Making Farming Safe for Senior Farmers

A Project to Explore the Influences of the Aging Process on Farmers and its Implications on Safety and Health.

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Background

In Canada persons over the age of 60 years represent approximately 12% of the population. Approximately 33% of traumatic farm fatalities occur to individuals over the age of 60 years.

Currently, few resources are available in the agricultural sector to assist senior farmers and their families or employers in being able to assess individuals abilities to safely perform specific farming tasks.

The North American Guidelines for Children's Agricultural Tasks is an example of a practical user friendly resource for children's caregivers to assess a child's readiness for specific farm work. This model provided the insight and motivation to pursue this project.

Project Objectives

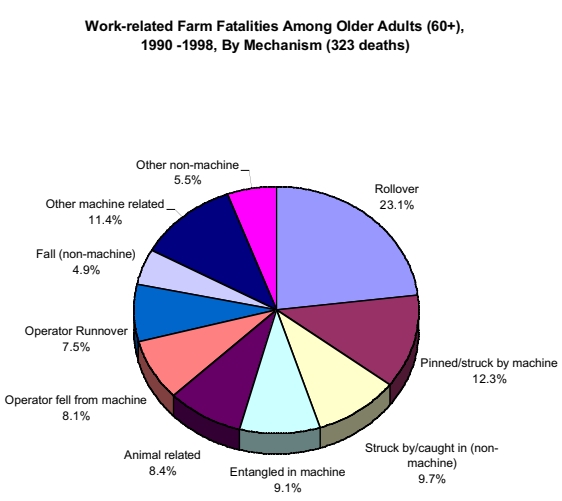
1. Research and compile a profile of physical, cognitive and social characteristics and attributes of persons 60 years and older.
2. Develop a document that will outline the above attributes in relation to selected groups of tasks seniors might perform on farming operations in Canada.
3. Conduct focus group evaluations of the guidelines with a cross-section of the agricultural community that is targeted by this project.*
4. Incorporate focus group recommendations, reproduce and make the guidance document available to interested parties across Canada.*

*Given the scope of this undertaking, these activities have been deferred to future research and development work.

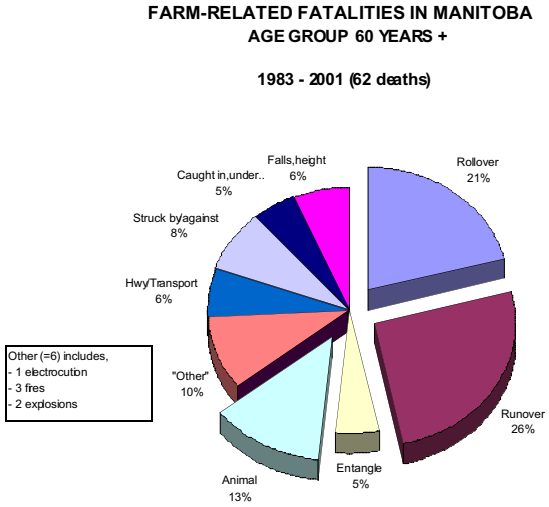
Making Farming Safe for Senior Farmers

Introduction

Persons aged 60 years and older represent approximately 13% of Canada's total farm population. This same grouping also accounts for over 33% of traumatic work related fatalities. Every year individuals as old as 90 years of age are killed while performing farm work.



Source: Canadian Agricultural Injury Surveillance Program



Source: Workplace Safety and Health Division, Manitoba Labour and Immigration

Investigations of these deaths regularly produce evidence that most of these incidents were preventable. Prevention of workplace deaths can be accomplished through awareness, education and process change.

The purpose of this resource is to assist senior farmers and their partners and family members in understanding and recognizing the interplay of each individual's abilities with what they are working with and the environment in which they are working. Acknowledgement of personal limitations coupled with the recognition and control of hazards associated with each task performed will protect everyone in the agricultural workplace.

This resource was developed following concepts established by the North American Guidelines for Children's Agricultural Tasks. The farm operator should make the decision of who performs a particular task. The informed decision should be based upon the hazards of the task, the individuals physical and intellectual abilities, as well training and supervision available for the person who will be performing the task.

What is Hazardous?

A hazard should be understood as an existing condition that has the potential to cause damage or harm. The degree of damage or harm will vary, however the potential or risk does exist unless steps are taken to control the hazard.

"Accidents" don't just happen! The interaction of a person, equipment, materials and the surrounding environment all play a role when someone is injured. Recognizing this interaction and adjusting who or how a task is performed will change the outcome.

