

Health, Medication Use and Agricultural Injury: A Review

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Abstract

Agricultural work in the United States and Canada continues to be one of the most dangerous vocations, and surveillance evidence suggests that older farmers (aged 60 years and older) are at greater risk of serious injury than their younger counterparts. The purpose of this paper is to outline illnesses and medications that may contribute to older farmers' increased risk of agricultural injury. A review of farm injury literature was conducted examining disease and medication factors related to injury.

The older farm population is growing and will continue to grow into the future. Health care providers in rural areas need to be aware of the lifestyle and types of activities older farmers engage in while they continue to contribute to farm production. Farmers and farm families need to work closely with their health care providers to ensure issues such as chronic illnesses and polypharmacy do not add excessive risk to older farmers and that diseases and health conditions are managed in the most appropriate manner. It is incumbent on health care systems and professionals to address health and illness issues that can mitigate the injury burden for the individual farmer and for society.

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Introduction

Agricultural work in the United States and Canada continues to be one of the most dangerous vocations (Brison & Pickett, 1995; Bureau of Labor Statistics, 2006; Frank, McKnight, Kirkhorn, & Gunderson, 2004; McCurdy & Carroll, 2000; Pickett, Hartling, Brison, & Guernsey, 1999; Voaklander, Hartling, Pickett, Dimich-Ward, & Brison, 1999). In 2005, agriculture had the highest occupational fatality rate in the United States (US) with 32.5 fatalities per 100,000 workers; this is a 23% increase from 2004 (CFOI, 2006), while in Canada the fatality rate is somewhat lower at about 20.3 fatalities per 100,000 workers, ranking it as Canada's fourth most dangerous occupation (Pickett et al., 1999).

North America is experiencing a significant demographic shift which has resulted in a larger proportion of older individuals in the population. In the US in 2005, there were an estimated 36.8 million people or 12.4% of the total population aged 65 and older; and by the year 2030, this older population is expected to more than double and reach an estimated 71.5 million (Administration on Aging, 2006). The latest Canadian census (2006) estimates that the proportion of those aged 65 and older will double in Canada by 2031 reaching an estimated eight million or 21% of the total population (Statistics Canada,).

This noteworthy trend in aging has also been prominent in the agricultural sector in both the US and Canada. Among all occupations in the US in 1998, farming had the highest percentage (68.5%) of workers over the age of 45, which is more than twice the average for all US employees (33.7% of all US employees are over age 45) (Bureau of Labor Statistics, 2000). The National Agricultural Statistics Service (NASS) reported that the average age of principal

farm operators in the US in 2002 was 55.3 years old (Allen & Harris, 2005). To complicate matters, many farmers continue to perform farm work well beyond the typical retirement age of workers characteristically engaged in heavy physical labor or work involving heavy machinery. The purpose of this paper is to present research on the health or disease related factors and medications that may increase the risk of injury for older farmers.

Background

Throughout the agriculture and injury literature, research has consistently established that older farmers are at greater risk for fatal agricultural injury than younger farmers. Myers et al. (1999) explored data from two national occupational fatality databases and found that fatality rates for older farmers ranged from 39.2 to 57.8 per 100,000 farm workers. The National Safety Council found that farmers over the age of 75 had a death rate of 57 per 100,000 making them more than twice as likely to die while farming than younger farmers (NSC, 2003). Using national data from the Census of Fatal Occupational Injury (CFOI) for fatal injuries in production agriculture in the US in the years 1992-1998, (Hard, Myers, & Gerberich, 2002) found that workers aged 55 and older comprised approximately 52% of these fatalities. In Canada, the injury related mortality rate for farmers increases steeply after the age of 60. For example, for ages 60-69 the injury rate is 23.2/100,000 workers; this climbs to 50.8/100,000 for ages 70-79, and 65.1/100,000 for ages 80 and older (Voaklander et al., 1999). The vast majority of deaths in older farmers occur while they are engaged in work that is typical of farmers of all ages (Voaklander et al., 1999).

In other heavy industries, legislation and enforcement of safety standards have led to reductions in the number and severity of injuries experienced by workers. However, these

regulatory approaches are often considered unpalatable within much of the agricultural community (Kelsey, 1994; Murphy, 1992). Therefore, injury control specialists have been forced to identify intervention points that are either outside of a legislative/enforcement strategy, or to provide substantive evidence that specific safety standards be developed and applied.

