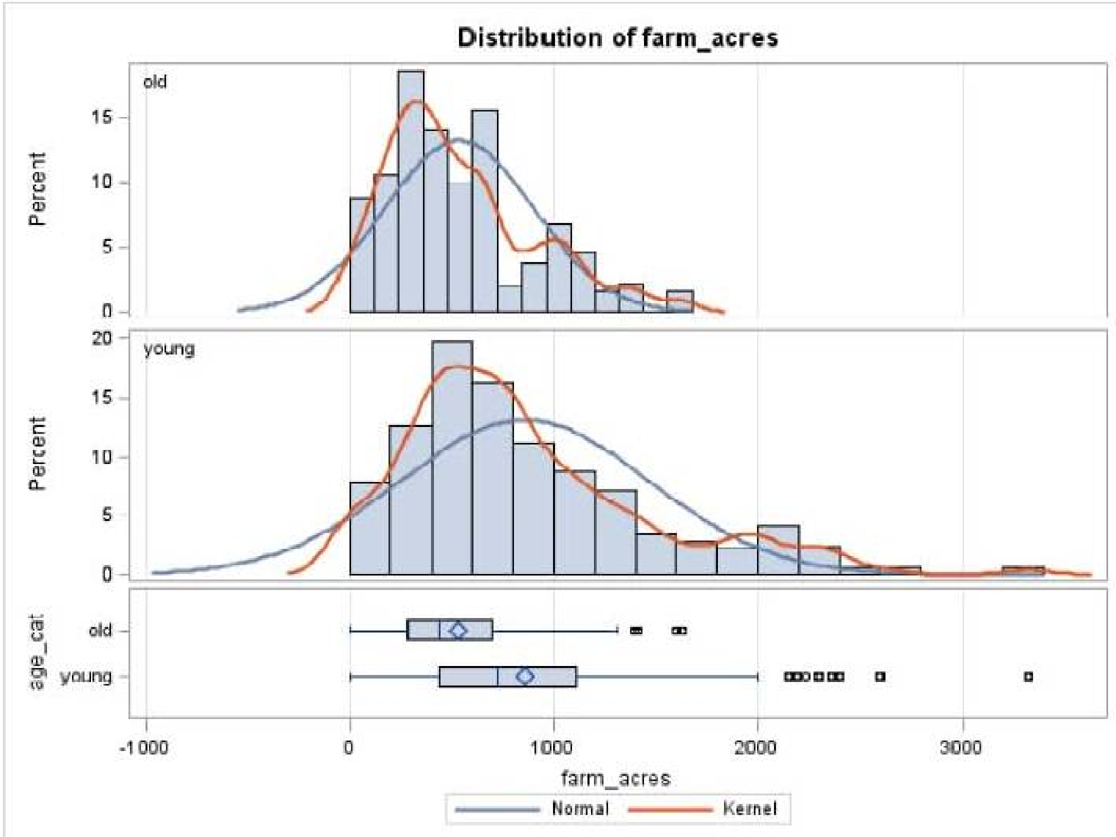

Figure 7: Distribution of farm acres for older and younger farmers

<u>Representativeness of the sample</u>

The demographic characteristics of the study participants were similar to those of Iowa farmers in general (Table 15). As this study took place between the years of 1999-2003, both the 1997 and the 2002 Census of Agriculture were used for comparison (Iowa Agricultural Statistics Service, U.S. Department of Agriculture, 2012; USDA, 2012). The study participants were similar in age, gender, and ethnicity to Iowa farmers, but the study farmers tended to farm more acres than the average state of Iowa farmer.

Table 15: Demographics and farm production characteristics of the study participants as compared to Iowa farmers

Variables	Study Participants (n= 316)	Iowa Farmers* 1997	Iowa Farmers* 2002
Average Age (years)	50	52.3	54.3
Ethnicity (% white)	100	99.9	99.3
Gender (% male)	98	95	93
Average total acres	751	334	350

**Sources:* Iowa Agricultural Statistics Service, U.S. Department of Agriculture. (2012). *1997 census of agriculture state profile: Iowa.*

USDA. (2012). *Historical highlights: 2002 and earlier census (Iowa).*

Nonfatal Agricultural Injuries

An overview of reported nonfatal agricultural injuries for the entire cohort will briefly be discussed with further discussion on the differences between the younger and older farmers to follow later in the chapter as each individual research question is addressed and results are discussed. Only nonfatal injuries are discussed in this study. Therefore, the future mention of agricultural injury will denote reported nonfatal agricultural injuries only.

Frequency distributions on reported agricultural injuries: month injured, number of injuries sustained, types and sources of injury, and finally body parts injured, are presented in Table 16. A total of 168 farmers sustained one or more agricultural injuries in this study. There were a total of 318 injuries reported with a total of 758 person-years of follow-up time. Person-years observed were calculated by the number of months the farmer participated in each quarter divided by 12 (12 months in a year) to get a quarterly person-years; then each of the 10 quarterly person-years were added together for total person-years. Overall injury rate for the whole cohort was 41.95 injuries/100 person-years of follow-up. The majority of farmers (n=168, 54%) in the study were injured at least once during the study. Forty-six percent of farmers had no injuries, 29% had one injury, 13 % had two injuries, 5% had three injuries, 3% had 4 injuries, 3% had five injuries, and less than 1% had six or more (up to 10) injuries.

Table 16: Frequencies of agricultural injuries by age group

Injury Variables	**No. (%) of Older Farmers**	**No. (%) Younger Farmers**	**No. (%) of All Farmers**
Ever had an injury			
Yes	50 (49)	**118 (56)**	**168 (54)**
No	**53 (51)**	92(44)	148 (46)
Number of Injuries			
0	**53 (51)**	**92 (44)**	**145 (46)**
1	**30 (29)**	**60 (29)**	**90 (29)**
2	8 (8)	34 (16)	42 (13)
3	3 (3)	13(6)	16(5)
4	5(5)	5 (2)	10 (3)
5	4(4)	4 (2)	8 (3)
6	0	1 (<1)	1 (<1)
7	0	0	0
8	0	0	0
9	0	0	0
10	0	1 (<1)	1 (<1)
Total Number of Injuries:	**95**	**223**	**318**
Injury Month			
January	5 (6)	17 (8)	22 (8)
February	5 6)	13 (6)	18 (6)
March	5 (6)	17 (8)	22 (8)
April	6 (7)	16 (8)	22 (8)
May	7 (8)	19 (9)	26 (9)
June	6 (7)	8 (4)	14 (5)
July	6 (7)	17 (8)	23 (8)
August	**9 (11)**	**21 (10)**	**30 (11)**
September	6 (7)	9 (4)	15 (5)
October	**10 (12)**	**33 (16)**	**43 (15)**
November	5 (6)	18 (9)	23 (8)
December	5 (6)	9 (4)	14 (5)
No Month Listed	8 (10)	4 (2)	12 (4)

Table 16 continued

Injury Variables	**No. (%) of Older Farmers**	**No. (%) Younger Farmers**	**No. (%) of All Farmers**
Type of Injury			
Bruise	**25 (30)**	**37(18)**	62 (22)
Burn	3 (4)	13 (6)	16 (6)
Cut	**22 (27)**	**40 (20)**	62(22)
Crush	2 (2)	13 (6)	15 (5)
Fracture	4 (5)	7 (3)	11 (4)
Puncture	1 (1)	5 (2)	6 (2)
Sprain/strain	**17 (20)**	**48 (24)**	**65 (23)**
Other	8 (10)	37(18)	45 (16)
NA	1 (1)	1 (<1)	2(<1)
Source of Injury			
Tractor	2 (2)	12 (6)	14 (5)
Other machinery	13 (16)	31 (15)	44 (15)
Livestock	12 (14)	20 (10)	32 (11)
Hand tool	3 (4)	20 (10)	23 (8)
Pesticide/chemical	0	0	0
Plant/tree	2 (2)	4 (2)	6 (2)
Working surface	4 (5)	15 (7)	19 (7)
Truck/auto	2 (2)	2 (1)	4 (1)
Other vehicle	0	1 (<1)	1 (<1)
Human error	**19 (23)**	**51 (25)**	**70 (25)**
Other	**20 (24)**	**37 (18)**	**57 (20)**
NA	6 (7)	8 (4)	14 (5)
Body Part Injured			
Head/neck	7 (8)	21(10)	28 (10)
Eye(s)	1 (1)	6 (3)	7 (2)
Chest/trunk	3 (4)	5 (2)	8 (3)
Back	9 (11)	30 (15)	39 (14)
Arms/shoulder	7 (8)	14 (7)	21 (7)
Finger	**18 (22)**	**38 (19)**	**56 (20)**
Hand/wrist	8 (10)	24 (12)	32 (11)
Leg/knee/hip	**21 (25)**	**41 (20)**	**62 (22)**
Foot	4 (5)	11 (5)	15 (5)
Other	5 (6)	11 (5)	16 (6)

Note: Number (percent) of each group of farmers in regards to injury; highest frequency of each injury variable is presented in **bold type**

The majority of reported injuries (15%) occurred in the month of October, which is the time of year that farmers begin to harvest their crops. The most common self-reported source of injury for all farmers was human error (n=70, 25%), followed by other (n=57, 20%) and other machinery (n=44, 15%). The most common type of injury for this cohort of farmers was sprain/strain (n=65, 23%), followed by cuts (n=62, 22%) and bruises (n=62, 22%). The most common body part injured was the leg/knee/hip (n=62, 22%) followed by finger injuries (n=56, 20%) and back injuries (n=39, 14%).

Medications

An overview of reported medications for the entire cohort will briefly be discussed with further discussion on the differences between the younger and older farmers to follow later in the chapter as each individual research question is addressed and results are discussed.

Frequency distributions on reported medication use in this cohort of farmers can be found in Table 17. The frequencies of reported medication use are in regards to *ever* taking a medication at any time in the study. The majority (n=154, 56%) of farmers did not report taking any medication during the study, while 123 (44%) of farmers reported taking at least one medication at some point in the study. The number of medications reported per quarter ranged from 0-6 (M = 0.52, SD = 1.03). The most common medication classes that farmers reported taking include: central nervous system (CNS) (n=68, 25%), cardiac (n=54, 20%), and blood formation and coagulation (n=40, 15%). The most common subclasses reported include: pain medications (n=57, 21%) a subclass of CNS, and blood pressure (BP) medications (n=43, 16%) which is a subclass of cardiac medications.

Table 17: Frequencies for medication variables by age group

Medication Variable	N (missing)		No. (%) of Older Farmers	No. (%) of Younger Farmers	No. (%) of All Farmers
Taking any medication	279	Yes	56 (60)	67 (37)	123 (44)
	(39)	No	38 (40)	116 (63)	154 (56)
Antihistamine drugs	270	Yes	4 (4)	5 (3)	9 (3)
	(46)	No	88 (96)	173 (97)	261 (97)
Anti-infective agents	269	Yes	4 (4)	0	4 (1)
	(47)	No	87 (96)	178 (100)	265 (99)
Autonomic drugs	270	Yes	2 (2)	1 (<1)	3 (1)
	(46)	No	90 (98)	177 (99)	267 (99)
Blood formation & coagulation	274	Yes	17 (18)	23 (13)	40 (15)
	(42)	No	76 (82)	158 (87)	234 (85)
***Cardiac drugs**	271	Yes	32 (34)	22 (12)	54 (20)
	(45)	No	61 (66)	156 (88)	217 (80)
Alpha blockers	269	Yes	7 (8)	2 (1)	9 (3)
	(47)	No	84 (92)	176 (99)	260 (97)
Beta blockers	270	Yes	15 (16)	9 (5)	24 (9)
	(46)	No	77 (84)	169 (95)	246 (91)
ACE inhibitors	270	Yes	8 (9)	4 (2)	12 (4)
	(46)	No	84 (91)	174 (98)	258 (96)
BP medications	270	Yes	26 (28)	17 (10)	43 (16)
	(46)	No	66 (72)	161 (90)	227 (84)
****CNS agents**	275	Yes	28 (30)	40 (22)	68 (25)
	(41)	No	64 (70)	143 (78)	207 (75)
Pain medications	276	Yes	25 (27)	32 (17)	57 (21)
	(40)	No	68 (73)	151 (83)	219 (79)
Antidepressants	269	Yes	0 (0)	2 (1)	2 (<1)
	(47)	No	92 (100)	175 (99)	267 (99)
GI drugs	273	Yes	6 (6)	11 (6)	17 (6)
	(43)	No	87 (94)	169 (94)	256 (94)
Hormones	270	Yes	13 (14)	4 (2)	17 (6)
	(44)	No	79 (86)	174 (98)	253 (94)
Vitamins	270	Yes	5 (5)	7 (4)	12 (4)
	(46)	No	87 (95)	171 (96)	258 (96)

Note: Medication variables based on *ever* taking that medication at any time during the study.

*The class of cardiac drugs has four subclasses: alpha blockers, beta blockers, ACE inhibitors, and BP medications. A farmer that reported taking any of these subclasses is also counted in the major class of cardiac medications. Also, alpha blockers, beta blockers, and ACE inhibitors are considered BP medications and therefore farmers taking these are also counted under the BP medications subclass.

**The class of CNS agents has two subclasses: pain medications and antidepressants. Therefore, a farmer that reported any of these subclasses is also counted in the major class of CNS medications.

Age Effects on Medication Use and Nonfatal Agricultural Injury

Research Question 1: What types of medications are older and younger farmers taking?

The number and percentage of older and younger farmers reporting medications use in each specific AHFS class is presented in Table 17. For the purpose of reporting descriptive statistics or proportions of farmers reporting use of medications in this cohort, analysis was done using *ever* medication variables. These *ever* medication variables were constructed based on whether or not a farmer had *ever* reported taking medication in any of the 10 quarters during the three year study. The repeated measures medication variables (all 10 quarters of medication variables) were used in the bivariate risk analysis of the relationship of medication use and age (older or younger).

Sixty percent of older farmers had reported taking a medication at some point in the study, whereas only 37% of the younger farmers had reported ever taking a medication. Cardiac medication were reported by 34% (n=32) and were the most common medications reported by the older farmers. Other common medications reported by older farmers included CNS medications (n=28, 30%), blood pressure (BP) medications (n=26, 28%) and pain medications (n=25, 27%). The most common medication reported by the younger farmers was central nervous system (CNS) medications (n=40, 22%). followed by pain medications (n=32, 17%), blood formation and coagulation medications (n=23, 13%), and finally cardiac medications (n=22, 12%). Other noted differences included the reported use of antidepressants by younger farmers (n=2, 1%), whereas no older farmers reported using antidepressants. Older farmers reported using some sort of anti-infective (n=4, 4%), whereas no younger farmers reported using an anti-infective agent.

The bivariate risk analysis of reported medication use and age group revealed several statistical differences in reported medication use in regards to age (Table 18). The odds ratio (OR) and confidence intervals (CI) will be reported for all medications. The odds of older farmers taking a medication were 3.08 times greater than the odds of younger farmers taking medication; (OR: 3.08; 95%CI 1.94-4.92). There were several medication classes or subclasses in which older farmers had statistically significant greater odds of use than the younger farmers. These medications include alpha blockers (OR: 17.63; 95% CI: 3.47-89.59), hormones (OR: 8.54; 95% CI: 2.46-29.64), ACE inhibitors (OR: 4.43; 95% CI: 1.14-17.21), BP medications (OR: 4.18; 95% CI: 2.04-8.57), cardiac medications (OR: 3.92; 95% CI: 2.06-7.47), beta blockers (OR: 3.40; 95% CI: 1.31-8.83), pain medications (OR: 2.51; 95% CI: 1.30-4.84), and finally CNS medications (OR: 2.30; 95% CI 1.25-4.22).

Table 18: Type of medication use of older farmers in comparison to younger farmers

Medication Variable	N Missing	OR (95% CI) (odds ratio and 95% confidence intervals)	P value†
Taking any medication	2378 (147)	**3.08 (1.94-4.92)**	**<0.0001**
Antihistamine drugs	2378 (147)	1.44 (0.28-7.46)	0.6614
Anti-infective agents	2377 (148)	-	-
Autonomic drugs	2378 (147)	5.66 (0.48-66.37)	0.1673
Blood formation & coagulation	2378 (147)	1.67 (0.77-3.60)	0.1944
***Cardiac drugs**	2378 (147)	**3.92 (2.06-7.47)**	**<0.0001**
Alpha blockers	2374 (151)	**17.63 (3.47-89.59)**	**0.0005**
Beta blockers	2378 (147)	**3.40 (1.31-8.83)**	**0.0121**
ACE inhibitors	2378 (147)	**4.43 (1.14-17.21)**	**0.0317**
BP medications	2378 (147)	**4.18 (2.04-8.57)**	**<0.0001**
****CNS agents**	2378 (147)	**2.30 (1.25-4.22)**	**0.0074**
Pain medications	2377 (148)	**2.51 (1.30-4.84)**	**0.0060**
Antidepressants	2377 (148)	-	-
GI drugs	2378 (147)	1.04 (0.33-3.29)	0.9428
Hormones	2378 (147)	**8.54 (2.46-29.64)**	**0.0007**
Vitamins	2378 (147)	0.83 (0.22-3.09)	0.7808

Notes: N=number of responses to quarterly calls

†p values determined by logistic regression using GEE; statistically significant factors are shown in **bold type**

- Too few farmers using the medication to establish ORs.

*The class of cardiac drugs has four subclasses: alpha blockers, beta blockers, ACE inhibitors, and BP medications. A farmer that reported taking any of these subclasses is also counted in the major class of cardiac medications. Also, alpha blockers, beta blockers, and ACE inhibitors are considered BP medications and therefore farmers taking these are also counted under the BP medications subclass.

**The class of CNS agents has two subclasses: pain medications and antidepressants. Therefore, a farmer that reported any of these subclasses is also counted in the major class of CNS medications.

Research Question 2: Are older farmers taking more medications than younger farmers?

The frequency distribution of medications reported per quarter is displayed in Table 19 and Figure 8. The majority of older (58%) and younger (81%) farmers did not report taking any medication. The most common number of medications reported taken quarterly by older farmers was two (14%) followed by one (12%), whereas the most common number reported by younger farmers was one (11%) followed by two medications (10%). It was uncommon for younger farmers to report taking more than two medications; less than one percent of younger farmers took three or more medications. Nine percent of older farmers reported taking three medications per quarter, five percent reported four, one percent reported five medications and finally only two older farmers were reported taking six medications per quarter.

Table 19: Frequency distribution of medications taken per quarter

Number of Medications taken per quarter	**No. (%) of Older Farmers**	**No. (%) of Younger Farmers**	**No. (%) of All Farmers**
0	465 (58)	1285 (81)	1750 (74)
1	98 (12)	155(10)	253 (11)
2	113 (14)	114 (7)	227 (10)
3	69 (9)	11 (<1)	82 (3)
4	42 (5)	14 (<1)	56(2)
5	8 (1)	4 (<1)	12 (<1)
6	2 (<1)	0	2(<1)

Note: Data taken from all 10 quarters (n=2380, missing= 145)

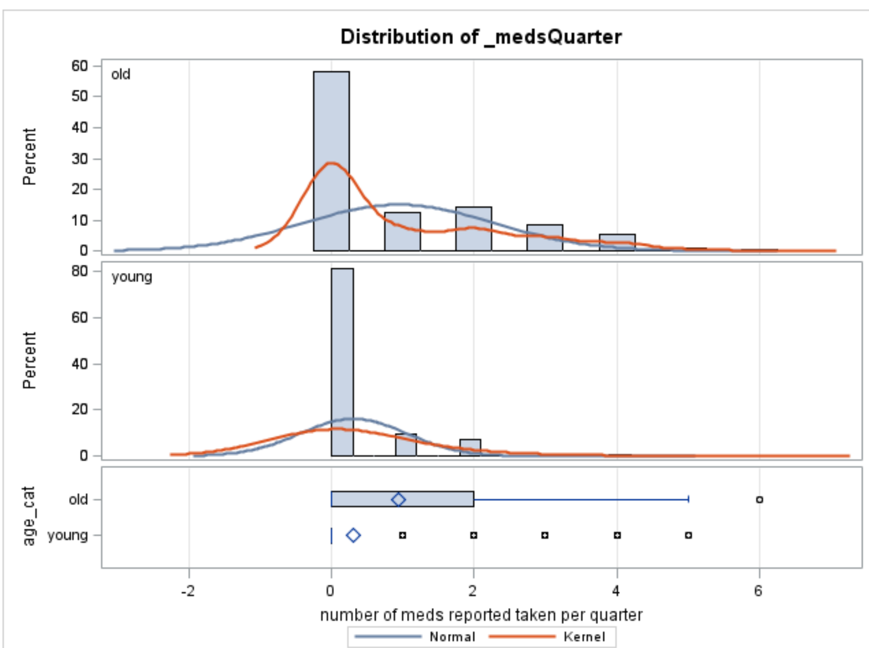

Figure 8: Distribution of number of medications reported taken per quarter

The mean number of reported medications per quarter is presented in Table 20. Older farmers reported taking more medications per quarter (M=0.94, SD=1.33, range=0-6) than the younger farmers (M=0.31, SD=0.75). There was a significant effect for age group, $t(2378) = 14.82,\ p < 0.0001$ with older farmers reporting taking more medications than younger farmers (Figure 3). Older farmers also reported taking more cardiac medications per quarter (M=0.42, SD=0.92, range=0-6) than the younger farmers (M=0.10, SD=0.37, range=0-3). This difference was significant $t(2378) = 12.13,\ p < 0.0001$. Finally, older farmers also reported taking more CNS medications per quarter (M=0.18, SD=0.39, range=0-2) than the younger farmers (M=0.11, SD=0.37, range=0-3). This difference was significant $t(2378) = 4.55,\ p < 0.0001$.

Table 20: Mean number of reported medications taken per quarter

Medications per quarter	**Mean (range) of Older Farmers**	**Mean (range) of Younger Farmers**	**Mean (range) of All Farmers**	**P value**
All meds	0.9423 (0-6)	0.3108 (0-5)	0.5224 0 (0-6)	<0.0001
Cardiac meds	0.4241 (0-6)	0.1011 (0-3)	0.2090 (0-6)	<0.0001
CNS meds	0.1819 (0-2)	0.1074 (0-3)	0.1328 (0-3)	<0.0001

Note: Independent sample t-tests were used in the analysis of continuous data.

All tests were two-tailed and a p-value of <0.05 was deemed to be statistically significant.

Question 3: What are the nonfatal injury rates for older and younger farmers?

The frequency distribution of injuries reported by older and younger farmers are presented in Table 16. The farmers in this study reported a total of 318 injuries in 758 person years of follow-up. Person-years of follow-up were calculated each quarter by adding the number of months the farmer participated in that quarter and dividing it by 12.

During the duration of the study, 50 of the 103 older farmers reported a total of 95 injuries; 30 (29%) older farmers reported only one injury, 8 (8%) reported two injuries, three (3%) reported three injuries, five (5%) reported four injuries, and four (4%) reported five injuries. Of the 210 younger farmers, 118 of them reported a total of 223 injuries; 60 (29%) reported one injury, 34 (16%) reported two, 13 (6%) reported three, five (2%) reported four, four (2%) reported five, 1 (<1) had six, and 1 younger farmer reported 10 injuries (Figure 9 and Table 16). The most number of injuries reported by an older farmer was five; as compared to the younger farmer who reported 10 injuries. The mean number of injuries reported per quarter was very similar between older (M = 0.92, SD = 1.33) and younger (M = 1.06, SD = 1.37) farmers. No statistical difference was found in the mean number of injuries reported by older and younger farmers; $t(311) = -0.85,\ p = 0.3936$.