As an example: In the process of feeding a large round bale of hay to a pen of cattle, the 'worker' may have to get off the tractor and remove the twine securing the bale. The most recognizable hazards including; cattle crowding to eat, a slippery uneven walking surface, bulky winter clothing, noise (tractor running, cattle bawling), presence of a bale feeder and so on. What does the person bring to these hazards? Conditions such as; ability to maintain balance, physical strength, dexterity to move among animals and peripheral vision are all important. These are some of the basic personal abilities necessary to safely perform the task. Factors such as glasses, medications which may effect balance, physical conditions causing shortness of breathe or conditions such as arthritis - limiting range of motion, all have the potential to place the individual at greater risk of injury.

The important point to remember is that the work can continue to be performed if the risk factors are recognized and steps taken to control the work situations to protect the worker.

Making Injury Prevention Work on Your Farm

To create a safer farm work environment, talk about the hazards that exist with the people who have done or will be doing the work. Assess their abilities and then make the changes necessary to ensure that they will be able to perform the work safely.

The following tables will assist farm family members in understanding;
(a) the changes in our bodies which can occur as we age,
(b) the effects of medical conditions, medications and our life style and
(c) planning work activities to compensate for any personal limitation resulting from the aging process, medical conditions or other factors.

Table I presents the inter-relationships of four factors affecting our abilities to perform tasks.

- **SYSTEM:** the specific body system that governs certain activities.

- **POTENTIAL AGE-RELATED CHANGES:** these are the system changes, which typically occur. It is important to recognize that each person is different and may not necessarily experience these changes at a specific time in their lives.

- **POSSIBLE FUNCTIONAL CONSEQUENCES:** the possible effect of the aging process on the system's functioning.

- **OTHER POTENTIAL INFLUENCES ON FUNCTION:** factors, other than age, that also can have an impact on the system's functioning

Table II presents several Job Safety Analysis worksheets for tasks commonly conducted by seniors. Several of these activities have resulted in deaths and serious injuries to older individuals.

The Job Safety Analysis worksheet examples set out the tasks, minimum abilities to safely perform the tasks, hazards of the tasks, personal risk factors and action plans to make the task safer. These worksheets are not complete, they are samples and the variability each individual brings to the task will determine the personal risk factors and action plans. These have to be completed for the individual who will be doing the job.

To effectively utilize these resources the following considerations should be made:

- It is important to work within personal physical limitations,

- recognize latency of medications and

- recognize environmental conditions including ice, snow, glare, noise, dust and varying light conditions which may combine to change an otherwise safe work situation to a hazardous one.

TABLE I

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
NEUROLOGICAL	• There are changes in the brain, which can decrease the person's ability to perform complex tasks quickly and efficiently. • It takes a longer time for the brain to interpret information coming from our eyes and ears, and for us to then respond with an action. • There are changes to the nerves controlling our muscles, which affect the body's sense of position and movement.	• Thought/ information processing slows down and may be incomplete. This means that you may make decisions based on less information. • You may have less tolerance for temperature changes or extremes of heat or cold. • There are changes in sleep patterns, which can affect your alertness. • There are changes to balance and a sense of stability, increasing your risk of tripping and stumbling.	• Stress, anxiety, depression may all reduce your ability to cope with daily tasks. • Diseases or conditions such as Alzheimer's disease further affect your abilities. • It takes less medication and alcohol to create impairment. • Health conditions including diabetes, heart disease, blood pressure problems can affect your abilities.

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
SENSORY • ***VISION***	• There are changes in the eyes, which can decrease your vision ability (clarity) and your night vision.	• There is less ability to judge distance. Objects that are moving are not seen clearly. • There is a decrease in your field of vision and the sharpness of what you see. • Poorer night vision will affect night driving. • You need more time to adapt to changes in light, going from indoors to outdoors, and recovering from sun glare.	• Diabetes can speed up these losses in vision abilities. • Eye conditions such as cataracts or glaucoma, and their medications, usually adversely affect your vision.
• ***SMELL***	•	• You lose the ability to identify certain smells or may not even smell them unless they are strong. You may lose the warning to a dangerous smell.	• Smoking affects your sense of smell (and taste).
• ***HEARING***	• Changes in the ear reduce its ability to pick up and respond to all sounds.	• Some sounds become more difficult to hear, such as high-pitched noises and squeals. • It becomes harder to hear one sound if there is a lot of background noise, such as hearing someone talking when there is machinery running. • There may be a change in your sense of balance, which is controlled inside your ear.	• Some medications can affect hearing. For example, Aspirin can cause ringing in the ear. • Your ears can get plugged with wax, or from having a cold or ear infection. • Long time exposure to noise may have already reduced your hearing without you realizing it.
• ***TOUCH***	• Touch receptors in the skin deteriorate over time.	• You have a reduced sense of touch, vibration and pressure • You have a reduced ability to feel heat, cold, or pain.	• Skin diseases like eczema reduce your sense of touch. • Strokes and heart disease can reduce the sense of touch.