Farming as an occupation demands a variety of skills that come under the general label of human sensorimotor performance. These include skills in vision, hearing, memory, and vigilance, as well as the ability to make decisions while performing both complex and repetitive tasks (Murphy, Purschwitz, Mahoney, & Hoskin, 1993). The integration of these skills influences a person's ability to work effectively in the farm workplace, and degradation of any of these skills through disability or disease may increase their risk for injury. Experimental and epidemiological evidence also suggests that the use of certain medications is associated with increased risks for personal injury (Harrison, Subhan, & Hindmarch, 1985; Hindmarch, 1997; Leipzig, Cumming, & Tinetti, 1999a; Leipzig, Cumming, & Tinetti, 1999b; Mattila, 1984; Ridout & Hindmarch, 2001), and this may be especially true for farmers who are working in mechanized and other potentially high-risk situations (Elkington, 2002).

While there are many distinct circumstances where injuries occur to older farmers (Golonka, Belton, Strain, Hunter, & Voaklander, 2007; Golonka, Belton, Strain, Hunter, & Voaklander, In Press; Pickett et al., 2001; Voaklander et al., 1999) there are some injury mechanisms that appear to be more prevalent. The leading sources of fatal injury included tractors, animals, and mowing machines in which older farm workers accounted for more than 60% of the fatalities (Myers et al., 1999). In the US, 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, Truszczynska, Reed, & McKnight, 1998; Rautiainen, Lange, Hodne,

Schneiders, & Donham, 2004; Zhou & Roseman, 1995; Zwerling et al., 1995). In Canada, the distribution of injuries and fatalities in older farmers has been compared to their younger counterparts through the Canadian Agricultural Injury Surveillance Program (Golonka et al., 2007; Golonka et al., In Press; Voaklander et al., 1999). These data indicate that the operation of tractors is commonly related to older farmer injury and fatality. For non-machinery injury, the most common type of injury cause is falls. For tractor and machinery related injury and fatality, it is also frequent for the older operator to have fallen from the machinery being used. Thus, work from studies that have identified disease and medication related risk factors for fall and driver related injury in seniors may also be informative.

Methods

Literature searches were conducted using Medline and CINAHL health literature databases. Key words included: farm, farmer, agriculture, agricultural, injury, injuries, trauma, accident, factor, risk, incidence and prevalence. Reports were excluded if they were: (a) review articles, (b) case studies, case series or surveillance articles, (c) unpublished studies or theses or (d) non-English publications.

Results

A total of 24 studies reported at least one health or disease risk factor that was significantly related to farm injury (Table 1). Seven studies reported that medication use was related to farm injury (Table 2). Four of these studies reported on specific medication classes (Table 2).

Discussion

Health and Disease Related Risk Factors for Farm Injury

Almost certainly the most common health problem related to farm injury is prior injury (Browning et al., 1998; Carlson et al., 2005; Carruth, Skarke, Moffett, & Prestholdt, 2001; Low, Griffith, & Alston, 1996; McGwin, Enochs, & Roseman, 2000; Shipp et al., 2007; Tiesman et al., 2006; Voaklander et al., 2006; Zhou & Roseman, 1994). For owner-operators, there may be a tendency to return to active farming prior to fully functional conditioning after suffering an injury. The work is self-paced; however, reaction to the farm environment may be impacted by acute or chronic strength, endurance or mobility limitations caused by previous injury. Rehabilitation in rural settings may be less available and preparation for the resumption of rigorous farming activity after injury or disability may be inadequate. A major predictor of re-injury in both sports (Voaklander, Saunders, & Quinney, 1998) and occupational settings (Voaklander, Beaulne, & Lessard, 1995) is previous injury and lack of comprehensive rehabilitation. Alternatively, prior injury may be a marker for poor farm safety practices or the presence of older, less-safe equipment (Browning et al., 1998).

Another common health problem related to farm injury in farmers is a hearing deficit (Choi et al., 2005; Sprince et al., 2002; Sprince et al., 2003; Sprince, Zwerling, Lynch, Whitten, Thu, Gillette et al., 2003; Sprince, Zwerling, Lynch, Whitten, Thu, Logsden-Sackett et al., 2003). Hearing loss can contribute to injury by preventing older farmers from becoming aware of hazardous situations as well as limiting their ability to respond to communication from others in work situations (Hager, 2002). Hearing loss is extremely prevalent among farmers due to constant exposure to high levels of noise from tractors, machinery, chain-saws and shop

maintenance activities (Eddington, Moore, Rooney, & Pensiero, 1995; Solecki, 1998; Williams, Forby-Atkinson, Purdy, & Gartshore, 2002). Combined with these noise hazards is the relatively slow uptake of personal hearing protection in the farm community (Day, Boulter, & McGrath, 1999; Karlovich, Wiley, Tweed, & Jensen, 1988; McCullagh, Lusk, & Ronis, 2002).