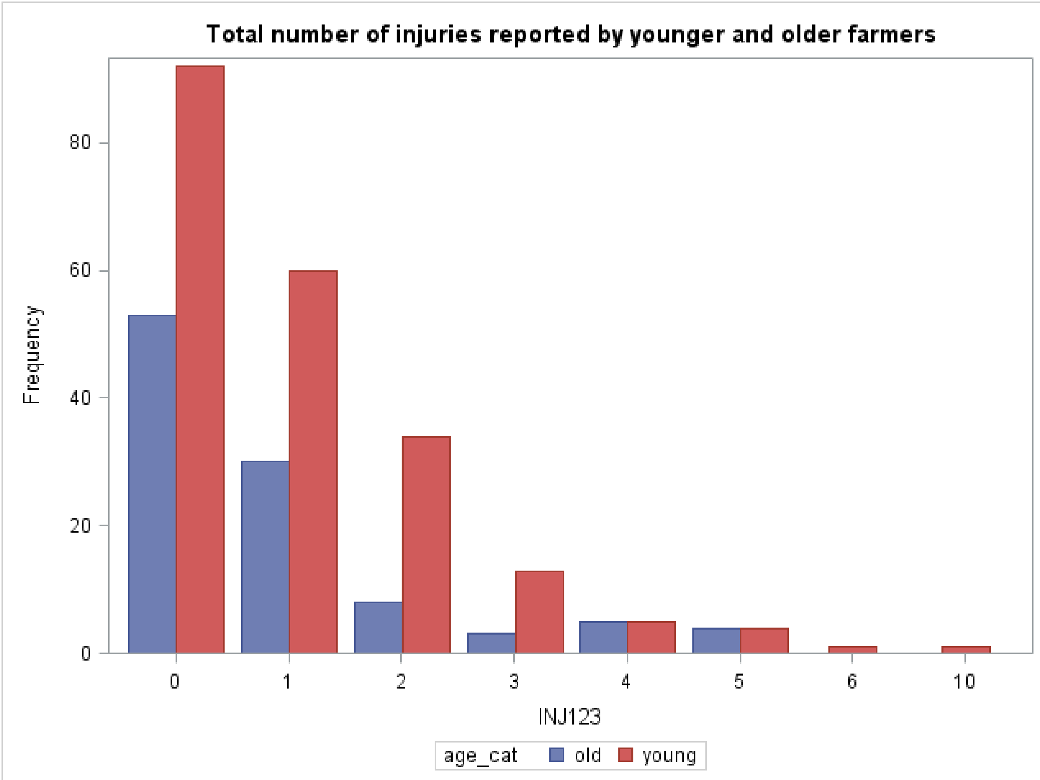

Figure 9: Frequency distribution of total number of reported injuries by age group

Table 21 presents the person-years of exposure and crude injury rates by age group. Person-years are a valuable way of articulating injury rates by using the number of injuries divided by the person years over which a group has been observed. In research, individuals may be observed for different periods of time, and person-years allow the researcher to calculate the time of observation for all participants so that participants can be compared. For the current research, person-years were calculated by taking the number of months the farmer participated in each quarter divided by 12 (12 months in a year) to get a quarterly person-years; then each of the 10 quarterly person-years were added together for total person-years. There was a total of 758 person years for the whole cohort. Injury rates were calculated by the number of injuries reported multiplied by 100 then divided by the number of person-years observed. The injury rate for the whole cohort of farmers was 41.95 injuries/100 years. The older farmers' injury rate was 38.35 injuries/100 person- years, while younger farmer injury rate was 44.01 injuries/100 person-years.

Table 21: Reported injuries and person years of exposure

Age Group	Number of Injuries	Person Years of Exposure	Injury Rate per 100 person years
Older farmers	95	247.75	38.35
Younger farmers	223	506.67	44.01
All farmers	318	758.08	41.94

Bivariate risk analysis of agricultural injury and age group revealed no statistical difference for risk of injury in regards to age. The odds of older farmers having reported an agricultural injury were 0.82 times the odds of younger farmers; (OR 0.82 95%CI: 0.58-1.1670); these findings were not statistically significant.

Finally, analysis was completed exploring non-fatal injury rates for the farmers when categorized within five age groups. Figure 10, presents the injury rates for each age group. This was completed to explore potential trends in injury rates in regards to age. The age group with the highest injury rate is those farmers in the age group 40-49 years of age (48.29 injuries/100 person-years). The next highest injury rate group is farmers in the age group 70-80 years of age (45.38 injuries/100 person-years). Farmers in the age group 26-39 years old had an injury rate of 38.81 which was very similar to farmers in the age group 60-69 (38.77 injuries/100 person-years). Therefore, it is noted that the age group 40-49 has the highest injury rate, yet after the age of 50 there is a definite trend of increasing injury with increasing age.

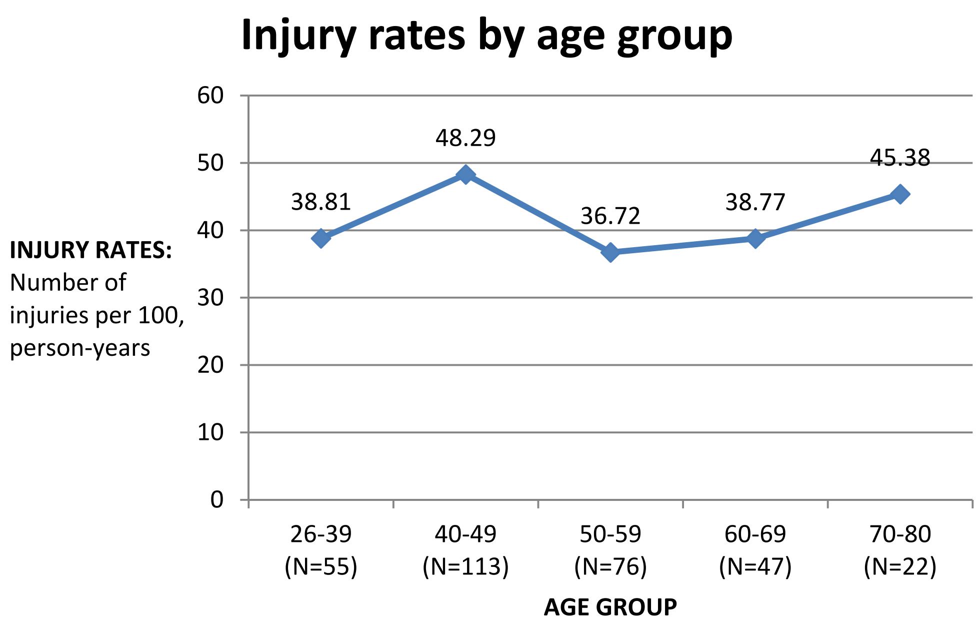

Figure 10: Injury rates by age group

Question 4: In what months are older and younger farmers getting injured?

The months in which farmers reported injuries are presented in Table 16. October (n=43, 15%), August (n=30, 11%) and May (n=26, 9%) had the highest proportions of reported injuries. The monthly pattern of reported injury for older and younger farmers was similar; October (older =12%; younger = 16%), August (older = 11%; younger = 10%), being the two months where the most injuries were reported. Chi-square statistics were computed, $x^2(12, N = 284) = 13.02,$ p=0.3673, there were no statistical difference in what months the older and younger farmers were reporting being injured.

Question 5: What types of nonfatal injuries are older and younger farmers sustaining?

The cross tabulation for types of injuries reported by older and younger farmers is presented in Table 16. The most common type of injuries reported by this cohort of farmers was sprains and strains (23%), followed by cuts (22%) and bruises (22%). For the older farmers, the most common type of injury reported was bruises (30%), and then cuts (27%) followed by strains (20%). For younger farmers, strain injuries (24%) were the most common type of injury reported, followed by cuts (20%), and bruises (18%). There were no significant differences found between young and old farmers in regards to the type of injuries they reported; $x^2(8, N = 284) = 11.8391,$ p=0.1585.

Question 6: What are the sources of nonfatal injuries for older and younger farmers?

The cross tabulation for the sources of injuries reported by older and younger farmers is presented in Table 16. The number one source of injury reported for both age groups was human error; older (n=19, 23%) and younger farmers (n=51, 25%). The next most common source reported for the two groups was other (20% for whole cohort); 24% for older farmers and 18% for younger farmers. Other machinery (older-16%, younger-15%) and livestock (older -14%, younger-10%), were also found as important sources of injury. There were no significant differences found between young and old farmers in regards to the source of reported injuries they reported; $x^2(10, N = 284) = 9.7455,$ p=0.4631.

Question 7: What body parts are older and younger farmers injuring?

The specific body part(s) affected by injury are presented in Table 16. Older and younger farmers had similar experiences with reported injuries, regarding body parts injured. The most commonly reported body part injured for both older (n=21, 25%) and younger (n=41, 20%) farmers was legs/knees/hips. The second most common body part injured was fingers; older farmers (n=18, 22%) and younger farmers (n=38, 19%). Back (older-11%), younger-15%) and head/neck injuries (older-8%, younger-10%). There were no significant differences found between young and old farmers in regards to the reported body parts injured; $x^2(9, N = 284) = 3.3787,$ p=0.9474.

Medication Use and Agricultural Injury

Question 8: How many nonfatal injuries occur with each medication class?

Descriptive analysis was conducted using a subset of data that included only farmers that had reported injuries. There were a total of 168 farmers that reported being injured in the cohort; this subset of injured farmers was used to describe the number of reported injuries occurred (up to a three injuries a quarter) to a farmer who also reported taking medication (Table 22).

Table 22: Frequency of reported injuries that occurred to farmers who also reported taking medication

Medication Variables	Number of Farmers Reporting Specific Number of Injuries per quarter			Total No. of Injuries (% of total number of injuries)
	1	2	3	
Taking any medication	77	5	1	90 (28)
Antihistamine drugs	6	1	0	8 (3)
Anti-infective agents	1	0	0	1 (<1)
Autonomic drugs	0	0	0	0
Blood formation & coagulation	**13**	0	**1**	16 (5)
***Cardiac drugs**	**35**	**1**	0	**37 (12)**
Alpha Blockers	6	0	0	6(2)
Beta Blockers	16	0	0	16(5)
ACE Inhibitors	10	0	0	10(3)
BP Medications	29	1	0	**31(10)**
****CNS agents**	**32**	**3**	**1**	**41 (13)**
Pain Medication	**24**	**3**	**1**	**33 (10)**
Antidepressants	1	0	0	1 (<1)
GI drugs	8	0	0	8(3)
Hormones	6	1	0	8 (3)
Vitamins	9	0	0	9 (3)
†Total number of injuries where medication was taken	**77 (30%)**	**5 (9%)**	**1 (11%)**	**90 (28)**
††Total Number of Injuries	***253**	***56**	***9**	***318**

Notes: Taken from 10 rounds of quarterly calls data (n=2385, missing=142).

The most common medications that were reported taken by farmers who also reported an injury in the same quarter are in **bold**.

†Total number of injuries when medication was taken; percentage of the total number injuries whether taking medication or not.

*The class of cardiac drugs has four subclasses: alpha blockers, beta blockers, ACE inhibitors, and BP medications. A farmer that reported taking any of these subclasses and was injured is also counted in the major class of cardiac medications. Also, alpha blockers, beta blockers, and ACE inhibitors are considered BP medications and therefore farmers taking these who had and injury are also counted under the BP medications subclass.

**The class of CNS agents has two subclasses: pain medications and antidepressants. Therefore, a farmer that reported any of these and was injured is also counted in the major class of CNS medications.

††Total number of injuries, whether taking medication or not.

Twenty-eight percent of reported injuries were sustained by a farmer who reported taking a medication in the same quarter of reporting an injury. The most common medication classes by farmers reporting an injury include cardiac (37 injuries, 12% of all injuries), CNS (41 injuries, 13% of all injuries), pain medications (33 injuries, 10% of all injuries) and BP medications (33, 11%) medications. All classes of medications were reported by an injured farmer except autonomic medications. There were two medication classes where only one farmer reported an injury while taking the medication, these included antidepressants (one farmer had one injury) and anti-infective medications (one farmer had one injury). Three injuries in one quarter was the greatest number of injuries reported by a farmer who reported taking a medication. One farmer reported three injuries in a single quarter and reported taking each of the following medications: blood formation and coagulation medication, CNS medication, and pain medication. The bivariate risk analysis of reported medication use and injury results can be found in Table 23. No medication classes were found to increase the odds of injury for this cohort of farmers.

Table 23: Bivariate regression analysis of reported medication use and injury

Medication Variable	**N** (missing)	**OR (95% CI)**	**†P value**
Taking any medication	2379 (146)	1.25 (0.90-1.70)	0.1819
Antihistamine drugs	2379 (146)	1.97 (0.61-6.38)	0.2558
Anti-infective agents	2378 (147)	0.73 (0.30-1.79)	0.4951
Autonomic drugs	2379 (146)	*	*
Blood formation & coagulation	2379 (146)	0.72 (0.39-1.34)	0.2990
Cardiac drugs	2379 (146)	1.02 (0.67-1.54)	0.9346
Alpha blockers	2375 (150)	1.04 (0.56-1.92)	0.8971
Beta blockers	2379 (146)	1.44 (0.83-2.50)	0.1989
ACE inhibitors	2379 (146)	1.51 (0.78-2.93)	0.2192
BP medications	2379 (146)	1.14 (0.73-1.79)	0.5573
CNS agents	2379 (146)	1.21 (0.79-1.84)	0.3957
Pain medications	2378 (147)	1.21 (0.74-1.98)	0.4405
Antidepressants	2378 (147)	0.38 (0.05-2.91)	0.3503
GI drugs	2379 (146)	1.27 (0.50-3.26)	0.6134
Hormones	2379 (146)	0.68 (0.36-1.28)	0.2292
Vitamins	2379 (146)	1.23 (0.42-3.63)	0.7078

Notes:† p values determined by logistic regression using GEE;

* Too few farmers using the medication to establish ORs.

Question 9, 10, and 11: What types of nonfatal injuries, what sources of nonfatal injuries, and what body parts were injured with each medication class?

Cross tabulations of reported medications by injury type can be found in Table 24. Cross tabulations of reported medications by injury source can be found in Table 25. And finally, cross tabulations of reported medications by body part injured can be found in Table 26. Following the tables describe the main types and sources of injury, and body parts injured for farmers reporting medication use; organized by medication class.

Table 24: Number (percentage) of injured farmers reporting taking medication by type of nonfatal injury reported

Type of Injury N = 272 Missing = 12	**Any Medication**	**Antihistamine**	**Anti-infective agents**	**Blood formation & coagulation**	**Cardiac**	**Alpha blockers**	**Beta blockers**	**ACE**	**BP**	**CNS**	**Pain**	**Antidepressants**	**GI**	**Hormones**	**Vitamins**
Bruise	**16 (20)**	1 (14)	0	1 (7)	**8 (22)**	1 (17)	**3 (19)**	1 (10)	**NV((27)**	3 (8)	3 (11)	0	**3 (38)**	**4 (57)**	1 (11)
Burn	3 (4)	2 (29)	0	0	0	0	0	0	0	0	0	0	1 (13)	0	0
Cut	**16 (20)**	2 (29)	0	**4 (29)**	**7 (19)**	**2 (33)**	**3 (19)**	**4 (40)**	**6 (20)**	**8 (22)**	**6 (21)**	**1 (100)**	0	0	**3 (33)**
Crush	5 (6)	0	0	1 (7)	2 (6)	0	1 (6)	0	1 (3)	3 (8)	3 (11)	0	0	0	1 (11)
Fracture	7 (8)	1 (14)	1 (100)	**3 (21)**	1 (3)	0	0	0	0	3 (8)	0	0	0	1 (14)	2 (22)
Puncture	1 (1)	0	0	1 (7)	0	0	0	0	0	1 (3)	0	0	0	0	1 (11)
Sprain/Strain	**21 (25)**	1 (14)	0	1 (7)	**12 (33)**	**2 (33)**	**6 (38)**	**2 (20)**	**9 (30)**	**10 (28)**	**9 (32)**	0	**2 (25)**	1 (14)	0

Table 24 continued

Type of Injury N = 272 Missing = 12	**Any Medication**	**Antihistamine**	**Anti-infective agents**	**Blood formation & coagulation**	**Cardiac**	**Alpha blockers**	**Beta blockers**	**ACE**	**BP**	**CNS**	**Pain**	**Antidepressants**	**GI**	**Hormones**	**Vitamins**
Other	14 (17)	0	0	**3 (21)**	**6 (17)**	1 (17)	**3 (19)**	3 **(30)**	**6 (20)**	**8 (22)**	**7 (25)**	0	**2 (25)**	1 (14)	0
9NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes: Number (percent) of farmers on medication by type, source and body part injury; most frequent in bold.

NA means the farmer did not answer the question.

Autonomic medication not in the table as no farmer on an autonomic medication sustained an injury.

Table 25: Number (percentage) of injured farmers reporting taking medication by source of nonfatal injury reported

Source of Injury N = 272 Missing = 12	**Any Medication**	**Antihistamine**	**Anti-infective agents**	**Blood formation & coagulation**	**Cardiac**	**Alpha blockers**	**Beta blockers**	**ACE**	**BP**	**CNS**	**Pain**	**Antidepressants**	**GI**	**Hormones**	**Vitamins**
Tractor	3 (4)	0	0	0	2 (6)	0	1 (6)	0	2 (7)	1 (3)	1 (4)	0	0	1 (14)	0
Other machinery	**12 (15)**	0	0	**2 (14)**	**6 (17)**	**1 (17)**	1 (6)	**2 (20)**	**5 (17)**	**7 (19)**	**5 (18)**	0	0	1 (14)	0
Livestock	11 (13)	0	0	**3 (21)**	**5 (14)**	0	**4 (25)**	0	4 (13)	4 (11)	**4 (14)**	0	**2 (25)**	1 (14)	0
Hand tool	7 (8)	**2 (29)**	0	**2 (14)**	1 (3)	0	0	0	0	4 (11)	2 (7)	0	0	0	**3 (33)**
Pesticide/chemical	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plant/tree	1 (1)	0	0	0	0	0	0	0	0	0	0	0	1 (13)	0	0
Working surface	10 (12)	1 (14)	0	1 (7)	3 (8)	0	**2 (13)**	0	2 (7)	**5 (14)**	3 (11)	**1 (100)**	0	0	1 (11)
Truck/auto	2 (2)	0	0	0	1 (3)	0	0	0	0	1 (3)	1 (4)	0	0	0	0
Other vehicle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 25 continued

Type of Injury N = 272 Missing = 12	**Any Medication**	**Antihistamine**	**Anti-infective agents**	**Blood formation & coagulation**	**Cardiac**	**Alpha blockers**	**Beta blockers**	**ACE**	**Pain**	**CNS**	**Antidepressants**	**BP**	**GI**	**Hormones**	**Vitamins**
Human error	**19 (23)**	1 (14)	1 (100)	**3 (21)**	**9 (25)**	**2 (33)**	**4 (25)**	**2 (20)**	**4 (14)**	**5 (14)**	0	**8 (27)**	**2 (25)**	**3 (43)**	**3 (33)**
Other	**13 (16)**	**3 (43)**	0	**3 (21)**	**5 (14)**	**1 (17)**	**3 (19)**	**3 (30)**	**6 (21)**	**7 (19)**	0	**5 (17)**	**2 (25)**	0	2 (22)
NA	5 (6)	0	0	0	4 (11)	**2 (33)**	1 (6)	**3 (30)**	2 (7)	2 (6)	0	4 (13)	1 (13)	1 (14)	0

Notes: Number (percent) of farmers on medication by type, source and body part injury; most frequent in bold.

NA means the farmer did not answer the question.

Autonomic medication not in the table as no farmer on an autonomic medication sustained an injury.

Table 26: Number (percentage) of injured farmers reporting taking medication by body part reported injured

Body Part Injured N = 272 Missing = 12	**Any Medication**	**Antihistamine**	**Anti-infective agents**	**Blood formation & coagulation**	**Cardiac**	**Alpha blockers**	**Beta blockers**	**ACE**	**BP**	**CNS**	**Antidepressants**	**Pain**	**GI**	**Hormones**	**Vitamins**
Head/neck	10 (12)	0	0	**5 (36)**	**4 (11)**	0	0	**2 (20)**	4 (13)	**6 (17)**	0	3 (11)	1 (13)	1 (14)	**4 (44)**
Eye(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chest/trunk	4 (5)	0	0	1 (7)	2 (6)	0	1 (6)	0	1 (3)	1 (3)	0	0	0	0	0
Back	**12 (14)**	0	0	0	7 (19)	**2 (33)**	**2 (13)**	**3 (30)**	**5 (17)**	3 (8)	0	2 (7)	1 (13)	1 (14)	0
Arm/shoulder	5 (6)	0	0	1 (7)	2 (6)	**1 (17)**	0	1 (10)	2 (7)	2 (6)	0	2 (7)	1 (13)	0	0
Finger	**20 (24)**	**3 (43)**	0	**3 (21)**	**8 (22)**	**2 (33)**	**3 (19)**	**2 (20)**	**5 (17)**	**9 (25)**	0	**8 (29)**	1 (13)	0	**3 (33)**
Hand/wrist	7 (8)	**3 (43)**	0	1 (7)	1 (3)	0	0	0	1 (3)	2 (6)	0	1 (4)	0	**2 (29)**	2 (22)
Leg/knee/hip	**18 (22)**	**1 (14)**	0	**2 (14)**	**8 (22)**	0	**7 (44)**	1 (10)	**8 (27)**	**11 (31)**	**1 (100)**	**10 (36)**	4 (50)	1 (14)	0

Table 26 continued

Body Part Injured N = 272 Missing = 12	**Any Medication**	**Antihistamine**	**Anti-infective agents**	**Blood formation & coagulation**	**Cardiac**	**Alpha blockers**	**Beta blockers**	**ACE**	**BP**	**CNS**	**Pain**	**Antidepressants**	**GI**	**Hormones**	**Vitamins**
Foot	2 (2)	0	0	0	1 (3)	0	1 (6)	0	1 (3)	0	0	0	0	1 (14)	0
Other	5 (6)	0	1 (100)	1 (7)	3 (8)	**1 (17)**	2 (13)	1 (10)	3 (10)	2 (6)	2 (7)	0	0	1 (14)	0

Notes: Number (percent) of farmers on medication by type, source and body part injury; most frequent in bold.

Autonomic medication not in the table as no farmer on an autonomic medication sustained an injury.

Taking any medication

Out of the 90 injuries reported by the farmers who were taking medication, the most common type of injury reported was a sprain/strain (n = 21, 25%), followed by cuts (n = 16, 20%) and bruises (n = 16, 20%). Fourteen (17%) farmers reported taking medication claimed 'other' as the type of injury, seven (8%) reported a fracture, five (6%) reported a crush, and three (4%) farmers had burns. The least common type of injury reported by farmers taking medication was a puncture (n = 1, 1%).

The main sources of injury that farmers taking medication reported was human error (n = 19, 23%), followed by 'other' (n = 13, 16%), other machinery (n = 12, 15%), livestock (n = 11, 13%), and working surface (n = 10, 12%). Less common sources reported were hand tools (n = 7, 8%), tractors (n = 3, 4%), truck/auto (n = 2, 2%), and plant/tree (n = 1, 1%). None of the injured farmers that reported using medications claimed that a pesticide/ chemical or 'other vehicle' was the source of their injury.

The most common identified body parts that farmers who reported taking medications injured included fingers (n = 20, 24%), leg/knee/hip (n = 18, 22%), back (n = 12, 14%), and head/neck. Less common was hand/wrist (n = 7, 8%), arm/shoulder (n = 5, 6%), 'other' (n = 5, 6%), chest/trunk (n = 4, 5%), and foot (n = 2, 2%). No farmers taking medication reported injuring their eyes.

Antihistamine drugs

There were eight injuries reported by farmers on antihistamines. The most common types of injuries for these farmers were burns (n = 2, 29%), and cuts (n = 2, 29%), followed by bruises (n = 1, 14%) and sprain/strain (n = 1, 14%). No farmers on antihistamines reported a crush, puncture, or 'other' as type of injury.

The main sources of injury for farmers who reported taking antihistamines included 'other' (n = 3, 43%), hand tools (n = 2, 29%), working surface (n = 1, 14%), and human error (n = 1, 14%). None of the farmers taking antihistamines reported tractor, other machinery, livestock, pesticide/chemical, plant/tree, truck auto, other vehicle, or NA as a source of their injury.

The most common identified body parts injured by a farmer on antihistamines included fingers (n = 3, 43%), hand/wrist (n = 3, 43%), and leg/knee/hip (n = 1, 14%). None of the farmers on antihistamines reported any of the following body parts as being injured: head/neck, eyes, chest/trunk, back, arm/shoulder, foot, or 'other'.

Anti-infective agents

There was only one injured farmer who reported the use of anti-infective medication. That farmer suffered a fracture, body part described as 'other', and source described as human error.

Blood formation and coagulation medications

There were 16 injuries reported by farmers on blood formation/coagulation medications. The most common reported types of injury for these farmers were cuts (n = 4, 29%), fractures (n = 3, 21%) and 'other' (n = 3, 21%), followed by bruises (n = 1, 7%), sprain/strain (n = 1, 7%), and crush injuries (n = 1, 7%). No farmers on blood formation/coagulation medications reported a burn or NA as type of injury.

The main sources of reported injury for farmers who were taking blood formation/coagulation medications included human error (n = 3, 21%), 'other' (n = 3, 21%), and livestock (n = 3, 21%). Followed by hand tools (n = 2, 14%), other machinery (n = 2, 14%), and working surface (n = 1, 7%). None of the farmers who reported taking blood formation/coagulation medications stated that tractors, pesticide/chemical, plant/tree, truck/auto, other vehicle, or NA as a source of their injury.

The main identified body parts injured by a farmer on blood formation/coagulation medications included head/neck (n = 5, 36%), followed by fingers (n = 3, 21%), leg/knee/hip (n = 2, 14%), hand/wrist (n = 1, 7%), and 'other' (n = 1, 7%).

None of the farmers reported any of the following body parts as being injured: eyes, back, or foot.

<u>Cardiac drugs</u>

There were 37 injuries reported by farmers on cardiac medications. The most common reported type of injury for these farmers was sprain/strain (n = 12, 33%), followed by bruises (n = 8, 22%), cuts (n = 7, 19%) and 'other' (n = 6, 17%). The least common was crush (n = 2, 6%) and fracture (n = 1, 3%). No farmers on cardiac medications reported a burn, puncture, or NA as type of injury.

The main sources of injury for farmers who reported cardiac medications included human error (n = 9, 25%), other machinery (n = 6, 17%), livestock (n = 5, 14%), and 'other' (n = 5, 14%). Followed by NA (n = 4, 11%), working surface (n = 3, 8%), tractor (n = 2, 6%), hand tools (n = 1, 3%), and truck/auto (n = 1, 3%). None of the farmers reported pesticide/chemical, plant/tree, or other vehicle as a source of their injury.

The main identified body parts injured by a farmer on cardiac medications included fingers (n = 8, 22%), leg/knee/hip (n = 8, 22%), and back (n = 7, 19%), followed by head/neck(n = 4, 11%), 'other' (n = 3, 8%), chest/trunk (n = 2, 6%), arm/shoulder/(n = 2, 6%), hand/wrist (n = 1, 3%),and foot (n = 1, 3%). The only body part not reported as being injured by farmers on cardiac medication was the eyes.

Alpha blockers

Alpha blockers are a type (sub-class) of cardiac medication. Six injuries were reported by farmers who reported they were taking an alpha blocker. The most common reported types of injury for these farmers were sprain/strain (n = 2, 33%) and cuts (n = 2, 33%), followed by bruises (n = 1, 17%), and 'other' (n = 1, 17%). No farmers on alpha blockers reported a burn, crush, fracture, puncture, or NA as type of injury.

The main reported sources of injury for farmers who were taking alpha blocker included human error (n = 2, 33%), and NA (n = 2, 33%), followed by other machinery (n = 1, 17%), and 'other' (n = 1, 17%). None of the farmers reported tractors, livestock, hand tools, pesticide/chemical, plant/tree, working surface, truck/auto, or other vehicle as a source of their injury.

The most common identified body parts injured by a farmer on alpha blockers included back (n = 2, 33%), fingers (n = 2, 33%), followed by arm/shoulder (n = 1, 17%), and 'other' (n = 1, 17%). None of the farmers reported any of the following body parts as being injured: head/neck, eyes, chest/trunk, hand/wrist, leg/knee/hip, or foot.

Beta blockers

Beta blockers are a type (sub-class) of cardiac medication. Sixteen injuries were reported by farmers who stated they were taking a beta blocker. The most common type of injury reported by these farmers was sprain/strain (n = 6, 38%), followed by bruises (n = 3, 19%), cuts (n = 3, 19%), and 'other' (n = 3, 19%). The least common type of injury was a crush injury (n = 1, 6%). No farmer reported a burn, fracture, puncture, or NA as type of injury.

The main reported sources of injury for farmers who reported taking beta blocker included human error (n = 4, 25%), livestock (n = 4, 25%), and 'other' (n = 3, 19%), followed by working surface (n = 2, 13%), tractor (n = 1, 6%), other machinery (n = 1, 6%), and 'NA' (n = 1, 17%). None of the farmers reported hand tools, pesticide/chemical, plant/tree, truck/auto, or other vehicle as a source of their injury.

By far the most common reported body part injured by a farmer on beta blockers included leg/knee/hip (n = 7, 44%). The fingers (n = 3, 19%), back (n = 2, 13%), 'other' (n = 2, 13%), chest/trunk (n = 1, 6%), and foot (n = 1, 6%) were also body parts that were injured by farmers on beta blockers. None of the farmers reported any of the following body parts as being injured: head/neck, eyes, arm/shoulder, or hand/wrist.

ACE inhibitors

ACE inhibitors are another type (sub-class) of cardiac medication. Ten injuries were reported by farmers who stated they were taking an ACE inhibitor. The most common reported type of injury for these farmers was cuts (n = 4, 40%), followed by 'other' (n = 3, 30%), and sprain/strain (n = 2, 20%). The least common type of injury was a bruise (n = 1, 10%). No farmer reported a burn, crush, fracture, puncture, or NA as type of injury.

The main sources of injury for farmers who reported ACE inhibitors included 'other' (n = 3, 30%), and 'NA' (n = 3, 30%), followed by other machinery (n = 2, 20%), and human error (n = 2, 20%). None of the farmers reported tractors, livestock, hand tools, pesticide/chemical, plant/tree, working surface, truck/auto, or other vehicle as a source of their injury.

The most common reported body part injured by a farmer on ACE inhibitors included back (n = 3, 30%). The fingers (n = 2, 20%), head/neck (n = 2, 20%), arm/shoulder (n = 1, 10%), leg/knee/hip (n = 1, 10%), and 'other' (n = 1, 10%) were also body parts that were injured by farmers on beta blockers. None of the farmers reported any of the following body parts as being injured: eyes, chest/trunk, hand/wrist, or foot.

BP medications

BP medications are another type (sub-class) of cardiac medication. Thirty-one injuries were reported by farmers who stated they were taking a BP medication. The most common reported type of injury for these farmers was sprain/strain (n = 9, 30%), followed by bruise (n = 8, 27%), cuts (n = 6, 20%) and 'other' (n = 6, 20%). The least common type of injury was a crush (n = 1, 3%). No farmer reported a burn, fracture, puncture, or NA as type of injury.

The main sources of injury for farmers who reported BP medications included human error (n = 8, 27%), followed by other machinery (n = 5, 17%), 'other' (n = 5, 17%), livestock (n = 4, 13%), 'NA' (n = 4, 13%). The least common reported sources of injury included tractor (n = 2, 7%) and working surface (n = 2, 7%). None of the farmers reported hand tools, pesticide/chemical, plant/tree, truck/auto, or other vehicle as a source of their injury.

The most common identified body part injured by a farmer on BP medications included leg/knee/hip (n = 8, 27%), followed by the back (n = 5, 17%), fingers (n = 5, 17%), and head/neck (n = 4, 13%). The 'other' body part (n = 3, 10%), arm/shoulders (n = 2, 7%), chest/trunk (n = 1, 3%), hand/wrist (n = 1, 3%), and foot (n = 1, 3%) were also body parts that were reported by farmers on BP medications. The only body part not reported as being injured by farmers on a BP medication was the eyes.

CNS agents

There were 41 injuries reported by farmers on a CNS medication. The most common reported type of injury for these farmers were sprain/strain (n = 10, 28%), followed by cuts (n = 8, 22%), 'other' (n = 8, 22%), bruise (n = 3, 8%), crush (n = 3, 8%), and fracture (n = 3, 8%). The least common type of injury was a puncture (n = 1, 3%). No farmers on CNS medications reported a burn or 'NA' as a type of injury.

The main reported sources of injury for farmers who reported taking CNS medications included other machinery (n = 7, 19%) and 'other' (n = 7, 19%), followed by working surface (n = 5, 14%), human error (n = 5, 14%), livestock (n = 4, 11%), hand tools (n = 4, 11%) and NA' (n = 2, 6%). The least common source reported was 'tractors (n = 1, 3%) and truck/auto (n = 1, %). None of the farmers taking CNS medications reported pesticide/chemical, plant/tree, or other vehicle.

The most common identified body part injured by a farmer on a CNS medication included leg/knee/hip (n = 11, 31%), followed by fingers (n = 9, 25%), head/neck (n = 6, 17%), back (n = 3, 8%), arm/shoulder (n = 2, 6%), and 'other' (n = 2, 6%). The least common body part injured was chest/trunk (n = 1, 3%). None of the farmers on CNS agents reported any of the following body parts as being injured: eyes or foot.

Pain medications

Pain medications are another type (sub-class) of CNS medication. Thirty-three injuries were reported by farmers who stated they were taking a pain medication. The most common reported type of injury for these farmers was sprain/strain (n = 9, 32%), followed by 'other' (n =7, 25%), cuts (n = 6, 21%), bruise (n = 3, 11%), and crush (n = 3, 11%). No farmer reported a burn, fracture, puncture, or NA as type of injury.

The main reported sources of injury for farmers who reported pain medications included 'other' (n = 6, 21%), followed by other machinery (n = 5, 18%), livestock (n = 4, 14%), human error (n = 4, 14%), working surface (n = 3, 11%), and hand tool (n = 2, 7%). The least common sources of injury included tractors (n = 1, 4%) and truck/auto (n = 1, 4%). None of the farmers reported pesticide/chemical, plant/tree, or other vehicle as a source of their injury.

The most common identified body part injured by a farmer on pain medications included leg/knee/hip (n = 10, 36%), followed by fingers (n = 8, 29%), and head/neck (n = 3, 11%). The back (n = 2, 7%), 'other' (n = 2, 7%), and hand/wrist (n = 1, 4%) were also body parts that were injured by farmers on pain medications. None of the farmers on pain medications reported any of the following body parts as being injured: eyes, chest/trunk, or foot.

Antidepressants

Antidepressants are another type (sub-class) of CNS medication. Only one of the farmers who reported an injury also reported taking an antidepressant. The injury reported was a cut to the leg/knee/hip; the source was a working surface.

GI drugs

There were eight injuries reported by farmers on a GI medication. The most common reported type of injury for these farmers were bruises (n = 3, 38%), followed by sprain/strain (n = 2, 25%), 'other' (n = 2, 25%). The least common type of injury was a burn (n = 1, 13%). No farmers on GI medications reported a cut, crush, fracture, puncture, or 'NA' as a type of injury.

The main reported sources of injury for farmers who reported taking GI medications included livestock (n = 2, 25%), human error (n = 2, 25%), and 'other' (n = 2, 25%). The least common reported source was plant/tree (n = 1, 13%) and 'NA' (n = 1, 13). None of the farmers taking GI medications reported tractor, other machinery, hand tools, pesticide/chemical, working surface, truck/auto, or other vehicle.

The most reported common body part injured by a farmer on a CNS medication included leg/knee/hip (n = 11, 31%), followed by fingers (n = 9, 25%), head/neck (n = 6, 17%), back (n = 3, 8%), arm/shoulder (n = 2, 6%), and 'other' (n = 2, 6%). The least common body part injured was chest/trunk (n = 1, 3%). None of the farmers on GI medications reported any of the following body parts as being injured: eyes or foot.

Hormones

There were eight injuries reported by farmers taking hormones. The most common reported type of injury for these farmers were bruises (n = 4, 57%). Other common types of injuries were fractures (n = 1, 14%), sprain/strain (n = 1, 14%), and 'other' (n = 1, 14%). None of the farmers on hormones reported a burn, cut, crush, puncture, or 'NA' as a type of injury.

The main reported sources of injury for farmers who reported taking hormones was human error (n = 2, 25%). Other common sources included tractors (n = 1, 14%), other machinery (n = 1, 14%), livestock (n = 1, 14%), and 'NA' (n = 1, 14%). None of the farmers taking hormones reported hand tools, pesticide/chemical, plant/tree, working surface, truck/auto, other vehicle, or 'other'.

The most reported common body part injured by a farmer on a hormones was the hand/wrist (n = 2, 29%), head/neck (n = 1, 14%), back (n = 1, 4%), leg/knee/hip (n = 1, 14%), and 'other' (n = 1, 14%). None of the farmers on hormones reported any of the following body parts as being injured: eyes, chest/trunk, arm/shoulder, or finger.

Vitamins

There were nine injuries reported by farmers taking vitamins. The most common reported type of injury for these farmers was cuts (n = 3, 33%). Other common types of injuries included fractures (n = 2, 22%), bruise (n = 1, 11%), crush (n = 1, 11%), and puncture (n = 1, 11%). None farmers on vitamins reported a burn, sprain/strain, 'other', or 'NA' as a type of injury.

The main reported sources of injury for farmers who reported taking vitamins were hand tools (n = 3, 33%) and human error (n = 3, 33%). Other common sources included 'other' (n = 2, 22%), and working surface (n = 1, 11%). None of the farmers taking vitamins reported tractors, other machinery, livestock, pesticide/chemical, plant/tree, truck/auto, other vehicle, or 'NA'.

The most common reported body part injured by a farmer on a vitamin was the head/neck (n = 4, 44%), followed by the finger (n = 3, 33%), and hand/wrist (n = 2, 22%). None of the farmers taking vitamins reported any of the following body parts as being injured: eyes, chest/trunk, back, arm/shoulder, leg/knee/hip, foot, or 'other'.

Medication Use and Risk for Agricultural Injury

Question 12: What is the relationship between taking medication and nonfatal agricultural injury?

In the parent study, the researchers found that group affiliation or status (control vs. intervention) had no significant effect on the outcome of injury, to insure that it has no effect on the outcome analyzed in this study, it was included in all models. Thus, the candidate pool of variables used in the model selection process included the following thirty-one variables: date of birth; education; livestock; hours of work on farm per week; farm acres; exposure to dust, noise, chemicals and heavy lifting; depression; currently taking medications, antihistamine drugs, anti-infective agents, autonomic drugs, blood formation & coagulation, cardiac drugs, central nervous system (CNS) agents, gastrointestinal (GI) drugs, hormones, vitamins, alpha blockers, beta blockers, ACE inhibitors, pain medications, and blood pressure (BP) medications; number of medications taken per quarter: all medications, CNS medications, cardiac mediations; general health; stress and CSF status.

Bivariate risk analysis for nonfatal agricultural injury

Bivariate regression analyses were completed to calculate the effect each factor individually had on agricultural injury (Table 27). The individual risk factors analyzed include: date of birth; education; livestock; hours of work on farm per week; farm acres; exposure to dust, noise, chemicals and heavy lifting; depression; currently taking medications, antihistamine drugs, anti-infective agents, autonomic drugs, blood formation & coagulation, cardiac drugs, central nervous system (CNS) agents, gastrointestinal (GI) drugs, hormones, vitamins, alpha blockers, beta blockers, ACE inhibitors, pain medications, and blood pressure (BP) medications; general health; stress and CSF status.

Table 27: Bivariate risk analysis for nonfatal agricultural injury

Variables	**N (missing)**	**Unadjusted OR (95% CI)**	**P value**
DOB			
1919-1929	2505	1.17 (0.60-2.28)	
1930-1939	(20)	0.97 (0.54-1.74)	
1940-1949		0.92 (0.54-1.58)	
1950-1959		1.29 (0.83-2.02)	
1960-1973 (ref)		--	
Age category			
Older (≥ 55)	2505	0.82 (0.58-1.17)	0.2747
Younger (>55) (ref)	(20)	--	--
Education			
High school	2363	1.13 (0.76-1.69)	0.7544
Bachelor’s degree	(162	1.07 (0.68-1.69)	0.5359
Some college (ref)		--	--
Farm acres (farm cat)			
Large (<640 acres)	2517	1.24 (0.67-2.32)	0.4931
Medium (161-639 acres)	(8)	1.17 (0.63-2.19)	0.6253
T □117□>161 acres) (ref)		--	--
Livestock			
Yes	2459	**1.52 (1.09-2.11)**	**0.0141**
No(ref)	(66)	--	--
Hours week			
0-9.9 (ref)	2504	--	--
10-19.9	(21)	0.94 (0.40-2.20)	0.8833
20-29.9		1.05 (0.45-2.44)	0.9149
30-39.9		1.03 (0.44-2.42)	0.9439
40-49.9		1.08 (0.48-2.45)	0.8488
50+		1.43 (0.67-3.05)	0.3531
Exposure- dust			
Yes	2517	**1.45 (1.05-2.01)**	**0.0243**
No	(8)	--	--
Exposure- noise			
Yes	2517	**1.62 (1.19-2.20)**	**0.0021**
No(reference)	(8)	--	--

Table 27 continued

Variables	**N (missing)**	**Unadjusted OR (95% CI)**	**P value**
Exposure- chemicals or pesticides			
Yes	2517	**1.84 (1.41-2.40)**	**<0.0001**
No(reference)	(8)	--	--
Exposure- heavy lifting			
Yes	2513	**1.92 (1.34-2.75)**	**0.0004**
No(reference)	(12)	--	--
Alcohol			
3 or more/week	2458	**0.62 (0.41-0.96)**	**0.0316**
2 or less/week	(67)	0.90 (0.62-1.79)	0.5831
None (reference)		--	--
General health			
Excellent (reference)	2458	--	
Very good	(67)	0.75 (0.50-1.14)	0.1755
Good		0.95 (0.63-1.43)	0.8049
Fair/poor		**2.05 (1.03-4.09)**	**0.0413**
Stress			
Low (reference)	2511	--	
Med	(14)	1.21 (0.79-1.86)	0.3900
High		0.88 (0.61-1.28)	0.5022
Depression			
Low (reference)	2517	--	
Med	(8)	1.12 (0.55-2.30)	0.7600
High		0.81 (0.61-1.06)	0.1227
CSF status			
Control (reference)	2525		
Intervention	(0)		
Taking any medication			
Yes	2379	1.25 (0.90-1.72)	0.1819
No(reference)	(146)	--	--
Antihistamine drugs			
Yes	2379	1.97 (0.61-6.38)	0.2558
No(reference)	(146)	--	--

Table 27 continued

Variables	N (missing)	Unadjusted OR (95% CI)	P value
Anti-infective agents			
Yes	2378	0.73 (0.30-1.79)	0.4951
No(reference)	(147)	--	--
Autonomic drugs			
Yes	2379	*	*
No	(146)		
Blood Formation and coagulation			
Yes	2379	0.72 (0.39-1.34)	0.2990
No(reference)	(146)	--	--
Cardiac drugs			
Yes	2379	1.02 (0.67-1.54)	0.9346
No(reference)	(146)	--	--
Alpha blockers			
Yes	2375	1.04 (0.56-1.92)	0.8971
No(reference)	(150)	--	--
Beta blockers			
Yes	2379	1.44 (0.83-2.50)	0.1989
No(reference)	(146)	--	--
ACE			
Yes	2379	1.51 (0.78-2.93)	0.2192
No(reference)	(146)	--	--
BP medications			
Yes	2379	1.14 (0.73-1.79)	0.5573
No(reference)	(146)	--	--
CNS agents			
Yes	2379	1.21 (0.79-1.84)	0.3957
No(reference)	(146)	--	--
Pain medications			
Yes	2378	1.21 (0.74-1.98)	0.4405
No(reference)	(147)	--	--
Antidepressants			
Yes	2378	0.38 (0.05-2.91)	0.3503
No(reference)	(147)	--	--

Table 27 continued

Variables	N (missing)	Unadjusted OR (95% CI)	P value
GI drugs			
Yes	2379	1.27 (0.50-3.26)	0.6134
No(reference)	(146)	--	--
Hormones			
Yes	2379	0.68 (0.36-1.28)	0.2292
No(reference)	(146)	--	--
Vitamins			
Yes	2379	1.23 (0.42-3.63)	0.7078
No(reference)	(146)	--	--

Notes: Odds Ratios (ORs) and p values determined by logistic regression using GEE; statistically significant factors are shown in **bold** type.

The bivariate analysis found several factors to be associated with nonfatal agricultural injury. Agent factors such as having livestock (OR: 1.52; 95% CI: 1.09-2.11), exposure to dust (OR: 1.45; 95% CI: 1.05-2.01), noise (OR: 1.62; 95% CI: 1.19-2.20), chemicals (OR: 1.84; 95% CI: 1.41-2.40), and heavy lifting (OR: 1.92; 95% CI: 1.34-2.75). Host risk factors that were significantly associated with injury included a self-report of poor health (OR: 2.05; 95% CI: 1.03-4.09). Host risk factors that were significantly protective included drinking three or more alcoholic beverages a week (OR: 1.52; 95% CI: 1.09-2.11). No medication variables were found to be associated with agricultural injury in bivariate analysis.

As other factors were not accounted for in the bivariate models, confounding is an issue and these results were only completed to explore individual relationships between the factors and injury. Bivariate analysis can be useful in the process of model building as a way to explore what factors will be useful in the final multiple regression model. It is only the first step of the process and was followed by the stepwise variable removal, starting with the variable with highest p-value from the model and continued this process until the largest p-value for the remaining variables was below a chosen threshold of p=0.10.

Multiple logistic regression

In the parent study, the researchers found that group affiliation or status (control vs. intervention) had no significant effect on the outcome of injury, to insure that it has no effect on the outcome analyzed in this study, it was included in all models. Thus, the candidate pool of variables used in the model selection process included the following thirty-one variables: date of birth; education; livestock; hours of work on farm per week; farm acres; exposure to dust, noise, chemicals and heavy lifting; depression; currently taking: medications, antihistamine drugs, anti-infective agents, autonomic drugs, blood formation & coagulation, cardiac drugs, central nervous system (CNS) agents, gastrointestinal (GI) drugs, hormones, vitamins, alpha blockers, beta blockers, ACE inhibitors, pain medications, and blood pressure (BP) medications general health; stress and CSF status.

Model building

To identify the best predictive model for the association between medication use and agricultural injury, a model selection procedure based on multiple logistic regression analysis was employed. Generalized estimating equations (GEE) were used for model fitting. SAS was used to determine ORs and confidence intervals (CIs) based on the GEE analysis. An initial model was fit using the full list of variables in the aforementioned candidate pool. Next was the process of variable removal, starting with the variable with highest p-value from the model and continued this process until the largest p-value for the remaining variables was below a chosen threshold of p=0.10. The candidate pool variable terms were initially entered into the model as "additive", no interactions were considered due to the large number of variables in the candidate pool. Once the final list of retained "additive" variables was determined, some interactions with medication use and health status were also explored.