Sleep deprivation has been identified as a risk factor for farm injury along with the most common treatment for sleep disorders, benzodiazepines (Low et al., 1996; Spengler, Browning, & Reed, 2004; Sprince, Zwerling, Lynch, Whitten, Thu, Logsdon-Sackett et al., 2003; Stallones, Beseler, & Chen, 2006; Voaklander et al., 2006). Chronic lack of quality sleep may lead to daytime sleepiness, inattention to tasks and an inability to respond appropriately to hazards in the farm environment. Sleep disorders can be caused by asthma, heart problems, Parkinson's disease, stroke, diseases related to frequent urination and arthritis-related pain (Conn & Madan, 2006; Woodward, 1999).

Arthritis has also been linked to farm injury among farmers (Sprince et al., 2003; Sprince, Zwerling, Lynch, Whitten, Thu, Gillette et al., 2003; Voaklander et al., 2006). As well, joint mobility problems and back pain have been found to be related to subsequent farm injury (Carruth et al., 2001; Hwang et al., 2001; Shipp et al., 2007). One study found that limited work capacity due to any health problem or impairment was related to further injury (Lewis et al., 1998). Older farmers coping with chronic mobility problems caused by arthritis or pain may have significant limitations when reacting to a lively work environment that includes machinery, large animals and other hazards. Arthritis and joint function is a major predictor of injury in older persons due to impaired movement, balance and pain-related mobility limitations (Alencar et al., 2007; Arden et al., 1999; Jones et al., 1995).

Depression has also been correlated with farm injury (Park et al., 2001; Tiesman et al., 2006; Zwerling et al., 1995), as well as to injury in other settings (Carroll, Cassidy, & Cote, 2004; Currie & Wang, 2005; Galambos, Terry, Moyle, Locke, & Lane, 2005; Peele & Tollerud, 2005). It is not clear how depression leads to injury, but farmers could be at risk due to behavioral anomalies, inattention or dissatisfaction with farm-related job tasks (Zwerling et al., 1995). Depression is also linked to chronic muscular-skeletal injury which in itself is a determinant of further acute injury (Brisson, Vezina, & Vinet, 1992; Rosecrance, Rodgers, & Merlino, 2006; Tjepkema, 2003). In addition to depression, excessive stress has also been linked to farm injury (Low et al., 1996; Simpson, Sebastian, Arbuckle, Bancej, & Pickett, 2004). Emotional responses to acute and chronic stress may impede reaction time due to high levels of cognitive activity devoted to the stressors (Simpson et al., 2004). Stress can also increase physiologic activity and elevate hormone levels, which may lead to fatigue and an inability to competently deal with a demanding work environment (Dienstbier, 1989; Gump & Matthews, 1999; Matthews, Gump, & Owens, 2001; Pruessner, Hellhammer, & Kirschbaum, 1999; Schmidt-Reinwald et al., 1999).

Several other health risk factors have been linked to injury in single studies. Neurotoxicity symptoms were related to injury in Ohio farmers (Crawford et al., 1998). The risk of receiving an injury may be increased due to long term peripheral nerve damage or neurobehavioral symptoms such as confusion, drowsiness or poor concentration (Crawford et al., 1998). Asthma has recently been identified as a risk factor for back-injury in the farm population (Sprince et al., 2007). Investigators have suggested that hypersensitivity to allergens and asthmatic reactions may be related to altered reactions to mechanical stressors leading to agricultural injury (Hurwitz & Morgenstern, 1999; Sprince et al., 2007). Urinary tract disorders in older male farmers have also been linked to injury (Voaklander et al., 2006). This may be due

to the distraction caused by the inability to urinate and fully empty the bladder, the exacerbation of postural and mobility problems, or urgency to urinate which may increase the haste in which farm activities are conducted (Voaklander et al., 2006).