Logistic regression using GEE was utilized to model the binary response variable of injury (yes/no). Due to the repeated measures collected over time (quarterly) on individual farmers, a first-order autoregressive correlation structure was used to model the dependence between observations within a farmer. The model was fitted using PROC GENMOD in SAS, and the general form of the coding for the model is shown below:

```
PROC GENMOD data=farmers;
class FARMID quarter <all other class variables>;
model INJURY= <all model variables> / dist= binomial link= logit
offset=Months;
repeated subject=FARMID /within=quarter type=ar(1);
run;
```

The items in the *repeated* statement line declare the dependence structure. The *offset* (Months) option was used to account for the varying exposure between quarterly phone calls to the farmers. When the repeated statement is utilized in PROC GENMOD, this invokes an estimation procedure with generalized estimating equations (GEEs), and essentially relates to how the correlation structure is estimated. Backward model selection was performed (using p-value criterion with a removal threshold of p=0.10 for retainment). Appendix H, Table H1 presents the model selection process and when the variables were removed from the model.

Final model

Table 28 presents the results of the backward model section and the resulting final model variables. The final model included the subsequent variables: farm exposure variables- loud noise, chemical/pesticide use, heavy lifting and raising livestock; health variables: general health and depression; and finally medication variables- taking any medication, ACE inhibitors, beta blockers, cardiac medications category, blood formation/coagulation medications, and hormones. Using the terms in the final model, interactions between general health and all medication variables, as well as between general health and the variable currently taking meds were investigated. These interactions will be discussed next.

Table 28: Analysis results for final model

Variables	DF	Chi-Square	P-value
Exposure to loud noise	1	4.25	0.0393
Exposure to chemicals and pesticides	1	13.95	0.0002
Exposure to lifting	1	5.84	0.0157
Livestock	1	5.41	0.0201
Taking medication	1	4.22	0.0400
ACE inhibitors	1	3.52	0.0607
Beta Blockers	1	3.61	0.0575
Blood formation & coagulation	1	4.93.	0.0264
Hormones	1	5.29	0.0214
Cardiac medication category	2	5.67	0.0586
Depression	1	4.66	0.0974
General health status	3	8.67	0.0340

Note: Final model chosen using p-value criterion for backward step-wise removal and a threshold of p = 0.10

<u>*Interactions*</u>

To address the issue of confounding by indication and drug-disease interactions, we used terms from the above noted final model and investigated numerous interactions between *general health* (excellent, very good, good, fair/poor) and specific medication variables (each medication class) as well as the variable *taking medication* (yes/no).

Some of the interactions were not estimable (not enough data to estimate) and many others were not significant. The one interaction term that was estimable and significant at the p=0.10 level was between *general health* and *taking medication*.

To investigate the interaction between taking medication and general health, the LSMeans option in SAS was used and provided information on the 'adjusted probability' for each of the eight possible groups. For example, consider a farmer in poor health (general health=4) and on medication (taking meds=1), the LSMean for such a farmer provides information on the probability of an injury 'averaging over all other variables in the model'. So, the probability coincides with the 'average farmer in poor health and on medication'. This interpretation is useful as these farmers could have any number of farm acres, exposures, or be of any age. Table 29 presents the LSMeans or 'adjusted means' for the eight possible groups.

Table 29: LSMeans or adjusted means

Taking medication	**General Health**			
	1-Excellent	***2-Very Good***	***3-Good***	***4-Fair/Poor***
1-Yes	-5.46	-5.93	-5.87	-5.20
2-No	-6.45	-6.54	-5.96	-4.82

In logistic regression, these LSMeans or adjusted means are not immediately easily interpretable; therefore they were converted into adjusted probabilities. The ilink option in the SAS LSMeans statement in PROC GENMOD was used to convert the LSMeans to 'adjusted probabilities' and then, pairwise comparisons for the 8 groups were completed (Table 30).

Table 30: Pairwise comparisons; adjusted probabilities

Taking medication	**General Health**			
	1-Excellent	***2-Very Good***	***3-Good***	***4-Fair/Poor***
1-Yes	0.004247	0.002639	0.002792	0.005466
2-No	**0.001574**	**0.001434**	0.002560	**0.008037**

Table 30 presents the adjusted probabilities, which are just estimates and do not denote any statistical differences between groups. Out of these 8 groups, a farmer in poor health and not on medications has the highest estimated probability of having an injury, while a farmer in excellent or very good health not on medications has the lowest estimated probabilities of having an injury. Also, a farmer in excellent health taking medication and a farmer in poor health on medication have similar probabilities of having an injury.

To explore which of the eight groups were significantly different from each other; pairwise comparisons for these eight groups were completed. The following SAS statement was used for this:

```
lsmeans gen_health*TakingMeds/pdiff adjust=tukey;
```

From this SAS statement we get the following significant comparisons that are presented in Table 31. The level for significance was set at the $p = 0.10$ level after adjusting for multiple comparisons.

Table 31: Significant comparisons

Comparison Groups	P-Value
Taking meds /excellent health vs. Not taking meds/excellent health	0.0612
Taking meds/excellent health vs. Not taking meds/Very good health	0.0157
Not taking meds/Excellent health vs. Taking Meds/Poor health	0.0010
Not taking meds/Very good health vs. Taking meds/poor health	<0.001
Not taking meds/excellent vs. Not taking meds/poor health	0.0020
Not taking meds/very good health vs. Not taking meds/poor health	0.0004
Not taking meds/good health vs. Not taking meds/poor health	0.0914

Each of the above statistically significant comparisons will be discussed in context of their adjusted probabilities from Table 30. The first comparison, taking meds/excellent health (adjusted probability=0.004247) vs. no meds/excellent health (adjusted probability=0.001574), it is noted that the former (taking meds/excellent health) has a larger probability of injury. The next comparison of taking meds/excellent health (adjusted probability=0.004247) vs. no meds/very good health (adjusted probability=0.001434) can be interpreted similarly, farmers taking meds with very good health have higher probability of having an injury.

The third comparison of not taking meds/excellent health (adjusted probability=0.001574) vs. taking meds/poor health (adjusted probability=0.005466), it is noted that a farmer in poor health not taking medication has a higher probability of injury than a farmer in excellent health not on medication. The fourth comparison of not taking meds/very good health (adjusted probability=0.001434) vs. taking meds/poor health (adjusted probability=0.005466), it is noted that a farmer in poor health taking medication has a higher probability of injury than a farmer in very good health not on medication. The fifth comparison of not taking meds/excellent health (adjusted probability=0.001574) vs. not taking meds/poor health (adjusted probability=0.008037), it is noted that a farmer in poor health not taking medication has a higher probability of injury than a farmer in excellent health not on medication.

The next comparison of not taking meds/ good health (adjusted probability=0.002560) vs. not taking meds/poor health (adjusted probability=0.008037), it is noted that a farmer in poor health not taking medication has a higher probability of injury than a farmer in very good health not on medication. The final comparison of not taking meds/very good health (adjusted probability=0.001434) vs. not taking meds/poor health (adjusted probability=0.008037), it is noted that a farmer in poor health not taking medication has a higher probability of injury than a farmer in good health not on medication.

Thirty-one variables were included in the initial logistic regression model and backward step-wise elimination was used to determine the most parsimonious final model. Upon selection of the final model, adjusted odds ratios were estimated using GEE in SAS for the independent variables present in the final model.

The odds ratios (ORs) for this multiple logistic regression analysis should be interpreted as 'after conditioning upon all other variables'. Therefore, for any class variable, SAS defines one of the groups as a reference or control group to which all other groups automatically gets compared. For example, looking at 'loud noise', the reference group is 'loud noise'=no, or not exposed to 'loud noise' and it is compared to 'loud noise'=yes, or exposed to loud noise. The OR for the exposure to loud noise 'yes' group is 1.39. This can be interpreted as the odds of having an injury for a farmer exposed to loud noise after conditioning upon all other variables is 1.39 times higher than the odds of having an injury for a farmer not exposed to loud noise. Table 32 presents the final model results including the odds ratios and 95% confidence intervals for each variable in the final model.

Table 32: Multivariate logistic regression analysis for nonfatal agricultural injury risk factors

Variables	**†OR(95%CI)**
EXPOSURE VARIABLES:	
LOUD NOISE	
Yes	**1.39 (1.02-1.90)**
No	reference
CHEMICAL/PESTICIDE USE	
Yes	**1.88 (1.39-2.55)**
No	reference
HEAVY LIFTING	
Yes	**1.55 (1.06-2.28)**
No	reference
RAISING LIVESTOCK	
Yes	**1.49 (1.08-2.06)**
No	reference
MEDICATION VARIABLES	
BLOOD FORMATION & COAGULATION	
Yes	**0.50 (0.28-0.93)**
No	reference
HORMONES	
Yes	0.47 (0.20-1.08)
No	reference
BETA BLOCKERS	
Yes	**2.30 (1.07-4.97)**
No	reference
ACE INHIBITORS	
Yes	**2.72 (1.15-6.46)**
No	reference
Number of CARDIAC MEDS:	
More than one	**0.35 (0.13-0.94)**
One	0.78 (0.35-1.70)
None	reference

Table 32 continued

Variables	**†OR(95%CI)**
HEALTH VARIABLES	
DEPRESSION:	
High	0.77 (0.34-1.72)
Medium	**0.71 (0.53-0.95)**
Low	reference
CURRENTLY TAKING MEDICATION* HEALTH STATUS:	
Taking meds/excellent health vs. not taking meds/excellent health	**2.71(1.40-5.23)**
Taking meds/excellent health vs. not taking meds/very good health	**2.97 (1.58-5.57)**
Not taking meds/excellent health vs. taking Meds/poor health	**0.29 (0.16-0.52)**
Not taking meds/very good health vs. taking meds/poor health	**0.26 (0.15-0.46)**
Not taking meds/excellent vs. not taking meds/poor health	**0.19 (0.09-0.44)**
Not taking meds/very good health vs. not taking meds/poor health	**0.18 (0.08-0.39)**
Not taking meds/good health vs. not taking meds/poor health	**0.32 (0.14-0.71)**

Notes:†Odds Ratios (ORs) determined by logistic regression using GEE;

ORs are adjusted for all factors listed in this table using the full model; statistically significant factors are shown in **bold** type.

N=2273, missing=252 (responses to quarterly calls)

Agricultural work exposures associated with injury included noise (OR 1.39, 95% CI: 1.02-1.90), chemical/pesticide use (OR 1.88, 95% CI: 1.39-2.55), heavy lifting (1.55, 95% CI: 1.06-2.28) and raising livestock (OR 1.49, 95% CI: 1.08-2.06).

Medication classes significantly associated with an increased risk for agricultural injury included taking two different types of heart medications: beta blockers (OR 2.30, 95% CI: 1.07-4.97) and ACE inhibitors (OR 2.72, 95% CI: 1.15-6.46). Hormones were not found to be significantly associated with nonfatal agricultural injury (OR 0.47, 95%

CI: 0.20-1.08). Taking a blood formation/coagulation medication was found to be protective (OR 0.50, 95% CI: 0.28-0.93).

When exploring the issue of polypharmacy, we not only looked at interactions between all medications classes and how many medications were taken per quarter, but more specifically the number of CNS and cardiac medications taken per quarter. No medication interactions were found to be significant. Number of cardiac medications taken per quarter, was found to be statistically significant. The odds of nonfatal agricultural injury were significantly lower with the use of more than one cardiac medication (OR: 0.35; 95% CI: 0.13-.0.94) compared to a farmer taking no cardiac medications.

Finally, health conditions related to agricultural injury included depression and several interaction terms between taking medication and health status. Farmers reporting a medium level of depression were found to be less at risk for injury than farmers reporting a low level of depression (OR 0.71, 95% CI: 0.53-0.95). Farmers in excellent health and taking medication had 2.71 times the odds of an injury as farmers in excellent health that were not taking medications (OR: 2.71; 95% CI: 1.40-5.23). Also, farmers in very good health and taking medication had 2.97 times the odds of an injury as farmers in very good health that were not taking medications (OR: 2.97; 95% CI: 1.58-5.57). Farmers in excellent health not taking meds had less odds of injury compared to farmers in poor health taking medication (OR: 0.29; 95% CI: 0.16-0.52). Farmers in very good health not taking meds had less odds of injury compared to farmers in poor health taking medication (OR: 0.26; 95% CI: 0.15-0.46). Farmers in excellent health not taking meds had less odds of injury compared to farmers in poor health not taking medication (OR: 0.19; 95% CI: 0.09-0.44). Farmer in very good health not taking meds had less odds of injury compared to farmers in poor health taking medication (OR: 0.18; 95% CI: 0.08-0.39). Finally, farmers in good health not taking meds had less odds of injury compared to farmers in poor health taking medication (OR: 0.32; 95% CI: 0.14-0.71).

Summary

A total of 316 famers were included in the analysis. There were 103 older farmers (55 and older) and 210 younger farmers (54 and younger). A total of 318 nonfatal injuries were reported. Fifty of the older farmers reported a total of 95 injuries. One hundred and eighteen of the younger farmers reported a total of 223 injuries. The older farmer injury rate was 38.35 injuries/100 person- years, while younger farmer injury rate was 44.01 injuries/100 person-years. There were no statistically significant differences in older and younger farmers' reported experience of agricultural injury.

The majority (56%) of farmers did not take any medication during the study, while (44%) of farmers were reported being on at least one medication at some point in the study. The number of medications taken per quarter ranged from 0-6 (M = 0.52, SD = 1.03). The most common medication classes that farmers reported taking include: central nervous system (CNS) agents, cardiac agents, and blood formation and coagulation medication. The most common subclasses reported include: pain and blood pressure (BP) medications. Older farmers reported taking more medications than the younger farmers including more CNS and cardiac medications.

The multivariate logistic regression analysis found the following factors to be associated with nonfatal agricultural injury: Agricultural work exposures associated with injury included noise, chemical/pesticide use, heavy lifting and raising livestock. Medication classes significantly associated with an increased risk for agricultural injury included taking two different types of heart medications: beta blockers and ACE inhibitors. Medication variables that were found to be protective included taking blood formation/coagulation medications and the number of cardiac medications taken. The odds of nonfatal agricultural injury were significantly lower with the use of more than one cardiac medication versus the use of no cardiac medications. No interactions between medication classes were found to be significant.

Health conditions related to agricultural injury included depression and several interaction terms between taking medication and health status. Farmers reporting a medium level of depression were found to be less at risk for injury than farmers reporting a low level of depression. There is a trend that farmers in excellent/very good/good health have lower odds of injury if they are not taking medication versus if they did take medication. Another trend noted is that farmers with poor health have decreased odds of injury if they are taking medication versus if they did not take medication.

These results support the proposed conceptual framework in that the host factors of medication use and general health status, and the vectors of exposure to noise, chemical/pesticide use, heavy lifting and raising livestock directly affected the risk for nonfatal agricultural injury.

CHAPTER 5

DISCUSSION AND IMPLICATIONS

This final chapter provides an overview and discussion of the study. Interpretation of the study findings regarding age, medication use, and agricultural injury are discussed in light of current literature. The strengths and limitations of the study are addressed, as well as implications of the study findings on nursing practice, education, and policy. Finally, recommendations for future research are provided.

Study Overview

This descriptive and analytic study used a secondary data set to describe and compare medication use and agricultural injury experiences between younger ($\leq$54 years old) and older ($\geq$55 years old) farmers; and to examine the relationship between the use of specific classes of medication and reported agricultural injury. Theoretical underpinnings of Haddon's Matrix (Christoffel & Gallagher, 2006; Haddon et al., 1964; Haddon, 1968; Haddon, 1980; Runyan, 2003) and the causal model for injury discussed by Peek-Asa and Zwerling (Peek-Asa & Zwerling, 2003) were used to create a conceptual model for medication use and agricultural injury. This model was used to conceptualize the relationship between the use of medication and agricultural injury. The conceptual model successfully guided the research and was supported by the findings. The study findings support the proposed conceptual framework in that the host factors of medication use and general health status as well as vectors such as exposure to noise, chemical/pesticide use, heavy lifting and raising livestock directly affected the risk for nonfatal agricultural injury.

The study included a total of 316 farmers age 26 to 80 years old who participated in the original study; there were 103 (33% of total) older farmers (age 55 and older), and 210 (66% of total) younger farmers (age 54 and younger). The mean age of the whole cohort of farmers was 50 years old (SD = 11.4); median age was 48 years old. This cohort of farmers sustained a total of 318 nonfatal agricultural injuries; 168 farmers reported being injured at least once during the study. Descriptive analysis of demographic data was completed to depict the characteristics of the farmers, which were found to be similar to those of Iowa farmers in general. To match with the study time period comparisons were made with Iowa and U.S. census statistics for the year 2002. In 2002, the average age of all Iowa farmers was 52.3 years old, while the national mean age in the U.S. was 55.3 years old.

Descriptive statistics were also used to summarize and describe reported medication usage and agricultural injuries in regards to age (older/younger farmers). Older farmers were more likely to report taking a medication than the younger farmers; the odds of older farmers taking a medication are 3.08 times greater than the odds of younger farmers taking medication (OR: 3.08; 95% CI 1.94-4.92). There were several medication classes/subclasses in which older farmers had statistically significant greater odds of use than the younger farmers. These medications include alpha blockers (OR: 17.63; 95% CI: 3.47-89.59), hormones (OR: 8.54; 95% CI: 2.46-29.64), ACE inhibitors (OR: 4.43; 95% CI: 1.14-17.21), BP medications (OR: 4.18; 95% CI: 2.04-8.57), cardiac medications (OR 3.92; 95% CI: 2.06-7.47), beta blockers (OR: 3.40; 95% CI: 1.31-8.83), pain medications (OR: 2.51; 95% CI: 1.30-4.84), and finally CNS medications (OR: 2.30; 95% CI 1.25-4.22). Older farmers were also found to report taking more medication than younger farmers. On average older farmers took 0.94 medications per quarter, whereas younger farmers took 0.31 medications. Specifically, older farmers took more cardiac and CNS medications than the younger farmers. These findings are consistent with the current literature that older adults are the largest consumers of medications (Mitchell et al., 2006).

During the study, older and younger farmers had similar experiences with agricultural injury; no statistical difference was found in the mean number of injuries sustained by older and younger farmers; $t(311) = -0.85,\ p = 0.3936$. Furthermore, bivariate risk analysis of agricultural injury and age group revealed no statistical difference in injury in regards to age. The odds of older farmers having an agricultural injury were 0.82 times the odds of younger farmers; OR 0.82 (95%CI 0.58-1.1670); findings were not statistically significant. In regards to types, sources and body parts injured, no statistically significant difference was found between the older and younger farmers. These findings are consistent with the current literature that older and younger farmers are having similar experiences with nonfatal agricultural injury.

Bivariate regression analysis was conducted to measure each explanatory variable's relationship with the outcome variable of reported agricultural injury. This analysis facilitated the identification of important covariates for use in model building. Finally, multiple logistic regression analysis using GEE was used to examine the association between using specific classes of medication and agricultural injury taking into consideration a myriad of confounding factors.

Agricultural work exposures associated with injury included noise (OR: 1.39; 95% CI: 1.02-1.90), chemical/pesticide use (OR: 1.88; 95% CI: 1.39-2.55), heavy lifting (OR: 1.55; 95% CI: 1.06-2.28) and raising livestock (OR: 1.49; 95% CI: 1.08-2.06). Medication classes significantly associated with an increased risk for agricultural injury included taking two different types of heart medications: beta blockers (OR: 2.30; 95% CI: 1.07-4.97) and ACE inhibitors (OR: 2.72; 95% CI: 1.15-6.46). Hormones were not found to be significantly associated with nonfatal agricultural injury (OR: 0.47; 95% CI: 0.20-1.08). Farmers taking a blood formation/coagulation medication were found to have decreased odds of injury (OR: 0.50; 95% CI: 0.28-0.93).

When exploring the issue of polypharmacy, no medication interactions were found to be significant. Yet, the number of cardiac medications taken per quarter was found to be statistically significant. Use of more than one cardiac medication versus the use of none or one was statistically significant in regards to injury. The odds of nonfatal agricultural injury were lower with the use of more than one versus no cardiac medications (OR: 0.35; 95% CI: 0.13-.0.94).

Finally, health conditions related to agricultural injury included depression and several interaction terms between taking medication and health status. Farmers reporting a medium level of depression were found to be less at risk for injury than farmers reporting a low level of depression (OR 0.71, 95% CI: 0.53-0.95). Farmers in excellent health and taking medication had 2.71 times the odds of an injury as farmers in excellent health that were not taking medications (OR: 2.71; 95% CI: 1.40-5.23). Also, farmers in very good health and taking medication had 2.97 times the odds of an injury as farmers in very good health that were not taking medications (OR: 2.97; 95% CI: 1.58-5.57). Farmers in excellent health not taking meds had less odds of injury compared to farmers in poor health taking medication (OR: 0.29; 95% CI: 0.16-0.52). Farmers in very good health not taking meds had less odds of injury compared to farmers in poor health taking medication (OR: 0.26; 95% CI: 0.15-0.46). Farmers in excellent health not taking meds had less odds of injury compared to farmers in poor health not taking medication (OR: 0.19; 95% CI: 0.09-0.44). Farmer in very good health not taking meds had less odds of injury compared to farmers in poor health taking medication (OR: 0.18; 95% CI: 0.08-0.39). Finally, farmers in good health not taking meds had less odds of injury compared to farmers in poor health taking medication (OR: 0.32; 95% CI: 0.14-0.71).

Strengths of the Study

Agriculture is one of the most dangerous occupations in the U.S. The need to decrease injury rates has required agricultural safety and health professionals and health care professionals working with farmers to look beyond the usual risk factors and start considering host factors such as diseases and medication use as potential targets for injury prevention strategies. This study contributes to the limited knowledge base regarding medication use and agricultural injury.

The study contributes through the identification of classes and subclasses of medications that can increase the risk for agricultural injury through the use of the following: 1) longitudinal data, 2) an agricultural injury causal model based on the concepts of Haddon's Matrix, and finally 3) logistic regression to measure the relationships between usage of certain classes of medication and agricultural injury.

Limitations of the Study

Secondary Data Sets and Generalization of the Results

This research completed a secondary analysis of already existing data from the Certified Safe Farm study. The original CSF study was designed to evaluate the effectiveness of the CSF intervention and in doing so the authors chose a sampling frame that fit the purpose of their initial study. This included mailing out invitations to participate in the study to a very large number of farmers in a nine county area. This is a limitation as the study subject selection area only included nine of the 99 counties in Iowa. The authors completed a power calculation to achieve 0.80 (80%) power, alpha 0.05, sample size 125 (intervention) +125 (control), and an injury rate of 0.78 injuries per farm in 5 years. To achieve this power, the authors interviewed willing participants that received the invitation by mail until they reached the sample size of n=150 in the intervention group and n=150 in the control group. When looking at the numbers to establish response rate, we would have to conclude that out of the 5,287 farmers invited to participate, only 300 farmers became participants (response rate=6%, non-response rate= 94%). No information on non-respondents was available to examine whether they differed substantially from the farmers that did chose to respond. Therefore, the issue of non-response bias could not be addressed.

The sample size is also a limitation to the study. The small sample size may have limited the ability to obtain significant findings. A larger sample size would increase representativeness, decrease systematic bias, and decrease sampling error (Burns & Grove, 2005).

In designing clinical research, the level of non-response can compromise the external validity or generalizability of the study (Hulley, Cummings, Browner, Grady, Hearst, & Newman, 2001). Response bias may also be a limitation. The subjects that agreed to participate in the study may be different than those who refuse, and may prejudice the results of this study. Due to this type of selection bias, the results of this study are truly only generalizable to the respondents of the CSF study.

Methodological Limitations

Establishing Temporality

The greatest limitation to this study is the inability to establish without a doubt the temporal association between medication use and subsequent agricultural injury. The medication data was requested annually in the occupational health history and transformed to quarterly data to match the injury and exposure data that was received quarterly. To transform these data, the researcher had to look at the date the annual medication data were collected and match it to the closest quarter. Then that medication was added to each subsequent quarter until the date of the next annual occupational health history. At any time between these annual data collection times, the farmer could have quit taking the medication and started new medication(s). It is only at the annual checkpoints that it can be truly said that the farmer has reported taking the stated medications. This could lead to placing a medication as being taken in a specific quarter, when really it was not taken. This creates misclassification bias in classifying the farmers' exposures to certain classes of medications each quarter. This again may cause misclassification of medications per quarter and either under or over-estimate the association between certain classes of medication and agricultural injury affecting the internal validity of the study. There is also the issue that there is truly no proof that a farmer has indeed taken the medications that they reported taking. All of these data are based on self report.

Confounding by indication

Confounding is a very important issue when attempting to establish whether an exposure-outcome association in an observational study actually represents cause and effect (Koepsell, 2001). Confounding by indication is a term used to describe the confounding role of disease prognosis or severity and the medications used to treat the disease (Salas et al., 1999). Therefore, to avoid this confounding it is important to distinguish if a chronic disease puts the subject at risk for injury, if it is the medication they take for that disease, or if it is the combination of the disease and the medication. The best way to deal with confounding by indication is to explore the interactions between the disease and the medication taken for the disease. Unfortunately, on average there was approximately 30% of data missing for the chronic health variables. Due to these missing data, rather than dropping the subjects with missing data from the final data analysis, another variable- *general health status*, was used as a proxy for chronic disease in the logistic regression analysis to attempt to adjust for the confounding.

Measurement

Measurement issues are a concern for secondary data analysis. Measurement of medications for the original study included only four spaces for the farmers to report medications they were currently taking. This is a limitation as a farmer may have been taking more than the four medications but did not have adequate space on the data collection form to include additional medications. This measurement error or loss of data may have caused an underestimation of the association between medication use and agricultural injury (Pedhazur & Schmelkin, 1991).

Bias

The original CSF study was designed as an intervention study and looked at how the CSF program could decrease agricultural injury. It must be noted that farmers that chose to participate in this intervention study may in fact have safer farms and farm practices than those who choose not to participate introducing sampling bias. Farmers that do not consider their farms or farm practices to be safe, or may have been concerned about their farm being judged not safe may have opted out of this study creating a cohort of safer farms and farmers. If this was true, then the results would be biased toward fewer injuries and consequently decreasing the power of the association of medication use and agricultural injury. Yet, the CSF study had an overall injury rate of 42 per 100 person years which is significantly higher than the overall farming injury rate of 4.8 injuries per 100 workers/year noted by Myers et al (2009). Therefore, the aforementioned sampling bias may not have been an issue. The higher injury rate may be due to a greater willingness to report injuries due to the annual monetary compensation of $200 for intervention farmers and $75 per control farmers.

Misclassification Bias

Misclassification bias is an important source of bias in research. This bias occurs when there are errors in classifying either the outcome or the exposure status. Again, due to farmers not correctly remembering injuries or medication usage may introduce non-differential misclassification bias which results in a dilution of the study findings and biasing the results toward the null. Ultimately the above biases may inaccurately estimate the association between medication use and agricultural injury causing spurious conclusions.

Historical Bias

History or the age of the data is a potential threat to internal validity and needs to be addressed in this study (Myers & Hard, 1995). The data that were analyzed for this secondary data analysis were collected from 1999 through 2003. The time that has elapsed since the original data were collected creates a potential for historical bias. The historical context for this study has not drastically changed since the original data were collected; agricultural tasks/activities and medications have not changed significantly since the original data were collected. There have been the addition of new medications to the market, but many of the medications that were used when the original data were collected are still prescribed to treat many medical illnesses today. The potential threat to internal validity is there, but due to the historical context not significantly changing, the threat is considered to be minimal. Historical aspects of the data were considered when interpreting the results within the context of current issues.

Information and Recall Bias

There are several types of information bias that must be addressed in this study and may affect the internal validity of the study. Recall bias, when subjects may remember information regarding an outcome or exposure incorrectly or amplify their recollections. In this study, the reliability of the self-report of medication use and agricultural injury/illness introduces recall bias. There is a potential for a farmer to not recall an injury/illness or medication use correctly, or the farmer may have forgotten a medication or injury/illness completely. If farmers recall their medication use incorrectly, misclassification of medications may occur and either under or over-estimate the association between certain classes of medication and agricultural injury introducing misclassification bias to the study.

This study is based on self-report data of agricultural exposures and injuries, as well as self-reported use of medication and health status. There are limitations that must be addressed when using data that has been reported by the subjects. The following is a list of some of the issues that must be considered limitations to a study using self-reported data: subjects may exaggerate answers; subjects may too embarrassed to answer truthfully, subjects may forget pertinent details (recall bias); and the subjects' feeling can affect how they answer the questions. These limitations affect the reliability and validity of the study and must be taken into consideration when interpreting the findings.

Loss to follow-up, another type of information bias, occurs when participants that are lost to follow-up or withdraw from the study may be different from those who are followed for the entire study. The original study did incur loss to follow up due to drop-out. Additional recruitment in 2000 added 49 more farmers to keep the total number of farmers at 316 (Rautiainen et al., 2004).

Interpretations of Findings

Farmer Characteristics

The study included 316 farmers age 26 to 80 years old who participated in the study; there were 103 (33% of total) older farmers (age 55 and older), and 210 (66% of total) younger farmers (age 54 and younger). The mean age of the whole cohort of farmers was 50 years old (SD = 11.4, range= 26-80); median age was 48 years old. The cohort of farmer was 100% Caucasian. The farmers were primarily male (98%), married (88%) non-smokers (93%). The majority of farmers had at least some education after high school (64%). Younger farmers were more educated than older farmers. Older farmers owned significantly less acres than the younger farmers; older farmers (M=535 acres), younger farmers (M=857 acres). The farm size in the current study was much larger than the average farm size in the U.S. The National Agricultural Statistics Service (NASS) 2007 census states farmers under the age of 45 years old averaged 375 acres, 45 to 64 years old average 439 acres, and finally, farmers aged 65 and older average 408 acres (NASS, USDA, 2007). The CSF farmers were noted to have more acres than the average farmer in the U.S. and Iowa, as compared to data from the 1997 and 2002 Census of Agriculture (Iowa Agricultural Statistics Service, USDA, 2012; USDA, 2012). Yet, these findings are similar to another Midwestern cohort study on older farmers with older Illinois farmers having an average of 586 acres (Lizer & Petrea, 2007).

Older farmers reported working an average of 18.55 hours a week versus younger farmers who worked an average of 21.10 hours a week, a difference that was statistically significant. This finding contradicts the current literature that older farmers work hours on the farm similar to their younger counterparts (Lizer & Petrea, 2007; Voaklander et al., 2010). Older farmers were less likely to have reported be working a job off the farm, a finding that is consistent with the literature that older farmers are less likely to report off farm work (NASS, USDA, 2007).

In summary, this sample of farmers is similar to other Iowa farmers. Using the 1997 and the 2002 Census of Agriculture for comparison(Iowa Agricultural Statistics Service, USDA, 2012; USDA, 2012), it was found that the study participants were similar in age, gender, and ethnicity to Iowa farmers, but they tended to farm more acres than the average U.S. farmer and average state of Iowa farmer.

Age and Medication Use

Sixty percent of older farmers reported taking a medication at some point in the study, whereas only 37% of the younger farmers reported ever taking a medication. This study finding is consistent with the current literature on medication use; older adults (65+ years old) are the largest consumers of medication (Mitchell et al., 2006). The bivariate risk analysis of medication use and age group revealed several statistical differences in reported medication use in regards to age. The odds of older farmers reporting taking a medication are 3.08 times greater than the odds of younger farmers reporting taking medication; OR 3.08 (95%CI 1.94-4.92). There were several medication classes or subclasses in which older farmers had statistically significant greater odds of use than the younger farmers. These medications include alpha blockers OR 17.63 (95% CI: 3.47-89.59), hormones OR 8.54 (95% CI: 2.46-29.64), ACE inhibitors OR 4.43 (95% CI:

1.14-17.21), BP medications OR 4.18 (95% CI: 2.04-8.57), cardiac medications OR 3.92 (95% CI: 2.06-7.47), beta blockers OR 3.40 (95% CI: 1.31-8.83), pain medications OR 2.51 (95% CI: 1.30-4.84), and finally CNS medications OR 2.30 (95% CI 1.25-4.22). Several of these medications are considered cardiac medications: ACE inhibitors, BP medications, cardiac medications, and beta blockers. Again, the findings are consistent with the current literature on medication use; the most commonly used medications for older adults, prescribed and OTC, are cardiovascular agents (Qato et al., 2008).

Older farmers reported taking more medications per quarter (M=0.94, SD=1.33, range=0-6) than the younger farmers (M=0.31, SD=0.75). There was a significant effect for age group, with older farmers reporting taking more medications than younger farmers ($p < 0.0001$). Older farmers also reported taking more cardiac medications per quarter (M=0.42, SD=0.92, range=0-6) than the younger farmers (M=0.10, SD=0.37, range=0-3); this difference was significant ($p < 0.0001$). Finally, older farmers also reported taking more CNS medications per quarter (M=0.18, SD=0.39, range=0-2) than the younger farmers (M=0.11, SD=0.37, range=0-3); this difference was significant ($p < 0.0001$). Again, the study findings are consistent with the current literature on polypharmacy; older adults tend to take more than one medication. The study by Qato (2008) found that more than half of the older adults in their sample used five or more medications (Qato et al., 2008).

Age and Nonfatal Agricultural Injury

There were a total of 318 injuries in the cohort with a total of 752 person-years of follow-up time. The majority of farmers (54%, n=168) in the study reported being injured at least once during the study; 49% (n=50) percent of older farmers and 54% (n=118) of younger farmers. The most number of injuries reported by an older farmer was five; whereas one younger farmer reported 10 injuries during the study period. The mean number of injuries reported per quarter were very similar between older (M = 0.92, SD = 1.33) and younger (M = 1.06, SD = 1.37) farmers.

The injury rate for the whole cohort of farmers was 41.95 injuries/100 years. The injury rate for older farmers was 38.35 injuries/100 person- years, while the rate for younger farmers' was 44.01 injuries/100 person-years; there was no statistical difference in the nonfatal injury rate for older and younger farmers. When the cohort of farmers was divided into five age groups, there is a spike in the injury rate at age 40-49 where the injury rate is the highest at 48.29 injuries/100 person-years. The injury rate then drops down to 36.72 injuries/100 person-years for farmers aged 50-59 years old. Next, the injury rates increase with each subsequent age group until it reaches the second highest injury rate of 45.38 injuries/100 person-years for the farmers aged 70-80 years old. This study finding was inconsistent with the literature that the risk for nonfatal agricultural injury decreases with age (Crawford et al., 1998; Hwang et al., 2001; Lewis et al., 1998; Marcum et al., 2011; Myers et al., 2009; Myers et al., 1999; Zhou & Roseman, 1994). In addition, these injury rates are higher than those normally reported in the literature, including 4.6/100 workers/year (20-54 year olds) and 4.5/100 workers/year (≥55 year olds) (Myers et al., 2009), 9.3/100 workers/year (Marcum et al., 2011) and 4.9 cases/100 full-time workers (BLS, 2009). Possible reasons for these higher injury rates have previously been discussed by the parent study authors. They suggest that the injury rate may have been influenced by the data collection method, recall time, and injury definition due to the use of a broad injury definition, routine record keeping and quarterly phone calls for data collection (Rautiainen et al., 2004).

The majority of reported injuries (15%) occurred in the month of October, followed by the month of August (11%). These findings are not at all surprising. August and October are very active months for farmers, as August is time that farmers bale hay prepare for the harvest and October is harvest season. Hay fields are planted early spring or summer and are usually ready to bale a first and/or second time by the end of the summer. Hay cut too early does not cure as easily due to higher moisture content and will produce a lower yield per acre than grasses that have been left to mature. Hay cut too late is coarser and has lost some nutrients. This delicate balance is monitored closely by the farmer as there is about a 2 week "window" of time in which hay is at its prime for harvesting. This hay harvest time puts a lot of stress on farmers to get the hay in at the ideal time for best nutrient content for future use in the winter to feed livestock. This time limitation increases stress and can create longer work hours on hot days, making hay cutting and baling a time in which farmers may be at greater risk for injury. Similar time restraints surround the harvest of crops in the autumn, increasing work hours, stress, and fatigue, and therefore increasing the risk for injury.

There were no significant differences found between young and old farmers in regards to the type of injuries they reported. The most common types of injuries reported by both older and younger farmers included bruises, cuts and sprain/strains. The study findings were similar to the 2004 Occupational Injury Surveillance of Production Agriculture in which the most common type of injuries were sprains /strains and torn ligaments (22%), fractures (15%), and cuts (13%)(Department of Health and Human Services (DHHS), & National Institute of Occupational Safety and Health (NIOSH), 2010). The study findings are also similar to a more recent national study by Myers (2009). These findings on injuries for farmers 55 years and older state that sprains/strains, cuts, and bruises are some of the most prevalent types of injuries occurring to farmers (Myers et al., 2009). Myers (2009) found that the most common injuries to older farmers were fractures (21%), sprains/strains (18%), multiple diagnoses (17%), cuts (16%) and bruises (10%); younger farmers were more likely to sustain a sprain or strain (Myers et al., 2009). The main divergence from the Myers (2009) study identified in this study is that the most common type of injury reported in this cohort of older farmers was bruises (30%) and only 5% reported a fracture, whereas Myers (2009) reports that older farmers were most likely to report fractures (21%).

Older and younger farmers reported similar experiences with injuries, regarding body parts injured. The most commonly reported body part injured for both older and younger farmers was legs/knees/hips. Other common body parts reported include fingers (older farmers-22%, younger farmers-19%), back (older-11%, younger-15%) and head/neck injuries (older-8%, younger-10%). These findings are consistent with the literature where body parts most frequently injured by farmers include the torso, and upper and lower extremities such as fingers, hands/wrists, and legs (McCoy, Carruth, & Reed, 2002; Xiang et al., 1999; Zhou & Roseman, 1994).

The number one source of injury reported was human error for both older (23%) and younger farmers (25%). The next most common source reported for the two groups was 'other'; 24% for older farmers and 18% for younger farmers. Other machinery (older-16%, younger- 15%) and livestock (older -14%, younger-10%), were also found as important reported sources of injury. The finding of 'human error' as the most commonly reported source of injury was interesting, as it is inconsistent with the literature on sources of injury. The 2004 Occupational Injury Surveillance of Production Agriculture found that the most common source of injury were animals (16%), the ground (165, usually form falls), and tractors (5%) (Department of Health et al., 2010). Other studies also found the most common causes for injury include contact with objects such as tractors/machinery, livestock, and the ground (slips/trips) (Day et al., 2009; Sprince et al., 2003b).

Medication Use and Nonfatal Agricultural Injury

Twenty-eight percent of reported injuries were by farmers who also reported taking a medication in the same quarter of the injury. The most common medication classes taken by farmers sustaining an injury include cardiac (37 injuries, 12% of all injuries), CNS (41 injuries, 13% of all injuries), pain medications (33 injuries, 10% of all injuries) and BP medications (33, 11%) medications. All classes of medications were taken by an injured farmer except autonomic medications. There were two medication classes where only one farmer was injured while taking the medication, these included antidepressants (one farmer had one injury) and anti-infective medications (one farmer had one injury). Three injuries in one quarter was the greatest number of injuries sustained by a farmer on medication. One farmer reported three injuries in a single quarter; he reported taking each of the following medications: blood formation and coagulation medication, CNS medication, and pain medication. No medication classes were found in bivariate regression analysis to increase the odds of injury for this cohort of farmers.

Study findings concerning types of agricultural injuries, sources of agricultural injuries and body parts injured in regards to medication used are novel and new findings to add to the literature as they have never been reported before. Comparisons to the literature, therefore, cannot be made in regards to these new findings. Out of the 90 injuries sustained by the farmers who reported taking any medication in this study, the most common type of injury sustained was a sprain/strain (n = 21, 25%), followed by cuts (n = 16, 20%) and bruises (n = 16, 20%). Fourteen (17%) farmers taking medication claimed 'other' as the type of injury, seven (8%) reported a fracture, five (6%) reported a crush, and three (4%) farmers had burns. The least common type of injury sustained by farmers taking medication was a puncture (n = 1, 1%).

The main source of nonfatal injury that farmers taking medication reported was human error (23%), followed by 'other' (16%), other machinery (15%), livestock (13%), and working surface (12%). Less common sources were hand tools (8%), tractors (4%), truck/auto (2%), and plant/tree (1%). None of the injured farmers that reported using medications claimed that a pesticide/ chemical or 'other vehicle' was the source of their injury. The most common medication classes reported by injured farmers in this study include cardiac medications, CNS medications, pain medications, and BP medications. These medication classes have the potential to cause impaired balance, cognitive changes, sedation, and hypotension. A farmer experiencing these medication side effects may not realize that taking a medication or combination of medications (polypharmacy) could be the cause of his physical and cognitive changes. When experiencing these medication side effects and then sustaining an injury, the farmer may classify the cause or source of injury as 'human error' or 'other' as no other explanation may be obvious to the farmer, other than personal physical or cognitive deficits.

After 'human error' and 'other' as the most prevalent sources of injury, contact with other vehicles/vectors such as other machinery, livestock, and working surface were also common. The most common body parts that farmers taking medications reported injured included fingers (24%), leg/knee/hip (22%), back (14%), and head/neck. Less common was hand/wrist (8%), arm/shoulder (6%), 'other' (6%), chest/trunk (5%), and foot (2%). No farmers taking medication reported injuring their eyes.

<u>Multiple logistic regression analysis</u>

Agricultural work exposures associated with injury included noise (OR 1.39, 95% CI: 1.02-1.90), chemical/pesticide use (OR 1.88, 95% CI: 1.39-2.55), heavy lifting (OR 1.55, 95% CI: 1.06-2.28) and raising livestock (OR 1.49, 95% CI: 1.08-2.06). Health conditions related to agricultural injury included depression (low vs. medium) (1.09, 95% CI: 1.05-1.90) and several interaction terms between taking medication and health status. These findings are similar to the current literature on agricultural injury risk factors (Choi et al., 2005; Hwang et al., 2001; Lewis et al., 1998; Sprince et al., 2002; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003c; Sprince et al., 2007; Tiesman et al., 2006).

Medication classes significantly associated with an increased risk for agricultural injury included taking two different types of heart medications: beta blockers (OR 2.30, 95% CI: 1.07-4.97) and ACE inhibitors (OR 2.72, 95% CI: 1.15-6.46). These findings support previous research by Pickett and colleagues (1996) that heart and circulatory medications did indeed increase the odds of injury for farmers (OR 4.2, 95%CI: 1.2-143.7) (Pickett et al., 1996). These findings seem logical as some of the side effects of beta blockers and ACE inhibitors, such as orthostatic hypotension, dizziness, and increased fatigue could reasonably increase the risk of an injury (Agostini et al., 2004). These finding are important as the average age of farmers is increasing (Allen & Harris, 2005; NASS, 2007a) and with this aging trend comes an increase in chronic disease; cardiovascular disease ranks as the second most frequently occurring chronic conditions in the US (AoA, 2010). Cardiovascular issues are often treated with cardiovascular drugs that have various side effects that may affect a farmer's ability to farm safely (Dickstein et al., 2008; Mancia et al., 2007).

Medication variables that were found to be protective included taking blood formation/coagulation medications (OR 0.50, 95% CI: 0.28-0.93). Blood formation, coagulation, and formation medications includes medications such as aspirin, Coumadin and Plavix. In this group of CSF farmers, aspirin was the medication used most in this class of medications (88%) with only a handful using other medications such as Coumadin (10%) and Plavix (2%). Aspirin was the number one blood formation/coagulation medication used in this cohort. It can be theorized that the aspirin was protective due to its analgesic effect for use with musculoskeletal issues like arthritis or for its preventative properties for cardiovascular issues such as stroke and heart attack. Therefore, taking aspirin for minor aches and pains might make it safer to farm rather than farming while having arthritic or muscular pain. These study findings are new and add to the current literature. More research needs to be completed to replicate and validate these findings.

When exploring the issue of polypharmacy, exploration of interactions between medications was included in the analysis. No drug-drug interactions were found to be statistically significant. The total number of medications taken per quarter, as well number of CNS and cardiac medications taken per quarter were part of the analysis to explore the phenomena of polypharmacy. The odds of injury were significantly lower with the use of more than one versus no cardiac medications (OR: 0.35; 95% CI: 0.13-.0.94) and the use of more than one versus one cardiac medication (OR: 0.45; 95% CI: 0.23-.0.89). As with the noted significant pairwise interactions between medication use and general health, it may be that farmers who are taking more than one cardiac medication may actually be decreasing their risk for injury by taking more than one cardiac medication. Indeed, a farmer may be taking one cardiovascular medication for each of the following issues: hypertension, heart failure, coronary artery disease and hyperlipidemia. Current international guidelines strongly encourage polypharmacy to treat common cardiovascular conditions (Dickstein et al., 2008; Mancia et al., 2007). This would follow the logic that if a farmer has poor cardiac health status, cardiac medications addressing multiple cardiovascular problems would increase the ability of the heart to function more effectively and efficiently. With better functioning of the heart, a farmer may be able to work more safely.

Several interactions between taking medication and general health status were significant. This study is the first to look at the interaction of general health status with medication use in regards to risk for agricultural injury. Several statistically significant associations were found. A farmer in excellent health and taking medication had 2.71 times the odds of an injury as a farmer in excellent health that was not taking medications (OR 2.71, 95% CI: 1.40-5.23). Also, a farmer in very good health and taking medication had 2.97 times the odds of an injury as did a farmer in very good health that was not taking medications (OR 2.97, 95% CI: 1.58-5.57). A farmer in excellent health not taking meds had less odds of injury compared to a farmer in poor health taking medication (OR 0.29, 95% CI: 0.16-0.52). A farmer in very good health not taking meds had less odds of injury compared to a farmer in poor health taking medication (OR 0.26, 95% CI: 0.15-0.46). A farmer in excellent health not taking meds had less odds of injury compared to a farmer in poor health not taking medication (OR 0.19, 95% CI: 0.09-0.44).

A farmer in very good health not taking meds had less odds of injury compared to a farmer in poor health taking medication (OR 0.18, 95% CI: 0.08-0.39). Finally, a farmer in good health not taking meds had less odds of injury compared to a farmer in poor health taking medication (OR 0.32, 95% CI: 0.14-0.71).

In summary, there is a noted trend that farmers in excellent/very good/good health have lower odds of injury if they are not taking medication versus if they did take medication. Another trend noted is that farmers with poor health have decreased odds of injury if they are taking mediation versus if they did not take medication. This cannot be said definitively, as the estimated probabilities for comparison within the 'poor' health group had high p-values, perhaps due to the small number of farmers in this category compared to the other health groups. These findings follow logic that if you are healthy, taking a medication and dealing with side effects may put you at greater risk. And that if you are in poor health, not taking medications may cause health problems to worsen enough that the farmer is at greater risk for injury.