Like farm equipment operation, driving is a complex task that requires accurate sensory input, rapid information processing, reliable judgment and fast motor responses. Declines in these abilities associated with the aging process have been related to poor driving performance observed in older drivers. Disease and disability risk factors include deterioration of visual ability (Klein, 1991; Kline et al., 1992; Kosnik, Sekuler, & Kline, 1990; Wood & Troutbeck, 1995), hearing impairment (McCloskey, Koepsell, Wolf, & Buchner, 1994), and loss of reaction time, muscle strength, and joint flexibility (Isler, Parsonson, & Hansson, 1997; Marottoli & Drickamer, 1993; Stelmach & Nahom, 1992). In addition, declines in cognitive abilities, the onset of dementia and other neurological disorders have also been related to car crashes among older persons (Drachman & Swearer, 1993; Dubinsky et al., 1991; Fisk, Owsley, & Pulley, 1997; Marottoli & Drickamer, 1993; Owsley et al., 2001; Owsley, Stalvey, Wells, Sloane, & McGwin, 2001; Stelmach & Nahom, 1992). Other conditions related to motor vehicle collision in older persons include hypoglycemia (diabetes) (Cox, Clarke, GonderFrederick, & Kovatchev, 2001; Cox et al., 2003; Cox et al., 2006), heart disease (McGwin et al., 2000), stroke (McGwin et al., 2000) and syncope (Rehm & Ross, 1995).

Deficiencies in an older person's health status may also precipitate fall-related injury, even among those who live an active life such as farmers (Speechley & Tinetti, 1991). In general these deficiencies affect an individual's ability to maintain balance during activities of daily living such as walking and transferring (Ross, 1991). Usually, a single disease or characteristic is not at fault, with many fallers having an array of fall related risk factors. Vision

is often worse, especially at night, causing difficulty in seeing hazards such as electrical cords or uneven ground (Felson et al., 1989; Grisso, Schwarz, Wolfson, Polansky, & LaPann, 1992; Lord, Clark, & Webster, 1991a; Lord, Clark, & Webster, 1991b). Balance may also deteriorate; thus, gait patterns may change over time with persons having more propensity to sway (Alexander, 1996; Thornby, 1995; Wolfson, Whipple, Amerman, & Tobin, 1990), to have limited foot lift during walking (Alexander, 1996; Isaacs, 1985), and to be less agile (Alexander, 1996; Thornby, 1995; Wolfson et al., 1990). The need to urinate, which commonly increases with age, is also linked to increased fall risk (Baker, 1992; Fleming & Pendergast, 1993).

Disease and disability risk factors which affect balance and coordination include orthostatic and post-prandial hypotension (Lipsitz, 1985), syncope (Blake et al., 1988; Perry, 1982; Prudham & Evans, 1981), cardiac arrhythmias (Rigler, 1999), peripheral neuropathies (Richardson & Ashton-Miller, 1996; Rigler, 1999), visual disturbances (Cohn & Lasley, 1985; Maino, 1996; Owen, 1985), arthritis (Campbell et al., 1990), dementia (Morris, Rubin, Morris, & Mandel, 1987), Parkinsonism (Rigler, 1999; Rogers, 1996), past stroke (Prudham & Evans, 1981), transient ischemic attacks (Rigler, 1999), malnutrition (Vellas et al., 1992), age-related decreases in sight, reaction time, sensory awareness, and impairment of reflexes (Brandt & Dieterich, 1993; Felson et al., 1989; Grisso et al., 1992; Lord, Clark, & Webster, 1991b; Rigler, 1999).

Medication Use and Older Persons

Research has found that pharmacokinetics and pharmacodynamics in older persons are poorly understood (Mohane & Avorn, 1996). Pharmacokinetics is the process of what the body does to the drug. Four separate items determine the relationship between drug dosage and what concentration is in the blood: absorption, distribution, metabolism, and excretion (Bressler &

Bahl, 2003; Ginsberg, Hattis, Russ, & Sonawane, 2005; Vestal, Montamat, & Nielson, 1992). The rate of absorption into the blood is virtually identical for both young and old patients (Bressler & Bahl, 2003; Cusack & Vestal, 1986). In older persons, changes in body composition of lean body mass and body water alters the manner in which drugs are distributed within the body (Bressler & Bahl, 2003; McLean & Le Couteur, 2004; Shader, Greenblatt, Harmatz, Franke, & Koch-Weser, 1977). Drugs are also metabolized differently in older persons with certain classes of drugs being less predisposed to metabolize as quickly as in younger individuals (Bressler & Bahl, 2003; Mohane & Avorn, 1996). Finally, there is decreased renal blood flow and fewer nephrons in older persons, therefore when drugs depend on the kidneys for elimination, there is a time delay over what one would expect in younger patients (Bressler & Bahl, 2003; Rowe, Andres, Tobin, Norris, & Shock, 1976).