From these results, it is apparent that farmer's health status plays a significant role in how the risk for agricultural injury changes depending on whether or not the farmer is on medication. It is also apparent that making blanket statements regarding medication use and agricultural injury cannot be made; it is not always safer to take medication and it is not always safer to not take medication when it comes to risk for injury, as this research shows that medication as a risk factor is dependent on a farmer's health status.

These findings are novel and valuable, illuminating the complexity of host health risk factors relationship with agricultural injury. Yet, more research is needed to replicate and validate these findings. Research specifically exploring the interplay between health status, chronic diseases, and medication in regards to the risk for agricultural injury must be completed to fully understand these host risk factors.

Finally, depression was also found to be significantly associated with agricultural injury. Low levels versus medium levels of depression were found to increase the odds of injury for farmers, (OR 1.42, 95% CI: 1.05-1.90). These findings are consistent with a study by Tiesman (2006) in which depressive symptoms are found to significantly increase the risk for unintentional injury (Choi et al., 2005; Hwang et al., 2001; Lewis et al., 1998; Sprince et al., 2002; Sprince et al., 2003a; Sprince et al., 2003b; Sprince et al., 2003c; Sprince et al., 2007; Tiesman et al., 2006). More research on depression as well as taking medication for depression is needed.

Implications and Recommendations for Nursing Practice, Education and Policy

The findings of this study make a very important contribution to the literature regarding medication use and agricultural injury. This study will fill gaps in the knowledge regarding the types of medications farmers are currently taking while actively farming and about the relationship between the use of certain medications and increased risk for agricultural injury. This study is the first step in understanding medication use as a risk factor for agricultural injury. The findings will be important in the education of nurses and other agricultural safety and health professionals, as well as farmers themselves, regarding medication use as a risk factor for agricultural injury. The findings will also assist nurses and other safety and health professionals in tailoring evidenced based interventions for farmers that use medication.

At present, nursing curricula address rural health issues, but lack content in agricultural safety and health (Reed, Hoffman, & Westneat, 2005). Educating nurses about the occupational hazards and injuries of farming will assist nurses in serving the agricultural community. Nurses come into contact with farmers in many health care situations. For example, an emergency room nurse taking care of the farmer experiencing neurological changes due to pesticide poisoning, or the clinic nurse taking care of a farmer who has severe respiratory symptoms due to organic dust toxicity, or the pediatric nurse taking care of a farmer's child that got a hand amputated in an entanglement with a farm implement. If nurses were better educated about the perils of farming, they could play an important role in addressing health and safety issues for their farming clients.

As of now, there are very few formal educational experiences for nurses regarding agricultural safety and health. Most nurses whose practice includes taking care of farmers (emergency departments, medical/surgical in-patient units, etc.) learn about agricultural safety and health through the experience of taking care of sick or injured farmers, or because of their own personal experience with farming, or informal continuing education. There are a few nurses formally educated in agricultural safety and health for nurses. One opportunity for formal education is the agricultural safety and health certificate program through the University of Iowa College of Public Health. The goal of their Graduate Certificate Program in Agricultural Safety and Health is to train students to detect safety and illness hazards, and to treat and prevent farm-related illnesses and injuries and is aimed to practicing health or safety professionals, or students with an interest in rural areas and the agricultural health industry (University of Iowa College of Public Health, 2012).

One other important avenue for educating nurses on the perils of agricultural is the NIOSH funded Nurse Agricultural Education Project (NAEP) led by Deborah Reed, professor of nursing at the University of Kentucky. The NAEP is an evidence-based approach to training entry-level, graduate level, and experienced nurses in agricultural occupational health (Southeast Center for Agricultural Health and Injury Prevention & University of Kentucky College of Public Health, 2012a). The NAEP program served as the foundation for the translational project Nurses Utilizing Research, Service, and Education in Practice which is focused on three critical barriers to health care for farmers 1) delayed access to research findings that are needed to develop and deliver evidence-based nursing care, 2) lack of interventions tailored to local farm culture and needs, and 3) the limited number of nurses with expertise in agricultural occupational health and safety (Southeast Center for Agricultural Health and Injury Prevention & University of Kentucky College of Public Health, 2012b). The long-term goal of this project is to provide communities with tailored evidence-based health care and health promotion resources delivered by transdisciplinary teams.

Not only are formal education opportunities important for nurses, but content for agricultural safety and health should be added to current nursing curricula at both undergraduate and graduate levels. This could be done by adding formal courses on agricultural safety and health or by adding case studies focused on farmers to already established courses. Both of these are great ways to showcase current research completed by nurses in the field of agricultural safety and health.

These nursing educational experiences place nurses in a prime position to become agricultural safety and health specialists and establish new-evidence-based practice guidelines for clinical practice, develop health and safety interventions for farmers, and initiate new research. This study adds to the body of knowledge regarding risk factors for agricultural injury and can be used in future education materials to assist nurses in tailoring interventions for farmers that use medication.

One must also look at the education of farmers regarding the study findings. Nurses that work with farmers can use the study findings in educating farmers about potential risk factors for agricultural injury. As this study has found, taking certain medications can increase a farmer's risk for injury. These medications include beta blockers and ACE inhibitors. Nurses can teach farmers about the side effects of these medications and how their use can increase the risk for injury. Other medications were found to have a slight protective aspect such as blood formation/coagulation medications and hormones. Aspirin was the number one blood formation/coagulation medication used and can be theorized to have been protective due to its analgesic effect for use with musculoskeletal issues like arthritis. Therefore taking aspirin for minor aches and pains might make it safer to farm rather than farmer while dealing with arthritic or muscular pain. In light of the new findings regarding the interaction between taking medication and general health, it may be valuable to discuss with farmers with poorer health status the importance of taking their medications for the chronic health problem. Again, these findings need to be validated in other studies before widespread acceptance and educational initiatives are employed.

Nurses working with farmers are in a prime position to help educate farmers regarding medication side effects and issues surrounding polypharmacy, and ultimately offer potential interventions on how to decrease chances of injury while taking medication such as: 1) modifying agricultural tasks, 2) if possible, delegate more dangerous tasks to a co-worker, 3) monitor side-effects of medications and if creating health issues discuss with physician about potential medication changes (decrease dose, different medication, or discontinue medication- all under a physician's close supervision).

An important policy implication of this research is the need for reimbursable annual medication reviews for farmers. These reviews would be reimbursable as a preventative care service and would address the safety of medication use while farming by determining the following: 1) Is there documented and appropriate indication for the medications the farmer is currently taking? 2) Is the dosage appropriate for the farmer's age, weight, and renal or liver function? 3) Is there a documented allergy to the medication? 4) Are doses scheduled appropriately? 5) Is the duration of the treatment appropriate? 6) Is the medication the best one to treat the farmer (most effective with the least side effects)? 7) Are two or more medications prescribed for the same issues (therapeutic duplication? 8) Is the farmer experiencing any adverse side effects from any medications? 9) Are there any know drug-drug interactions? 10) Is there medical indication for the use of medication when not is prescribed? and finally, 11) Is the farmer using any over the counter medication inappropriately? (Meiner & Lueckenotte, 2005, pp.464-465).

Recommendations for Future Research

Data Collection

Medication data in the parent study was based on self-report and can introduce bias as noted previously. For future research it is important to use health records data such as from pharmacies to increase the reliability and validity of the data for prescribed medication use. This medication data should be collected monthly, rather than the annual collection taken place in the parent study. This would allow researchers to capture changes in medication use, such as newly prescribed medications or medications that have been discontinued. Other research tools that could assist the farmer in addressing use of over the counter (OTC) medication on a daily basis should be made available to farmers. This would allow for daily OTC medication monitoring which then could be matched up temporally with injury variables.

Another recommendation for medication data collection that could increase the validity and reliability of medication data is the use of one of the many medication adherence technologies available such as the MedMinder (Medminder Inc., 2012). The MedMinder pill dispenser allows for remote monitoring and provides detailed reports regarding medication activity. These reports include information such as when medication cup were taken out of the dispenser (exact time of day medications were taken), when the cups were refilled (can get coordinating reports from the pharmacy), and if any medication were missed (Medminder Inc., 2012). This would allow for daily medication monitoring which then could be matched up temporally with injury variables.

Injury data were collected quarterly and it is recommended to collect injury data monthly. A monthly phone call (survey) on injury and exposure data would decrease the potential for recall bias and help establish the temporal association between medication use and agricultural injury. Other research tools that could assist the farmer in addressing exposure and injury status on a daily basis would also be helpful in creating a better temporal association between medication use and subsequent injury.

The interplay between general health and medication use in regards to nonfatal agricultural injury

In light of the study results pertaining to the interaction between general health status and medication use in relation to agricultural injury, it is apparent that farmer's health status plays a significant role in how the risk for agricultural injury changes depending on whether or not the farmer is on medication. Future research is needed to replicate and validate these findings. Specifically, research that explores the interplay between health status, chronic diseases, and medication as risk factors for agricultural injury. Also it is apparent that making blanket statements regarding medication use and agricultural injury cannot be made; it is not always safer to take medication and it is not always safer to not take medication when it comes to risk for injury, as this research shows that medication as a risk factor is dependent on a farmer's health status.

Nurses in agricultural safety and health

Nurses are considered one of the most trusted professions (American Nurses Association (ANA), 2009). Consequently, this places nurses in a prime position to become change agents in their agricultural communities, yet there is a deficit in nurses specifically trained in agricultural safety and health (Reed et al., 2005). Also as stated previously, nursing curricula lack in agricultural safety and health content (Reed et al., 2005). Research looking into successful ways to add agricultural safety and health to curricula and educate already practicing nurses through continuing education is needed.

Conclusion

This descriptive and analytic study used CSF data to describe and compare medication use and agricultural injury experiences between younger ($\leq$54 years old) and older (≥55 years old) farmers; and to examine the relationship between the use of specific classes of medication and agricultural injury. The estimation of risk for agricultural injury for farmers taking specific classes of medication has rarely been conducted. This study has successfully contributed to the body of knowledge regarding medication as a host risk factor for injury for agricultural injury.

The results of this study support the need to address medication use as a host risk factor in future research regarding agricultural injury. Agricultural safety and health professionals need a complete understanding of all the potential risk factors for injury in order to serve the agricultural community successfully. This would include educating the farmers on all potential risk factors (host, agent, and environmental), as well as developing tailored interventions to address these risk factors.

As the average age of farmers continues to increase, the potential for health problems and medication use by farmers will also increase. Future research is needed to replicate and validate the findings of this study as well as to focus on the validation of medication interventions for agricultural injury.

APPENDIX A

RESEARCH ON HOST RISK FACTORS FOR AGRICULTURAL INJURY: AGE-RELATED PHYSIOLOGICAL CHANGES, CHRONIC ILLNESS, AND MEDICATION USE

Table A1: Research on host risk factors for agricultural injury: age-related physiological changes and chronic illness

Study	Design	Population	Mean Age (range)	Results
(Zwerling, Burmeister, & Jensen, 1995)	Cross Sectional Telephone survey Restricted activity or medical attention	237 participants (15 injuries)	(51 to 61)	**Depression – OR:3.05(1.03-9.55);** Hearing (poor & fair vs. better) –OR: 0.30(0.01-1.80); Sight (poor & fair vs. better) –OR: 2.17(0.57-7.10); Disabled) –OR: 1.81(0.48-5.87)
(Browning et al., 1998)	Cross sectional Telephone survey Any injury	998 participants (98) injuries; white males (98%): Kentucky, USA	68 years	Previous injury – OR:2.40(1.01-5.71); hearing difficulty (poor/fair vs. better)- OR 1.59 (0.95-2.67); vision difficulty- OR 1.42(0.76-2.63); health status (good)- OR0.63(0.341.15); fair/good- OR0.92(0.52-1.65); Neurological symptoms (linear trend); hearing-OR 1.90(0.82-4.40);
(Lewis et al., 1998)	Cross sectional Mail survey with telephone follow-up Restricted activity (> 4 hours), loss of consciousness, medical attention	390 farm operators (48 injuries)	54 years	**Work limited by health impairment – OR:2.38(1.48-3.82)** *Bivariate analysis:* **Respiratory problems- OR:2.03(1.05-3.92);** **Hearing problems- OR:2.04(1.02-4.07);** **Loss of balance- OR:2.20 (1.05-4.62);** Vision problems-OR:0.63(0.13-3-03); Seizures- OR:1.61(0.18-2.09); hand impairment-OR:1.46(0.53-3.98; health status- OR:1.52(0.72-3.21)
(Xiang et al., 1999)	Case-control; mail survey with telephone follow-up; restricted activity (≥ 4hr) or medical attention	90 cases, 1,475 controls; white males (100%); Ohio USA	<30 to >69; mean age of 54	**Neurological symptoms (linear trend);** Hearing- OR 1.90(0.82-4 .40)
(Hwang et al., 2001)	Cohort Telephone follow-up Restricted activity, loss of awareness or memory, or medical attention	113 participants (27 injuries over a mean follow-up period of 2.9 years) Colorado, USA	60-80+	**High blood pressure- OR:0.20(0.06-0.69);** Heart disease- OR:0.47(0.15-1.49); back pain- OR:3.35(0.97-11.60);allergies- OR:0.45(0.11-1.78); arthritis-OR: 0.47(0.15-1.49); hearing loss- OR:1.88(0.67-5.26); cancer- OR:2.76(0.70-11.30); HTN-OR 0.20 (90%CI 0.06-0.69) but not statistically significant.

Table A1 continued

Study	Design	Population	Mean Age (range)	Results
(Carruth et al., 2001)	Cohort Telephone follow-up Restricted activity (≥ 4 hours) or medical attention	1706 participants (174 injuries over a mean follow-up period of 0.99 years)	(18 to >65)	**Hearing loss – OR:1.86(1.22-2.83)** **Joint trouble – OR:2.56(1.52-4.32);**
(Park et al., 2001)	Cross Sectional Telephone survey Any injury	53 participants (64 injuries)	(18 to >65)	**Back Pain – OR:2.05(1.11-3.80);** diabetes- OR:1.50(0.59-3.83); vision- OR:1.20(0.66-2.21); hypertension- OR:1.02(0.54-1.90)
(Sprince et al., 2002)	Cohort Telephone follow-up Restricted activity, loss of consciousness, medical attention	290 participants (31 injuries over a mean follow-up period of 1 year)	(28 to >60)	**Depression – OR:3.22(1.04-9.99);** Hearing- OR:1.21(0.63-2.35); respiratory problems- OR:2.21(0.89-5.48); health status (poor or fair)-OR:1.54(0.49-4.85);
(Sprince et al., 2002)	Case-Control Mail Survey with telephone follow-up Medical attention related to machinery injury	205 cases 473 controls	Cases – 36.4 Controls – 42.7	**Uses hearing aid –4.37(1.55-12.25);** Vision (poor/fair)- OR: 0.47(0.20-1.10); wear glasses- OR:0.72(0.50-1.02); arthritis- OR:1.23(0.78-1.93); heart disease- OR:0.78(0.42-1.44); depression- OR:179(0.93-3.43);
(Sprince et al., 2003a)	Case-Control Mail Survey with telephone follow-up Medical attention for livestock related injury	116 cases 342 controls	Cases – 37.9 Controls – 40.2	**Uses hearing aid – OR:5.35(1.59-18.0)** **Arthritis – OR:3.0(1.7-5.2); asthma- OR:2.46(1.15-5.25);** vision (poor/fair)-OR:0.49(0.17-1.41); wears glasses- OR:1.62(0.97-2.73); depression- OR: 1.87(0.97-3.62); heart disease- OR:1.80(0.90-3.59); disability-OR:1.57(0.94-2.62)
(Sprince et al., 2003b)	Case-Control Mail Survey with telephone follow-up Medical attention	431 cases 473 controls	Cases – 47.5 Controls – 50.0	**Uses hearing aid – 2.36(1.07-5.20); arthritis- OR:1.50(1.06-3.13); hearing difficulty- OR:1.42(1.05-1.92); depression- OR:1.82(1.06-3.13);** wears glasses- OR:0.88(0.66-`.`8); vision(poor/fair)-OR:0.67(0.37-1.21); heart disease-OR:0.84(0.53-1.34); disability-OR:1.29(0.92-1.80)

Table A1 continued

Study	Design	Population	Mean Age (range)	Results
(Sprince et al., 2003c)	Case-Control Mail Survey with telephone follow-up Falls only – medical advice or treatment	79 cases; 473 un-injured controls	Cases – 50.3 Controls – 49.9	**Arthritis – OR:2.05(1.11-3.79)** **Hearing loss - OR:1.82 (1.07,3.08); hearing aid- OR:3.16(1.11-9.00); depression-OR:2.37(1.43-5.13); disability- OR:1.98(1.14-3.45);** wears glasses- OR:1.00(0.58-1.72); Vision (poor/fair)- OR: 0.39(0.10-1.56); heart disease- OR:1.76(0.88-3.53);
(Choi et al., 2005)	Case-control Mail survey Any injury	73 case farms 61 control farms Finland	Cases-43.8 Controls-44.3	**Musculoskeletal disorders- OR:1.75(1.14-2.69);** health complaints- OR: 1.51(0.76-3.03)
(Voaklander et al., 2006)	Cohort Telephone follow-up Pain, restricted activity, tissue damage or medical attention	150 participants (166 injuries over a mean follow-up period of 2.5 years)	49	**Hearing loss – RR:1.96(1.26-3.05)**
(Tiesman et al., 2006)	Case – Control Administrative health data linkage Hospital treatment (inpatient or emergency department)	282 cases; 1410 age matched controls	Cases – 71.4 Controls – 71.8	**Urinary tract disorders – OR:2.95(1.30-6.71)** **Previous injury – OR:1.42(1.04-1.95);; osteoarthritis-OR:1.57(1.15-2.14);**osteoporosis- OR:4.29(1.44-12.75); eye disorders- OR:1.23(0.83-1.83); hypertension- OR:0.67(0.44-1.02); cardiovascular disease- OR:0.97(0.70-1.38); diabetes- OR:1.63(0.77-3.43)
(Sprince et al., 2007)	Cohort Telephone follow-up Restricted activity (≥ 4 hours), loss of awareness or memory, or medical attention	1493 participants (492 injuries over a mean follow-up period of 3.2 years)	Males – 55.9 Females – 55.1	**Depression - RR:1.41(1.10-1.80)** **Previous injury – RR:1.34(1.06-1.67)** **Sleep deprivation - RR:1.23(1.00-1.52);** **Stress- OR:1.87(1.0-3.5)**
(Day et al., 2009)	Case-Control Mail Survey with telephone follow-up Medical attention for back pain	49 cases 465 controls	Cases – 36.6 Controls – 42.6	**Asthma –OR:4.26:1.49-12.10)** **Hearing loss – OR:1.98(1.02-3.80); arthritis- OR:3.99**
(Day et al., 2009)	Case-control Emergency department presentation	252 cases 504 controls Males; Australia	49 years (SD 14 years)	**Back pain-OR:0.59(0.42-0.83); chronic health problem-OR:0.65(0.46-0.93)**

Table A1 continued

Study	**Design**	**Population**	**Mean Age** (range)	**Results**
(Marcum et al., 2011)	Longitudinal cohort (4 years); Mailed survey and telephone survey; Any nonfatal injury	1,394 participants; 463 injuries with a crude injury rate of 9.3 injured farers/1100 years	50 and older; mean age= 59	Chronic bronchitis/emphysema-estimated OR[EOR]= 1.57, (95%CI:1.00-2.46); Back problems –EOR=1.37 (95% CI:1.00-1.87); **Arthritis-EOR=1.31 (95%CI:1.02-1.71);** Bivariate analysis: Hearing problems- OR: 1.63 (OR: 95%CI: 1.23-2.16); Vision problems- OR: 1.38 (OR: 95%CI: 1.07-1.77); Heart attack/condition- OR: 1.19 (OR: 95%CI: 0.89-1.60); High blood pressure- OR: 1.06 (OR: 95%CI: 0.85-1.32)

Note: Adapted from Voaklander, D., Umbarger-Mackey, M., & Wilson, M. (2009). Health, medication use, and agricultural injury: A review. *American Journal of Industrial Medicine, 52*(11), 876-889.

Table A2: Research on host risk factors for agricultural injury: medication use

Study	Design	Population	Mean Age, Years (range)	Results
(Brison & Pickett, 1992)	Cohort; personal interview; any injury; Medication data is self-report	547 participants	<20 to>60	**Any prescription medication RR: 2.6 p=0.07** (farm owners only- with total farm population no longer significant)
(Pickett et al., 1996)	Case-Control Mail Survey Restricted activity (≥ 4 hours); Medication data is self-report	136 cases 581 controls	(16 to >70)	**All Males – Stomach medication – OR:3.1(1.2,8.2)** **Males > 45 years – Heart medication – OR:4.2(1.2,14.7)**
(Browning et al., 1998)	Cross sectional; telephone survey; any injury; Medication data is self-report	998 participants (98 injuries); white males (98%); Kentucky, USA	68 years	**Current use of prescription medication :** **OR: 1.24 (0.75-2.05)**
(Xiang et al., 1999)	Cohort Telephone follow-up Restricted activity, loss of awareness or memory, or medical attention; Medication data is self-report	113 participants (27 injuries over a mean follow-up period of 2.9 years) Colorado, USA	60-80+	**Any prescription medication – OR:3.02(1.05-8.61)**
(Sprince et al., 2002)	Case-control; mail survey with telephone follow-up; medical attention related to machinery injury; Medication data is self-reports	205 cases; 473 controls; males (100%); Iowa, USA	Cases-36.4; controls-42.7	**Takes medication:** **OR: 1.19 (0.83-1.72)**
(Sprince et al., 2003a)	Case-control; mail survey with telephone follow-up; medical attention for livestock-related injury; Medication data is self-report	116 cases; 342controls; Iowa, USA	Cases-37.9; controls-40.2	**Any medication:** **OR: 2.07 (1.29-3.33)-** in bivariate analysis only;

Table A2 continued

Study	Design	Population	Mean Age, Years (range)	Results
(Sprince et al., 2003b)	Case-control; mail survey with telephone follow-up; medical attention; Medication data is self-report	431cases; 473 controls (males100%); Iowa, USA iCases-47.5; controls-	Cases-47.5; controls-50.0	**Any medication – OR:1.44(1.07-5.20)**
(Sprince et al., 2003c)	Case-control; mail survey with telephone follow-up; falls only medical advice or treatment; Medication data is self-report	79 cases; 473 un-injured controls; Iowa, USA	Cases-50.3; controls-49.9	**Any medication: OR:1.80 (2.02-3.18)**
(Spengler et al., 2004)	Cross sectional Telephone survey Medical attention needed; Medication data is self-report	1004 participants	49	**Sleep medication – OR:2.11(1.01-4.40)**
(Voaklander et al., 2006)	Case -Control Administrative health data linkage Hospital treatment (inpatient or emergency department); Medication data is from a computerized registry for provincial drug insurance	282 cases; 1410 age matched controls	Cases – 71.4 Controls – 71.8	**Sedative class medication – OR:3.01(1.39-6.52)** **Recent use of narcotic pain killers – OR:9.37(4.95-17.72)** **Recent use of non-steroidal anti-inflammatories – OR:2.40(1.43-4.03)**

Table A2 continued

Study	Design	Population	Mean Age, Years (range)	Results
(Tiesman et al., 2006)	Cohort Telephone follow-up Restricted activity (≥ 4 hours), loss of awareness or memory, or medical attention; Medication data is self-report	1493 participants (492 injuries over a mean follow-up period of 3.2 years)	Males – 55.9 Females – 55.1	**Depression medication – RR:1.53(1.13-2.09)**
(Sprince et al., 2007)	Case-control; mail survey with telephone follow-up; medical attention for back pain; Medication data is self-report	49 cases; 465 controls; Iowa, USA	CasesC36.6; controlsC42.6	**Any medication : OR: 1.63 (0.85-3.11)**
(Marcum et al., 2011)	Longitudinal cohort (4 years); Mailed survey and telephone survey; Any nonfatal injury	1,394 participants; 463 injuries with a crude injury rate of 9.3 injured farers/1100 years	50 and older; mean age= 59	Univariate analysis: Daily prescription EOR: 1.00 (95% CI 0.75-1.32)

Note: Adapted from Voaklander, D., Umbarger-Mackey, M., & Wilson, M. (2009). Health, medication use, and agricultural injury: A review. *American Journal of Industrial Medicine, 52*(11), 876.