Pharmacodynamics involves the process of what the drug does to the body. There has been relatively little work done in this area; so, it is not clear how all classes of drugs react in older persons (Mohane & Avorn, 1996). However, some studies suggest an increased sensitivity in older persons to drug dosages when compared to younger patients (Mohane & Avorn, 1996).

A more commonly referred to issue with medication use in older persons is polypharmacy (Frazier, 2005). Polypharmacy, the concurrent use of several medications, has become more prevalent in adults 50 years of age and older. Every year new medications are discovered to treat a wide range of chronic and acute disease processes. The American Association of Retired Persons (AARP) reported that 76% of adults aged 45 and older take at least one prescription drug on a regular basis and the average number of medications taken concurrently is four (American Association of Retired Persons, 2005). The AARP also found that the incidence of prescription drug use increases with each successive age category with over

half of respondents (56%) 45-49 years, (75%) age 50-64 years, and (87%) age 65+ using prescription drugs on a regular basis (American Association of Retired Persons, 2005). Multiple diseases in older persons predispose them to be multiple medication users. Additionally, multiple drugs consumed by an individual can cause postural hypotension and confusion and can interfere with an individual's orientation and coordination (Ross, 1991). The community-dwelling older person can consume an average of 12-15 prescription and over-the-counter medications daily (Vernon, 1994). In addition, irregular and incorrect medication use is more prevalent in older individuals (Frazier, 2005; Macdonald, 1985).

Medication Use and Injury in Farmers

Pickett, Chipman, Brison, & Holness (1996) reported an association between the use of stomach medication and injury in all farmers sampled and a relationship between the use of heart medication and injury in farmers over the age of 45 years. Sprince, Zwerling, Lynch, Whitten, Thu, Gillette et al. (2003), Sprince, Zwerling, Lynch, Whitten, Thu, Logsdan-Sackett et al. (2003), and Xiang, Stallones, & Chiu (1999) have all reported that the use of any prescription medication was an independent risk factor for farm injury. Several studies have examined the relationship between specific medication types and farm injury. Spengler et al. (2004) and Voaklander et al. (2006) reported an increased risk of injury for individuals taking sleeping medication. Voaklander et al. (2006) reported that the recent use of narcotic pain killers and non-steroidal anti-inflammatories were strongly predictive of subsequent injury. Most recently, Tiesman et al. (2006) reported a relationship between the use of anti-depressant medication and farm injury.

Medication use is an intrinsic factor that has been related to motor vehicle collision (MVC) in older persons. There are several drug classes that have been associated with the risk of MVC in older persons. Studies have reported that psychotropic drugs such as benzodiazepines (Hemmelgarn, Suissa, Huang, Boivin, & Pinard, 1997; Neutel, 1995; Oster, Huse, Adams, Imbimbo, & Russell, 1990) and antidepressants (Koepsell et al., 1994; van Laar, van Willigenburg, & Volkerts, 1995) are related to MVCs in older persons. In addition, angiotensin converting enzyme (ACE) inhibitors, anticoagulants and non-steroidal anti-inflammatory medication have been related to an increased risk of being involved in an at-fault automobile crash (McGwin, Sims, Pulley, & Roseman, 2000).

There are several drug classifications that have been associated with the risk of falling in older persons. Sedative and hypnotic drugs such as benzodiazepines have been strongly related to falls in older persons in a number of studies (Cumming et al., 1991; Herings, Stricker, de Boer, Bakker, & Sturmans, 1995; Leipzig, Cumming, & Tinetti, 1999a; Leipzig, Cumming, & Tinetti, 1999b; Mohane & Avorn, 1996; Mustard & Mayer, 1997; Neutel, Hirdes, Maxwell, & Patten, 1996; Thapa, Gideon, Fought, & Ray, 1995; Tinetti, Speechley, & Ginter, 1988). The chance of having a fall for individuals using these medications has been reported to be 70 to 200 percent higher than in non-users (Mohane & Avorn, 1996).

Drugs that lower blood pressure and/or pulse that are commonly used in the treatment of hypertension, cardiovascular conditions, and diabetes may cause precipitous drops in blood pressure, particularly when moving from a sitting to a standing position (Demarest, Osler, & Clevenger, 1990; Leipzig, Cumming, & Tinetti, 1999b; Macdonald, 1985; Mohane & Avorn, 1996). Additionally, diuretics or potassium supplements may cause orthostatic hypotension (Leipzig, Cumming, & Tinetti, 1999b; Ross, 1991), while many antidepressants may also

contribute to this condition (Davie, Blumenthal, & Robinson-Hawkins, 1981; Leipzig, Cumming, & Tinetti, 1999a).

Recommendations

Based on this review there are several areas where recommendations are merited. The first is in the area of muscular-skeletal pain including back-pain, arthritis and recovery from previous injury. Farmers should be advised to seek out and follow through with a return-to-work plan in conjunction with their health care providers. Premature return to work can expose the farmer to excess hazard in the farm work environment and lead to additional injury. Further, if a regimen of pain medication has been prescribed, farmers are advised to not prematurely end this therapy as pain is a significant risk factor for further injury. If work must be conducted due to farm demands, farmers are advised to seek assistance with chores if suffering from activity limiting pain or mobility problems. Farmers with pain from arthritis should also be encouraged to modify farm tasks, environment, and implements/tools as needed to decrease aggravation of arthritis. Modifications can include having a helper assist the older farmer with more difficult tasks, remove slip/trip hazards, and install extra hand grabs and extra steps on tractors/combines.

Farmers should preserve hearing through the use of personal hearing protection and other environmental interventions to remove sources of noise such as the installation of new mufflers on equipment or the separation of loud shop equipment from other areas on the farm. If farmers already suffer from a hearing deficit, they should be encouraged to wear hearing assistive devices in the work area.

Farmers who suffer from sleep disorders should enquire about new treatments that do not have the residual sedation effect or tolerance issues of benzodiazepines (Conn & Madan, 2006).

To facilitate a good night's sleep, alcohol and caffeine should be limited, particularly in the afternoon and evening and naps should be restricted to less than 30 minutes (Martin, Shochat, & Ancoli-Israel, 2000).

Finally, health care providers in rural areas need to be aware of the lifestyle and types of activities older farmers engage in while they continue to contribute to farm production. There are many ways in which this can be accomplished. First, primary care providers need to be educated on the health and safety issues of the agricultural community. Medical, nursing/ nurse practitioner, rehabilitation, pharmacist and physician assistant programs should add components of agricultural health and safety to their curriculum. Continuing education courses on the health and safety of the agricultural community should also be offered to rural practitioners. With increased knowledge on the tasks and lifestyles of agricultural communities, primary health care providers would be better suited to address the health and safety needs of this unique population of workers (Amshoff & Reed, 2005). Secondly, farmers and farm families need to work closely with their health care providers to ensure issues such as polypharmacy do not add excessive injury risk and that diseases and health conditions are managed in the most appropriate manner. This would include comprehensive medication reviews by the farmer's primary health care provider. A medication review would ensure that medications taken are still needed, are of the correct dosage, and are being taken according to instructions. This review should also include education of the farmer on possible side effects, potential drug interactions and on any medication that is specifically related to increased risk of injury should be conducted during the review.

As the average age of farmers continues to rise, the safety and health communities need to take into consideration the age-related health changes that will affect a farmer's ability to continue to farm safely. Farmers do not retire at a certain age like some other occupations, but rather they continue to farm well into their 70's and even 80's. By integrating research from the fields of gerontology, occupational health and safety, and injury prevention, innovative interventions could be constructed to assist the aging farmer in the continuation of farming.

Impact on Industry

The older farm population is growing and will continue to grow into the future. This presents a challenge for health and safety programming in the agriculture industry. This older farm population places a high value on independence and the contribution they make to the agriculture industry, the family farm and the sustainability of farm income. The health care systems that support older farmers are becoming increasingly burdened by this growing population. It is incumbent on health care systems and professionals to address health and illness issues that can mitigate the injury burden for the individual farmer and for society.