APPENDIX B

DRUG-DRUG INTERACTIONS

Table B1: Drug-drug interactions

Drug 1	Drug 2	Interaction	Adverse Effects
Warfarin (Coumadin)	Diltiazem Verapamil Metronidazole	Inhibits drug metabolism	↑ anticoagulation; potential bleeding
Warfarin	NSAIDS ASA\ Sulfa drugs Macrolides Acetaminophen combined with narcotic Fluconazole Cipro Biaxin	NSAID ↓ prostaglandin ↑GI erosion; ↓ platelet aggregation Unknown Inhibits metabolism and clearance ↑ INR	GI bleeding GI bleeding ↑ effects of warfarin. potential GI bleeding ↑ effects of warfarin. potential GI bleeding Bleeding
Digoxin	Amiodorone Clarithromycin Verapamil	↓ renal or nonrenal clearance of digoxin Inhibits renal clearance ↓ Cardiac impulse conduction & contraction	Digoxin toxicity Digoxin toxicity Potential bradycardia or heart block
Levothyroxine T_4	Calcium carbonate	L-thyroxine absorbs calcium carbonate in acidic environment	Reduced absorption of L-thyroxin
Glyburide	Co-trimoxazole	Potentiates effect of sulfonylureas	Hypoglycemia
Ace Inhibitors	Potassium-sparing diuretics	Unknown	Life-threatening hyperkalemia
Diuretic	NSAID	↓ renal perfusion	Renal impairment
Phenytoin (Dilantin)	Cimetidine, erythromycin, clarithromycin, fluconazole	Not specified	↑ levels of phenytoin within 1 week
Theophylline	Quinolones	↓ liver metabolism of Theophylline	Theophylline toxicity

Source: Zwicker, D., & Fulmer, T. (2008). *Chapter 12: Reducing adverse drug events*. In E. Capezuti, D. Zwicker, M. Mezey, T. Fulmer & D. Gray-Miceli (Eds.), *Evidence-based geriatric nursing protocols for best practice* (Third ed., pp. 257). New York: Springer Pub. .pp. 276-7.

APPENDIX C

APPROVAL LETTER TO USE CSF DATA

THE UNIVERSITY OF IOWA

COLLEGE OF PUBLIC HEALTH
Department of Occupational and Environmental Health

May 7, 2007

Dear Michelle Umbarger-Mackey,

I am familiar with your dissertation research project entitled "Older Farmers: Medication Use and Agricultural Injury" and your desire to use Certified Safe Farm (CSF) data that was collected from 1998-2003 (IRB ID #9708640).

As PI of the CSF study project, I agree to provide you with:

- CSF data collected from 1998 to 2003, including: farmer demographic information, medication usage, occupational demographics, health outcomes, medical history data, general health symptoms, agricultural exposures and PPE use, agricultural injury (including costs and treatment of injury)
- reasonable assistance to you in interpreting data provided by CSF
- permission to use these data for the purposes outlined in the dissertation project protocol

As a doctoral student at the University of Iowa, you agree to:

- treat these data provided by CSF in complete confidence
- restrict access to data provided by CSF to only members of your dissertation committee
- store data provided by CSF securely on the College of Public Health secure web server
- use data provided by CSF only for the purposes outlined in the dissertation project protocol or, for unforeseen purposes not described in the dissertation project protocol, only with the specific permission of CSF

We have also discussed the role of CSF data and I am satisfied that the identity and data of farmers that participated in the original CSF study are adequately protected as described in the research protocol. In addition, I understand that this research will be carried out following sound ethical principles and that involvement in this research, for both CSF and the farmers, is strictly voluntary and guarantees the protection of participant's privacy. In particular, we have discussed at length that I cannot provide you with data that might allow anyone to identify any farmer's answers unless permission has been specifically given by the subject. Therefore, CSF data to be used for your dissertation will be de-identified.

Therefore, as a representative of the Certified Safe Farm project, I agree to allow you to conduct your research using Certified Safe Farm data.

Sincerely,

Kelley J. Donham
PI, Certified Safe Farm Study
Professor, Department of Occupational and Environmental Health
UI College of Public Health

UI College of Public Health
100 Oakdale Campus, 124 IREH
Iowa City, Iowa 52242-5000
319-335-4415 *Fax* 319-335-4225
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APPENDIX D

HUMAN SUBJECTS APPROVAL

THE UNIVERSITY OF IOWA

Human Subjects Office
340 Medicine Administration Building
Iowa City, Iowa 52242-1101
319-335-6564 *Fax* 319-335-7310
irb@uiowa.edu
http://research.uiowa.edu/hso

IRB ID #: 200705781

To: Michelle Umbarger-Mackey

From: IRB-01 DHHS Registration # IRB00000099,
Univ of Iowa, DHHS Federalwide Assurance # FWA00003007

Re: Older Farmers: Medication Use and Agricultural Injury

Protocol Number:
Protocol Version:
Protocol Date:
Amendment Number/Date(s):

Approval Date: 06/17/07

Next IRB Approval Due Before: 06/16/08

Type of Application:	Type of Application Review:	Approved for Populations:
☒ New Project	☐ Full Board:	☐ Children
☐ Continuing Review	Meeting Date:	☐ Prisoners
☐ Modification	☒ Expedited	☐ Pregnant Women, Fetuses, Neonates
	☐ Exempt	

Source of Support:

Investigational New Drug/Biologic Name:
Investigational New Drug/Biologic Number:
Name of Sponsor who holds IND:

Investigational Device Name:
Investigational Device Number:
Sponsor who holds IDE:

This approval has been electronically signed by IRB Chair:
Martha Jones, CIP, MA
06/17/07 1001

IRB ID#: 200705781 06/17/07 Page 2 of 2

IRB Approval: IRB approval indicates that this project meets the regulatory requirements for the protection of human subjects. IRB approval does not absolve the principal investigator from complying with other institutional, collegiate, or departmental policies or procedures.

Agency Notification: If this is a New Project or Continuing Review application and the project is funded by an external government or non-profit agency, the original HHS 310 form, "Protection of Human Subjects Assurance Identification/IRB Certification/Declaration of Exemption," has been forwarded to the UI Division of Sponsored Programs, 100 Gilmore Hall, for appropriate action. You will receive a signed copy from Sponsored Programs.

Recruitment/Consent: Your IRB application has been approved for recruitment of subjects not to exceed the number indicated on your application form. If you are using written informed consent, the IRB-approved and stamped Informed Consent Document(s) are attached. Please make copies from the attached "masters" for subjects to sign when agreeing to participate. The original signed Informed Consent Document should be placed in your research files. A copy of the Informed Consent Document should be given to the subject. (A copy of the *signed* Informed Consent Document should be given to the subject if your Consent contains a HIPAA authorization section.) If hospital/clinic patients are being enrolled, a copy of the signed Informed Consent Document should be placed in the subject's chart, unless a Record of Consent form was approved by the IRB.

Continuing Review: Federal regulations require that the IRB re-approve research projects at intervals appropriate to the degree of risk, but no less than once per year. This process is called "continuing review." Continuing review for non-exempt research is required to occur as long as the research remains active for long-term follow-up of research subjects, even when the research is permanently closed to enrollment of new subjects and all subjects have completed all research-related interventions and to occur when the remaining research activities are limited to collection of private identifiable information. Your project "expires" at 12:01 AM on the date indicated on the preceding page ("Next IRB Approval Due on or Before"). You must obtain your next IRB approval of this project on or before that expiration date. You are responsible for submitting a Continuing Review application in sufficient time for approval before the expiration date, however the HSO will send a reminder notice approximately 60 and 30 days prior to the expiration date.

Modifications: Any change in this research project or materials must be submitted on a Modification application to the IRB for prior review and approval, except when a change is necessary to eliminate apparent immediate hazards to subjects. The investigator is required to promptly notify the IRB of any changes made without IRB approval to eliminate apparent immediate hazards to subjects using the Modification/Update Form. Modifications requiring the prior review and approval of the IRB include but are not limited to: changing the protocol or study procedures, changing investigators or funding sources, changing the Informed Consent Document, increasing the anticipated total number of subjects from what was originally approved, or adding any new materials (e.g., letters to subjects, ads, questionnaires).

Unanticipated Problems Involving Risks: You must promptly report to the IRB any serious and/or unexpected adverse experience, as defined in the UI Investigator's Guide, and any other unanticipated problems involving risks to subjects or others. The Reportable Events Form (REF) should be used for reporting to the IRB.

Audits/Record-Keeping: Your research records may be audited at any time during or after the implementation of your project. Federal and University policies require that all research records be maintained for a period of three (3) years following the close of the research project. For research that involves drugs or devices seeking FDA approval, the research records must be kept for a period of three years after the FDA has taken final action on the marketing application.

Additional Information: Complete information regarding research involving human subjects at The University of Iowa is available in the "Investigator's Guide to Human Subjects Research." Research investigators are expected to comply with these policies and procedures, and to be familiar with the University's Federalwide Assurance, the Belmont Report, 45CFR46, and other applicable regulations prior to conducting the research. These documents and IRB application and related forms are available on the Human Subjects Office website or are available by calling 335-6564.

APPENDIX E

CSF STUDY FLOWCHART

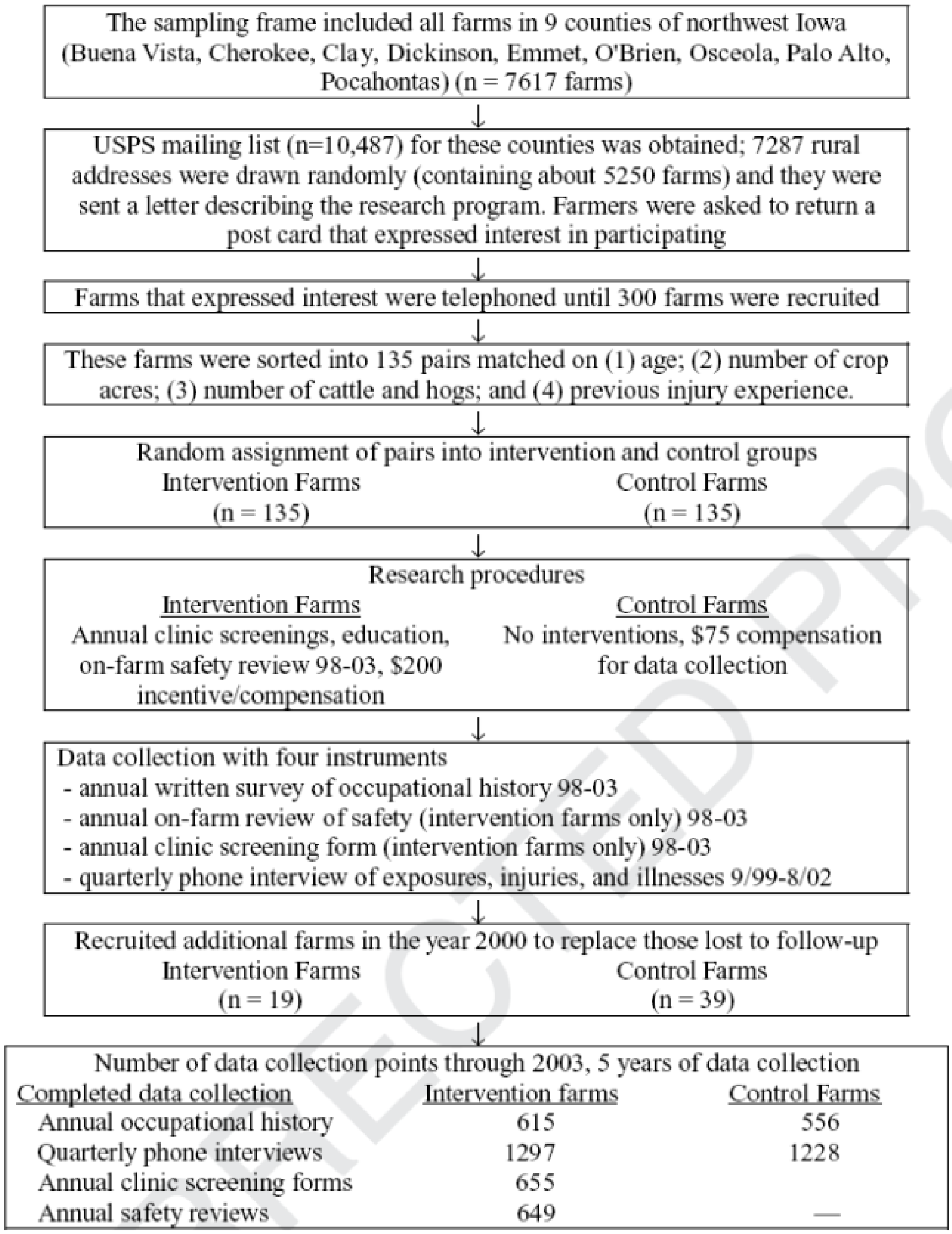
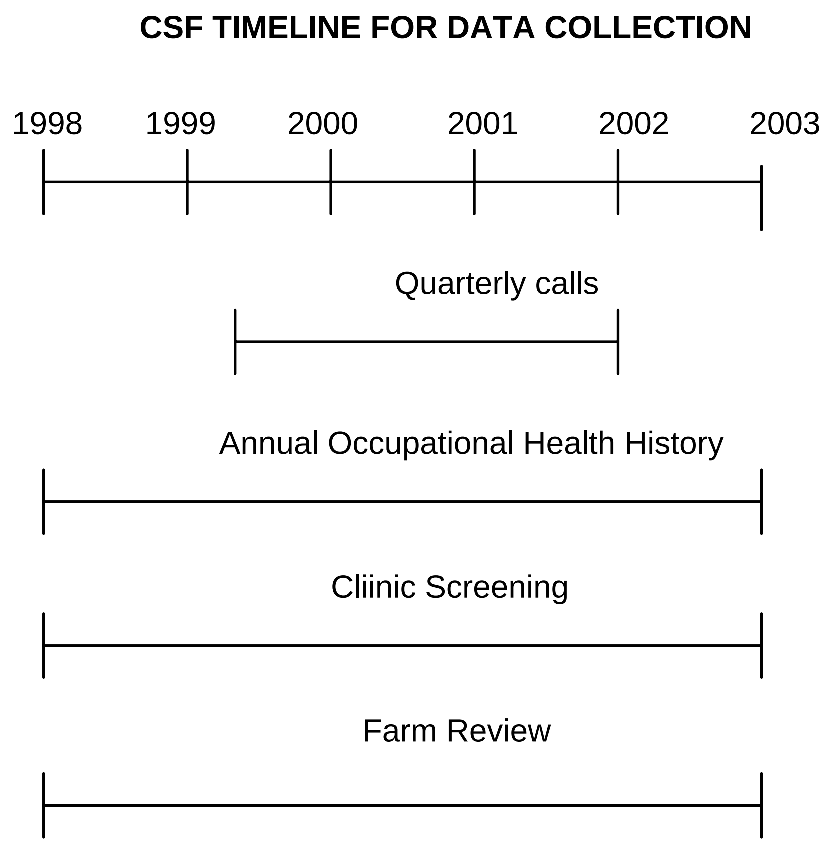


Figure E1: Flowchart for the identification of Study Population, Study Procedures, and the Collection of Data in the CSF original study

Source: Donham, K., & Thelin, A. (2006). *Agricultural medicine: Occupational and environmental health for the health professions*. Ames: Blackwell Publishing.Donham et al. (2007).

APPENDIX F

CSF TIMELINE FOR DATA COLLECTION



Data Collection	**Dates**
Quarterly Calls	9/1999-2002
Annual Occupational Health History	1998-2003
Clinic Screening	1998-2003
Farm Review	1998-2003

Figure F1: CSF timeline for data collection

APPENDIX G

AMERICAN HOSPITAL FORMULARY SERVICES (AHFS)

MEDICATION CLASSIFICATION

AHFS® PHARMACOLOGIC-THERAPEUTIC CLASSIFICATION©

0:01 Front Matter

4:00 Antihistamine Drugs

4:04 First Generation Antihistamines
- 4:04.04 Ethanolamine Derivatives
- 4:04.08 Ethylenediamine Derivatives
- 4:04.12 Phenothiazine Derivatives
- 4:04.16 Piperazine Derivatives
- 4:04.20 Propylamine Derivatives
- 4:04.92 Miscellaneous Derivatives

4:08 Second Generation Antihistamines
4:92 Other Antihistamines*

8:00 Anti-infective Agents

8:08 Anthelmintics§
8:12 Antibacterials
- 8:12.02 Aminoglycosides
- 8:12.06 Cephalosporins
  - 8:12.06.04 First Generation Cephalosporins
  - 8:12.06.08 Second Generation Cephalosporins
  - 8:12.06.12 Third Generation Cephalosporins
  - 8:12.06.16 Fourth Generation Cephalosporins
  - 8:12.06.20 Fifth Generation Cephalosporins
- 8:12.07 Miscellaneous β-Lactams
  - 8:12.07.04 Carbacephems
  - 8:12.07.08 Carbapenems
  - 8:12.07.12 Cephamycins
  - 8:12.07.16 Monobactams
- 8:12.08 Chloramphenicol
- 8:12.12 Macrolides
  - 8:12.12.04 Erythromycins
  - 8:12.12.12 Ketolides
  - 8:12.12.92 Other Macrolides
- 8:12.16 Penicillins
  - 8:12.16.04 Natural Penicillins
  - 8:12.16.08 Aminopenicillins
  - 8:12.16.12 Penicillinase-resistant Penicillins
  - 8:12.16.16 Extended-spectrum Penicillins
- 8:12.18 Quinolones
- 8:12.20 Sulfonamides
- 8:12.24 Tetracyclines
  - 8:12.24.12 Glycylcyclines
- 8:12.28 Antibacterials, Miscellaneous
  - 8:12.28.04 Aminocyclitols
  - 8:12.28.08 Bacitracins
  - 8:12.28.12 Cyclic Lipopeptides
  - 8:12.28.16 Glycopeptides
  - 8:12.28.20 Lincomycins
  - 8:12.28.24 Oxazolidinones
  - 8:12.28.28 Polymyxins
  - 8:12.28.30 Rifamycins
  - 8:12.28.32 Streptogramins
  - 8:12.28.92 Other Miscellaneous Antibacterials*

8:14 Antifungals
- 8:14.04 Allylamines
- 8:14.08 Azoles
- 8:14.16 Echinocandins
- 8:14.28 Polyenes
- 8:14.32 Pyrimidines
- 8:14.92 Antifungals, Miscellaneous

8:16 Antimycobacterials
- 8:16.04 Antituberculosis Agents
- 8:16.92 Antimycobacterials, Miscellaneous

8:18 Antivirals
- 8:18.04 Adamantanes

- 8:18.08 Antiretrovirals
  - 8:18.08.04 HIV Fusion Inhibitors
  - 8:18.08.08 HIV Protease Inhibitors
  - 8:18.08.12 Integrase Inhibitors
  - 8:18.08.16 Nonnucleoside Reverse Transcriptase Inhibitors
  - 8:18.08.20 Nucleoside and Nucleotide Reverse Transcriptase Inhibitors
  - 8:18.08.92 Antiretrovirals, Miscellaneous*
- 8:18.20 Interferons
- 8:18.24 Monoclonal Antibodies
- 8:18.28 Neuraminidase Inhibitors
- 8:18.32 Nucleosides and Nucleotides
- 8:18.40 HCV Protease Inhibitors
- 8:18.92 Antivirals, Miscellaneous

8:30 Antiprotozoals
- 8:30.04 Amebicides
- 8:30.08 Antimalarials
- 8:30.92 Antiprotozoals, Miscellaneous

8:36 Urinary Anti-infectives
8:92 Anti-infectives, Miscellaneous*

10:00 Antineoplastic Agents

12:00 Autonomic Drugs

12:04 Parasympathomimetic (Cholinergic) Agents
12:08 Anticholinergic Agents
- 12:08.04 Antiparkinsonian Agents*
- 12:08.08 Antimuscarinics/Antispasmodics

12:12 Sympathomimetic (Adrenergic) Agents
- 12:12.04 α-Adrenergic Agonists
- 12:12.08 β-Adrenergic Agonists
  - 12:12.08.04 Non-selective β-Adrenergic Agonists
  - 12:12.08.08 Selective β_1-Adrenergic Agonists
  - 12:12.08.12 Selective β_2-Adrenergic Agonists
- 12:12.12 α- and β-Adrenergic Agonists

12:16 Sympatholytic (Adrenergic Blocking) Agents
- 12:16.04 α-Adrenergic Blocking Agents
  - 12:16.04.04 Non-selective α-Adrenergic Blocking Agents
  - 12:16.04.08 Non-selective α_1-Adrenergic Blocking Agents
  - 12:16.04.12 Selective α_1-Adrenergic Blocking Agents
- 12:16.08 β-Adrenergic Blocking Agents
  - 12:16.08.04 Non-selective β-Adrenergic Blocking Agents
  - 12:16.08.08 Selective β-Adrenergic Blocking Agents

12:20 Skeletal Muscle Relaxants
- 12:20.04 Centrally Acting Skeletal Muscle Relaxants
- 12:20.08 Direct-acting Skeletal Muscle Relaxants
- 12:20.12 GABA-derivative Skeletal Muscle Relaxants
- 12:20.20 Neuromuscular Blocking Agents
- 12:20.92 Skeletal Muscle Relaxants, Miscellaneous

12:92 Autonomic Drugs, Miscellaneous

16:00 Blood Derivatives§

20:00 Blood Formation, Coagulation, and Thrombosis

20:04 Antianemia Drugs
- 20:04.04 Iron Preparations
- 20:04.08 Liver and Stomach Preparations*

Figure G1: AHFS medication classification schema

Source: AHFS. (2009). *AHFS DRUG INFORMATION 2009* (1st ed.). Bethesda, MD: American Society of Health-System Pharmacists®.

20:12 Antithrombotic Agents
- 20:12.04 Anticoagulants
  - 20:12.04.08 Coumarin Derivatives
  - 20:12.04.12 Direct Thrombin Inhibitors
  - 20:12.04.14 Direct Factor Xa Inhibitors
  - 20:12.04.16 Heparins
  - 20:12.04.92 Anticoagulants, Miscellaneous

20:12.14 Platelet-reducing Agents
20:12.18 Platelet-aggregation Inhibitors
20:12.20 Thrombolytic Agents
20:16 Hematopoietic Agents
20:24 Hemorrheologic Agents
20:28 Antihemorrhagic Agents
- 20:28.08 Antiheparin Agents
- 20:28.16 Hemostatics

24:00 Cardiovascular Drugs

24:04 Cardiac Drugs
- 24:04.04 Antiarrhythmic Agents
  - 24:04.04.04 Class Ia Antiarrhythmics
  - 24:04.04.08 Class Ib Antiarrhythmics
  - 24:04.04.12 Class Ic Antiarrhythmics
  - 24:04.04.16 Class II Antiarrhythmics*
  - 24:04.04.20 Class III Antiarrhythmics
  - 24:04.04.24 Class IV Antiarrhythmics
  - 24:04.04.92 Antiarrhythmics, Miscellaneous*
- 24:04.08 Cardiotonic Agents
- 24:04.92 Cardiac Drugs, Miscellaneous

24:06 Antilipemic Agents
- 24:06.04 Bile Acid Sequestrants
- 24:06.05 Cholesterol Absorption Inhibitors
- 24:06.06 Fibric Acid Derivatives
- 24:06.08 HMG-CoA Reductase Inhibitors
- 24:06.92 Antilipemic Agents, Miscellaneous

24:08 Hypotensive Agents
- 24:08.04 α-Adrenergic Blocking Agents*
- 24:08.08 β-Adrenergic Blocking Agents*
- 24:08.12 Calcium-Channel Blocking Agents*
  - 24:08.12.08 Dihydropyridines*
  - 24:08.12.92 Calcium-Channel Blocking Agents, Miscellaneous*
- 24:08.16 Central α-Agonists
- 24:08.20 Direct Vasodilators
- 24:08.24 Diuretics*
  - 24:08.24.04 Carbonic Anhydrase Inhibitors*
  - 24:08.24.08 Loop Diuretics*
  - 24:08.24.12 Osmotic Diuretics*
  - 24:08.24.16 Potassium-sparing Diuretics*
  - 24:08.24.20 Thiazide Diuretics*
  - 24:08.24.24 Thiazide-like Diuretics*
  - 24:08.24.92 Diuretics, Miscellaneous*
- 24:08.32 Peripheral Adrenergic Inhibitors
- 24:08.44 Renin-Angiotensin-Aldosterone System Inhibitors*
  - 24:08.44.04 Angiotensin-Converting Enzyme Inhibitors*
  - 24:08.44.08 Angiotensin II Receptor Antagonists*
  - 24:08.44.20 Mineralocorticoid (Aldosterone) Receptor Antagonists*
- 24:08.92 Hypotensive Agents, Miscellaneous*

24:12 Vasodilating Agents
- 24:12.08 Nitrates and Nitrites
- 24:12.12 Phosphodiesterase Type 5 Inhibitors
- 24:12.92 Vasodilating Agents, Miscellaneous

24:16 Sclerosing Agents
24:20 α-Adrenergic Blocking Agents
24:24 β-Adrenergic Blocking Agents
24:28 Calcium-Channel Blocking Agents
- 24:28.08 Dihydropyridines
- 24:28.92 Calcium-Channel Blocking Agents, Miscellaneous

24:32 Renin-Angiotensin-Aldosterone System Inhibitors
- 24:32.04 Angiotensin-Converting Enzyme Inhibitors
- 24:32.08 Angiotensin II Receptor Antagonists
- 24:32.20 Mineralocorticoid (Aldosterone) Receptor Antagonists
- 24:32.40 Renin Inhibitors

26:00 Cellular Therapy*

28:00 Central Nervous System Agents

28:04 General Anesthetics
- 28:04.04 Barbiturates
- 28:04.16 Inhalation Anesthetics*
- 28:04.92 General Anesthetics, Miscellaneous

28:08 Analgesics and Antipyretics
- 28:08.04 Nonsteroidal Anti-inflammatory Agents
  - 28:08.04.08 Cyclooxygenase-2 (COX-2) Inhibitors
  - 28:08.04.24 Salicylates
  - 28:08.04.92 Other Nonsteroidal Anti-inflammatory Agents
- 28:08.08 Opiate Agonists
- 28:08.12 Opiate Partial Agonists
- 28:08.92 Analgesics and Antipyretics, Miscellaneous

28:10 Opiate Antagonists
28:12 Anticonvulsants
- 28:12.04 Barbiturates
- 28:12.08 Benzodiazepines
- 28:12.12 Hydantoins
- 28:12.16 Oxazolidinediones*
- 28:12.20 Succinimides
- 28:12.92 Anticonvulsants, Miscellaneous

28:16 Psychotherapeutic Agents
- 28:16.04 Antidepressants
  - 28:16.04.12 Monoamine Oxidase Inhibitors
  - 28:16.04.16 Selective Serotonin- and Norepinephrine-reuptake Inhibitors
  - 28:16.04.20 Selective-serotonin Reuptake Inhibitors
  - 28:16.04.24 Serotonin Modulators
  - 28:16.04.28 Tricyclics and Other Norepinephrine-reuptake Inhibitors
  - 28:16.04.92 Antidepressants, M iscellaneous
- 28:16.08 Antipsychotics
  - 28:16.08.04 Atypical Antipsychotics
  - 28:16.08.08 Butyrophenones
  - 28:16.08.24 Phenothiazines
  - 28:16.08.32 Thioxanthenes
  - 28:16.08.92 Antipsychotics, Miscellaneous
- 28:16.92 Psychotherapeutic Agents, Miscellaneous*

28:20 Anorexigenic Agents and Respiratory and Cerebral Stimulants
- 28:20.04 Amphetamines
- 28:20.92 Anorexigenic Agents and Respiratory and Cerebral Stimulants, Miscellaneous

28:24 Anxiolytics, Sedatives, and Hypnotics
- 28:24.04 Barbiturates
- 28:24.08 Benzodiazepines
- 28:24.92 Anxiolytics, Sedatives, and Hypnotics; Miscellaneous

28:28 Antimanic Agents
28:32 Antimigraine Agents
- 28:32.28 Selective Serotonin Agonists
- 28:32.92 Antimigraine Agents, Miscellaneous*

28:36 Antiparkinsonian Agents
- 28:36.04 Adamantanes
- 28:36.08 Anticholinergic Agents
- 28:36.12 Catechol-*O*-Methyltransferase (COMT) Inhibitors
- 28:36.16 Dopamine Precursors

Figure G1 continued

28:36.20 Dopamine Receptor Agonists
28:36.20.04 Ergot-derivative Dopamine Receptor Agonists
28:36.20.08 Nonergot-derivative Dopamine Receptor Agonists
28:36.32 Monoamine Oxidase B Inhibitors
28:40 Fibromyalgia Agents
28:92 Central Nervous System Agents, Miscellaneous

32:00 Contraceptives (foams, devices)*

34:00 Dental Agents*

36:00 Diagnostic Agents

36:04 Adrenocortical Insufficiency§
36:08 Amyloidosis*
36:10 Appendicitis*
36:12 Blood Volume*
36:16 Brucellosis*
36:18 Cardiac Function*
36:24 Circulation Time*
36:26 Diabetes Mellitus*
36:28 Diphtheria*
36:30 Drug Hypersensitivity*
36:32 Fungi§
36:34 Gallbladder Function§
36:36 Gastric Function*
36:38 Intestinal Absorption§
36:40 Kidney Function§
36:44 Liver Function§
36:48 Lymphogranuloma Venereum*
36:52 Mumps§
36:56 Myasthenia Gravis§
36:58 Ocular Disorders*
36:60 Thyroid Function*
36:61 Pancreatic Function§
36:62 Phenylketonuria*
36:64 Pheochromocytoma*
36:66 Pituitary Function§
36:68 Roentgenography*
36:72 Scarlet Fever*
36:76 Sweating*
36:80 Trichinosis*
36:84 Tuberculosis
36:88 Urine and Feces Contents*
36:88.12 Ketones*
36:88.20 Occult Blood*
36:88.24 pH*
36:88.28 Protein*
36:88.40 Sugar*

38:00 Disinfectants (for agents used on objects other than skin)*

40:00 Electrolytic, Caloric, and Water Balance

40:04 Acidifying Agents
40:08 Alkalinizing Agents
40:10 Ammonia Detoxicants
40:12 Replacement Preparations
40:18 Ion-removing Agents
40:18.16 Sodium-removing Agents*
40:18.17 Calcium-removing Agents
40:18.18 Potassium-removing Agents
40:18.19 Phosphate-removing Agents
40:18.92 Other Ion-removing Agents
40:20 Caloric Agents
40:24 Salt and Sugar Substitutes*
40:28 Diuretics
40:28.04 Carbonic Anhydrase Inhibitors*
40:28.08 Loop Diuretics
40:28.12 Osmotic Diuretics
40:28.16 Potassium-sparing Diuretics
40:28.20 Thiazide Diuretics
40:28.24 Thiazide-like Diuretics
40:28.28 Vasopressin Antagonists
40:28.92 Diuretics, Miscellaneous
40:36 Irrigating Solutions§
40:40 Uricosuric Agents

44:00 Enzymes§

48:00 Respiratory Tract Agents

48:04 Antihistamines
48:04.04 First Generation Antihistamines*
48:04.08 Second Generation Antihistamines*
48:08 Antitussives
48:10 Anti-inflammatory Agents
48:10.08 Corticosteroids*
48:10.08.04 Nasal Preparations*
48:10.08.08 Orally Inhaled Preparations*
48:10.24 Leukotriene Modifiers
48:10.32 Mast-cell Stabilizers
48:12 Bronchodilators*
48:12.04 Adrenergic Agents*
48:12.04.08 Non-selective β-Adrenergic Agonists*
48:12.04.12 Selective β_2-Adrenergic Agonists*
48:12.04.16 α- and β-Adrenergic Agonists*
48:12.08 Anticholinergic Agents*
48:12.12 Xanthine Derivatives*
48:16 Expectorants
48:24 Mucolytic Agents*
48:32 Phosphodiesterase Type 4 Inhibitors
48:36 Pulmonary Surfactants§
48:48 Vasodilating Agents*
48:92 Respiratory Agents, Miscellaneous

52:00 Eye, Ear, Nose, and Throat (EENT) Preparations

52:02 Antiallergic Agents
52:04 Anti-infectives
52:04.04 Antibacterials
52:04.16 Antifungals
52:04.20 Antivirals
52:04.92 Anti-infectives, Miscellaneous
52:08 Anti-inflammatory Agents
52:08.08 Corticosteroids
52:08.20 Nonsteroidal Anti-inflammatory Agents
52:08.92 Anti-inflammatory Agents, Miscellaneous
52:12 Contact Lens Solutions*
52:16 Local Anesthetics
52:24 Mydriatics
52:28 Mouthwashes and Gargles
52:32 Vasoconstrictors
52:40 Antiglaucoma Agents
52:40.04 α-Adrenergic Agonists
52:40.08 β-Adrenergic Agents
52:40.12 Carbonic Anhydrase Inhibitors
52:40.20 Miotics
52:40.24 Osmotic Agents*
52:40.28 Prostaglandin Analogs
52:40.92 Antiglaucoma Agents, Miscellaneous*
52:92 EENT Drugs, Miscellaneous

56:00 Gastrointestinal Drugs

56:04 Antacids and Adsorbents
56:08 Antidiarrhea Agents
56:10 Antiflatulents
56:12 Cathartics and Laxatives
56:14 Cholelitholytic Agents*
56:16 Digestants
56:20 Emetics
56:22 Antiemetics
56:22.08 Antihistamines
56:22.20 $5\text{-}HT_3$ Receptor Antagonists
56:22.92 Antiemetics, Miscellaneous

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Figure G1 continued

56:24 Lipotropic Agents*
56:28 Antiulcer Agents and Acid Suppressants
56:28.12 Histamine H_2-Antagonists
56:28.28 Prostaglandins
56:28.32 Protectants
56:28.36 Proton-pump Inhibitors
56:28.92 Antiulcer Agents and Acid Suppressants, Miscellaneous
56:32 Prokinetic Agents§
56:36 Anti-inflammatory Agents
56:92 GI Drugs, Miscellaneous

60:00 Gold Compounds§

64:00 Heavy Metal Antagonists§

68:00 Hormones and Synthetic Substitutes

68:04 Adrenals
68:08 Androgens
68:12 Contraceptives
68:16 Estrogens and Estrogen Agonist-Antagonists
68:16.04 Estrogens
68:16.12 Estrogen Agonist-Antagonists
68:18 Gonadotropins§
68:20 Antidiabetic Agents
68:20.02 α-Glucosidase Inhibitors
68:20.03 Amylinomimetics
68:20.04 Biguanides
68:20.05 Dipeptidyl Peptidase IV (DDP-4) Inhibitors
68:20.06 Incretin Mimetics
68:20.08 Insulins
68:20.16 Meglitinides
68:20.20 Sulfonylureas
68:20.28 Thiazolidinediones
68:20.92 Antidiabetic Agents, Miscellaneous*
68:22 Antihypoglycemic Agents
68:22.12 Glycogenolytic Agents
68:22.92 Antihypoglycemic Agents, Miscellaneous*
68:24 Parathyroid
68:28 Pituitary
68:30 Somatotropin Agonists and Antagonists
68:30.04 Somatotropin Agonists
68:30.08 Somatotropin Antagonists
68:32 Progestins
68:34 Other Corpus Luteum Hormones*
68:36 Thyroid and Antithyroid Agents
68:36.04 Thyroid Agents
68:36.08 Antithyroid Agents

72:00 Local Anesthetics

76:00 Oxytocics

78:00 Radioactive Agents*

80:00 Serums, Toxoids, and Vaccines

80:04 Serums
80:08 Toxoids
80:12 Vaccines

84:00 Skin and Mucous Membrane Agents

84:04 Anti-infectives
84:04.04 Antibacterials
84:04.06 Antivirals
84:04.08 Antifungals
84:04.08.04 Allylamines
84:04.08.08 Azoles

84:04.08.12 Benzylamines
84:04.08.16 Echinocandins*
84:04.08.20 Hydroxypyridones
84:04.08.28 Polyenes
84:04.08.32 Pyrimidines*
84:04.08.40 Thiocarbamates
84:04.08.92 Antifungals, Miscellaneous
84:04.12 Scabicides and Pediculicides
84:04.92 Local Anti-infectives, Miscellaneous
84:06 Anti-inflammatory Agents
84:08 Antipruritics and Local Anesthetics
84:12 Astringents
84:16 Cell Stimulants and Proliferants
84:20 Detergents§
84:24 Emollients, Demulcents, and Protectants§
84:24.04 Basic Lotions and Liniments*
84:24.08 Basic Oils and Other Solvents*
84:24.12 Basic Ointments and Protectants*
84:24.16 Basic Powders and Demulcents*
84:28 Keratolytic Agents
84:32 Keratoplastic Agents
84:50 Depigmenting and Pigmenting Agents§
84:50.04 Depigmenting Agents§
84:50.06 Pigmenting Agents§
84:80 Sunscreen Agents§
84:92 Skin and Mucous Membrane Agents, Miscellaneous

86:00 Smooth Muscle Relaxants

86:08 Gastrointestinal Smooth Muscle Relaxants
86:12 Genitourinary Smooth Muscle Relaxants
86:16 Respiratory Smooth Muscle Relaxants

88:00 Vitamins

88:04 Vitamin A§
88:08 Vitamin B Complex§
88:12 Vitamin C§
88:16 Vitamin D§
88:20 Vitamin E§
88:24 Vitamin K Activity
88:28 Multivitamin Preparations§

92:00 Miscellaneous Therapeutic Agents

92:04 Alcohol Deterrents
92:08 5-α-Reductase Inhibitors
92:12 Antidotes
92:16 Antigout Agents
92:20 Biologic Response Modifiers
92:24 Bone Resorption Inhibitors
92:28 Cariostatic Agents§
92:32 Complement Inhibitors
92:36 Disease-Modifying Antirheumatic Agents
92:40 Gonadotropin-releasing Hormone Antagonists§
92:44 Immunosuppressive Agents
92:56 Protective Agents
92:92 Other Miscellaneous Therapeutic Agents

94:00 Devices*

96:00 Pharmaceutical Aids*

* Category is currently not in use in the printed version of *AHFS Drug Information*®.

§ Omitted from the print version of *AHFS Drug Information* because of space limitations. Copies of these monographs are available on the *AHFS Drug Information* web site, http://www.ahfsdruginformation.com. See the Preface for details on accessing this site.

Figure G1 continued

APPENDIX H

MODEL SELECTION

Table H1: Model selection

Variables	**p1**	**p2**	**p3**	**p4**	**p5**	**p6**	**p7**	**p8**
ACE	0.079	0.062	0.062	0.061	0.052	0.053	0.054	0.054
Alcohol	0.119	0.117	0.106	0.107	0.106	0.103	0.105	0.105
Alpha blockers	0.094	0.094	0.093	0.093	0.093	0.095	0.08	0.08
BP	0.999	.	.	.	.	.	.	.
Beta blockers	0.134	0.081	0.081	0.081	0.069	0.064	0.064	0.062
Cardiac meds	0.388	0.367	0.365	0.366	0.338	0.339	0.058	0.059
Blood formation meds	0.039	0.04	0.039	0.039	0.032	0.034	0.035	0.035
Cardiac meds	0.693	0.659	0.658	0.658	0.625	0.638	0.634	0.635
Class24*C	0.803	0.801	0.8	0.8	0.809	.	.	.
CNS meds	0.645	0.639	0.639	0.637	0.452	0.425	0.422	0.428
Autonomic meds	0.685	0.686	0.691	0.688	0.691	0.629	0.664	0.666
GI meds	0.466	0.465	0.467	0.465	0.465	0.49	0.402	0.399
Hormones	0.163	0.163	0.163	0.162	0.164	0.168	0.053	0.051
Anti-infective meds	0.747	0.746	0.746	0.746	0.75	0.756	0.815	.
Vitamins	0.485	0.484	0.48	0.479	0.471	0.465	0.492	0.492
Other meds	0.614	0.609	0.609	0.611	0.612	0.632	0.35	0.356
Depression	0.222	0.222	0.225	0.223	0.223	0.224	0.22	0.211
EXP1_dust	0.243	0.245	0.24	0.236	0.236	0.239	0.24	0.243
EXP2_noise	0.09	0.09	0.091	0.091	0.091	0.092	0.092	0.09
EXP3_chemicals	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
EXP4_lifting	0.035	0.036	0.034	0.034	0.033	0.033	0.033	0.033
Pain meds	0.893	0.893	0.892	0.894	.	.	.	.
Taking med	0.294	0.293	0.293	0.288	0.288	0.208	0.218	0.217
# CNS meds	0.761	0.756	0.755	0.754	0.749	0.703	0.569	0.572
# meds per quarter	0.782	0.781	0.781	0.781	0.787	0.791	.	.
Age: old/young	0.289	0.289	0.297	0.304	0.308	0.3	0.292	0.293
Csf status	0.954	0.953	0.953	.	.	.	.	.
Education	0.675	0.675	0.678	0.685	0.691	0.699	0.687	0.679
Farm acres	0.977	0.977	.	.	.	.	.	.
General health	0.045	0.046	0.048	0.047	0.047	0.048	0.048	0.044
Hours work per week	0.591	0.591	0.581	0.58	0.583	0.587	0.59	0.592
Livestock	0.026	0.02	0.018	0.018	0.018	0.019	0.019	0.019
Stress	0.75	0.752	0.751	0.748	0.747	0.746	0.747	0.743

Table H1 continued

Variables	**p9**	**p10**	**p11**	**p12**	**p13**	**p14**	**p15**	**p16**
ACE	0.054	0.053	0.051	0.05	0.063	0.057	0.059	0.059
Alcohol	0.105	0.105	0.091	0.089	0.115	0.108	0.106	0.108
Alpha blockers	0.075	0.075	0.078	0.08	0.145	0.166	0.176	0.178
BP	.	.	.	.	.	.	.	.
Beta blockers	0.062	0.06	0.061	0.059	0.045	0.048	0.048	0.047
Cardiac meds	0.055	0.062	0.068	0.058	0.046	0.047	0.054	0.04
Blood formation meds	0.032	0.033	0.041	0.043	0.033	0.06	0.034	0.021
Cardiac meds	0.671	.	.	.	.	.	.	.
Class24*C	.	.	.	.	.	.	.	.
CNS meds	0.413	0.436	0.422	0.468	0.484	0.524	0.89	.
Autonomic meds	0.653	0.655	0.66	.	.	.	.	.
GI meds	0.388	0.384	0.386	0.359	0.3	0.266	0.27	0.217
Hormones	0.051	0.051	0.047	0.037	0.035	0.031	0.032	0.027
Anti-infective meds	.	.	.	.	.	.	.	.
Vitamins	0.513	0.514	0.528	0.546	0.558	.	.	.
Other meds	0.32	0.318	0.312	0.273	0.399	0.377	0.393	0.388
Depression	0.144	0.146	0.158	0.148	0.129	0.137	0.137	0.138
EXP1_dust	0.24	0.241	0.247	0.234	0.247	0.248	0.248	0.246
EXP2_noise	0.091	0.09	0.097	0.097	0.104	0.108	0.104	0.102
EXP3_chemicals	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
EXP4_lifting	0.03	0.029	0.029	0.028	0.031	0.031	0.03	0.031
Pain meds	.	.	.	.	.	.	.	.
Taking med	0.205	0.203	0.192	0.085	0.072	0.072	0.071	0.018
# CNS meds	0.539	0.572	0.545	0.521	0.556	0.526	.	.
# meds per quarter	.	.	.	.	.	.	.	.
Age: old/young	0.3	0.304	0.339	0.337	0.325	0.303	0.312	0.316
Csf status	.	.	.	.	.	.	.	.
Education	0.659	0.658	.	.	.	.	.	.
Farm acres	.	.	.	.	.	.	.	.
General health	0.044	0.045	0.048	0.048	0.04	0.044	0.042	0.042
Hours work per week	0.558	0.556	0.55	0.552	.	.	.	.
Livestock	0.021	0.021	0.016	0.016	0.021	0.025	0.024	0.024
Stress	.	.	.	.	.	.	.	.

Table H1 continued

Variables	p17	p18	p19	p20	p21	p22
ACE	0.061	0.062	0.059	0.061	0.061	**0.061**
Alcohol	0.095	0.091	0.083	0.123	0.139	**.**
Alpha blockers	0.161	0.14	0.132	0.146	.	**.**
BP	.	.	.	.	.	**.**
Beta blockers	0.062	0.064	0.065	0.061	0.073	**0.057**
Cardiac meds	0.049	0.051	0.066	0.048	0.059	**0.059**
Blood formation meds	0.026	0.023	0.041	0.051	0.042	**0.026**
Cardiac meds	.	.	.	.	.	**.**
Class24*C	.	.	.	.	.	**.**
CNS meds	.	.	.	.	.	**.**
Autonomic meds	.	.	.	.	.	**.**
GI meds	0.243	0.242	.	.	.	**.**
Hormones	0.016	0.017	0.019	0.014	0.016	**0.021**
Anti-infective meds	.	.	.	.	.	**.**
Vitamins	.	.	.	.	.	**.**
Other meds	.	.	.	.	.	**.**
Depression	0.133	0.127	0.117	0.113	0.105	**0.097**
EXP1_dust	0.25	.	.	.	.	**.**
EXP2_noise	0.105	0.036	0.041	0.042	0.04	**0.039**
EXP3_chemicals	<.001	<.001	<.001	<.001	<.001	**<.001**
EXP4_lifting	0.03	0.017	0.017	0.013	0.013	**0.016**
Pain meds	.	.	.	.	.	**.**
Taking meds	0.019	0.02	0.04	0.052	0.05	**0.04**
# CNS meds	.	.	.	.	.	**.**
# meds per quarter	.	.	.	.	.	**.**
Age: old/young	0.25	0.225	0.232	.	.	**.**
Csf status	.	.	.	.	.	**.**
Education	.	.	.	.	.	**.**
Farm acres	.	.	.	.	.	**.**
General health	0.039	0.041	0.046	0.048	0.047	**0.034**
Hours work per week	.	.	.	.	.	**.**
Livestock	0.026	0.025	0.024	0.016	0.018	**0.02**
Stress	.	.	.	.	.	**.**

Note: Final model variables in **bold type**

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