Table 1

– *Studies relating disease factors to farm injury*

Study	Design	Population	Mean Age, (range)	Results
Zhou & Roseman, 1994	Cross Sectional Mail survey with telephone follow-up Restricted activity (≥ 4 hours) or medical attention	718 participants (71 injuries)	(25 to > 64)	Previous injury – OR:3.71(1.83,7.52)
Zwerling et al., 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)
Low et al., 1996	Cohort Telephone survey Limitation of activity (≥ 1 day) or medical attention	919 properties (425 injuries)	unknown	Previous injury Sleep Deprivation Stress
Browning et al., 1998	Cross Sectional Telephone survey Any injury	998 participants (98 injuries)	68 years	Previous injury – OR:2.40(1.01-5.71)
Crawford et al., 1998	Case-Control Mail survey with telephone follow-up Restricted activity (≥ 4 hours) or medical attention	90 cases 1,475 controls	<30 to > 69)	Neurological symptoms (linear trend)
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)
McGwin et al., 2000	Cohort Mail survey with telephone follow-up Restricted activity (> 4 hours) or medical attention	1246 participants (140 injuries over a mean follow-up period of 2.5 years)	(<40 to >59)	Previous injury – OR:1.5(1.0,2.1)
Hwang et al., 2001	Cohort Telephone follow-up Restricted activity (≥ 4 hours) or	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)

Study	Design	Population	Mean Age, (range)	Results
	medical attention			
Carruth 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)
Park et al., 2001	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)
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)
Sprince, Zwerling, Lynch, Whitten, Thu, Gillette et al., 2003	Case-Control Mail Survey with telephone follow-up Falls only – medical advice or treatment	79 cases; 473 uninjured controls	Cases – 50.3 Controls – 49.9	Arthritis – OR:2.05(1.11-3.79) Hearing loss - OR:1.82 (1.07,3.08)
Sprince, Zwerling, Lynch, Whitten, Thu, Logsdon-Sackett et al., 2003	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)
Sprince et al., 2003	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)
Simpson et al., 2004	Cross Sectional Mail survey Medical attention	6101 participants (361 injuries)	(<30 to >46)	Life Stress – Men – OR:1.81(1.23,2.68) Life Stress – Women – OR:2.30(1.16,4.53)
Spengler et al., 2004	Cross Sectional Telephone survey Medical attention needed	1004 participants	49	Sleep apnea (3 symptoms) – OR:2.48(1.13,5.41)
Carlson et al., 2005	Cohort Telephone follow-up Restricted activity (≥ 4 hours), loss of awareness or memory, or	16,537 participants (156 injuries)	(<20 to > 55)	Previous injury – OR:2.02(1.39,2.94)

Study	Design	Population	Mean Age, (range)	Results
	medical attention for injuries associated with tractors			
Choi et al., 2005	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)
Choi et al., 2006	Cohort Telephone follow-up Restricted activity (≥ 4 hours), loss of awareness or memory, or medical attention	1345 participants (316 injuries over a mean follow-up period of 1.99 years)		Sleep deprivation – RR:1.61(1.21,2.15)
Stallones et al., 2006	Cross Sectional Telephone survey Any injury - Restricted activity (≥ 4 hours) or medical attention	262 respondents (46 with injuries)	(13 – 18)	Sleep deprivation (ORs ranging from 1.82 to 2.30 depending on sleep measure)
Voaklander 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)
Tiesman et al., 2006	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)
Sprince et al., 2007	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)
Shipp et al., 2007	Cross Sectional Internet survey Back pain ≥ 4 hours of restricted activity or medical attention	345 participants (15.5% with back pain)	<14 to >19)	Previous back injury – OR:9.04(3.55,23.01)

Table 2

– *Studies relating medication use to farm injury*

Study	Design	Population	Mean Age, Years (range)	Results
Pickett et al., 1996	Case-Control Mail Survey Restricted activity (\geq 4 hours)	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)
Xiang et al., 1999	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)	(60 to 80+)	Any prescription medication – OR:3.02(1.05,8.61)
Sprince, Zwerling, Lynch, Whitten, Thu, Gillette et al., 2003	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	Any medication - OR: 1.80(2.02-3.18)
Sprince, Zwerling, Lynch, Whitten, Thu, Logsdon-Sackett et al., 2003	Case-Control Mail Survey with telephone follow-up Medical attention	431 cases 473 controls	Cases – 47.5 Controls – 50.0	Any medication – OR:1.44(1.07,5.20)
Spengler et al., 2004	Cross sectional Telephone survey Medical attention needed	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)	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)
Tiesman et al., 2006	Cohort Telephone follow-up Restricted activity (\geq 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 medication – RR:1.53(1.13-2.09)

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