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
MUSCULOSKELETAL • ***BONES***	• Our bones become weaker as we get older.	• The bones break more easily, from less force or injury.	• Thyroid disease affects the strength of your bones. • The strength of your bones is related to how much activity and exercise you do (the more exercise, the better). • Your bone strength depends on your food habits. You need enough calcium and vitamin D, especially from dairy products or vitamin pills.
• ***MUSCLE***	• Our muscles become weaker and may shrink in size.	• The decreased muscle strength and coordination makes it harder to lift and move heavy objects. • The muscles need more time to react to a situation, for example, to jump out of the way. • Changes to posture and balance can increase your risk of falling.	• If you are not regularly active, your muscles will be in poor shape. They need exercise in order to say healthy. •
• ***JOINT & CONNECTIVE TISSUE***	• Over time, our joints wear down from all the strain of daily activities.	• There is a reduced feeling of stability, which can make you more prone to falling down. • Regular wear and tear can produce joint stiffness, pain and swelling. • The reduced joint mobility increases the risk of strains and sprains.	• Previous injuries to joints affect their ability to perform. • Joint diseases cause pain and reduce the joint's range of motion. • Repeated heavy lifting puts extra wear and tear on the joints. • Obesity puts extra strain on the joints.

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
CARDIOVASCULAR	• The heart as a muscle to pump blood becomes stiff and weaker over time. • The heart has changes to the blood vessels, which affect how well it does its work.	• The blood pressure needs more time to adjust to a change in body position . For example, you may feel faint when first standing up after sitting or kneeling on the ground. • You may tire easily or have trouble breathing during hard work activities. • There is an increased risk of dizziness during hard work.	• Any type of heart disease will negatively affect your heart health. For example, coronary heart disease will increase your tiredness and shortness of breath. • Your general level of wellness is affected adversely by smoking, stress, poor nutrition, lack of exercise. • Some medications may affect your heart and blood circulation.
RESPIRATORY	• The lungs and chest wall become stiff and do not move as easily. • The lungs are not able to accommodate as much air.	• While doing hard work, breathing becomes strained and you may get tired more easily. • There is an increased risk of getting lung infections.	• Smoking or being around second hand smoke damages your lungs. • Exposure to heavy dust, for example grain dust, can irritate your lungs. • Exposure to toxic gases (for example, manure pit gases) and chemicals can damage your lungs. • You may already have some lung disease from early years of exposure to substances, and you do not realize it.

Conducting a Job Safety Analysis

The following information considers the overall aspect of farm safety. When conducting a Job Safety Analysis for a job that a senior person is going to be performing added consideration must be given to the possible limitations the person brings to the task.

Those most familiar with a job are best suited to evaluate the risks associated with the particular job. They must consider it impartially and suppress thoughts about how it is done and focus on how the tasks should be performed to avoid injury or property damage.

The process of conducting a job safety analysis is straightforward. Refer to table II for examples of common farming tasks analyzed using a job hazard analysis format. The last column of each table is BLANK because it is your DECISION and how to control the hazards.

1. Identify a specific job someone performs
2. Break that job down into the individual steps or tasks required to complete the entire job.
3. Identify the potential hazards that are associated with performing each task.
4. Determine what actions or measures would be necessary to eliminate or control the hazards of each task.
5. Make the necessary changes through changes in equipment / product, engineering (guards or barriers) and ensure effective training.

Step 2 – Break the Job Down into steps.

Every task can be broken down into steps and there is usually a particular order to the steps that is best. This sequence of steps will eventually become the basis of the safe work procedure.

Identifying every step of the task is essential to the end result. Ensure you consider ***everything*** the person doing the work will have to do. After each step is identified, you can go back and combine things or eliminate unnecessary detail.

To give a clear understanding of the task, the steps must include every key activity that is inherent in doing the task correctly, but exclude those that will over burden the process.

Step 3 – Identify potential hazards in each step.

Examine every aspect of the task to determine potential hazards. Every aspect of the task should be considered, including safety, quality, and production. Also consider losses to the area or environment where the task is being done and possible long-term effects of performance.

Questions to ask:

People:

- Could the worker be caught in, on or between? Struck by? Fall from? Fall into?
- What contacts are present that could cause injury, illness, stress, or strain.
- What practices are likely to downgrade safety, productivity, or quality?

Equipment:

- What hazards are presented by the tools, machines, vehicles or other equipment?
- What equipment emergencies are most likely to occur?
- How might the equipment emergencies cause loss of safety, productivity or quality?

Material:

- What harmful exposures are presented by chemicals, raw materials or products?
- What are the specific problems involving materials handling?
- How might materials cause loss of safety, productivity or quality?

Environment:

- What are the potential problems of housekeeping and order?
- What are the potential problems of sound, lighting, heat, cold or ventilation?
- Is there anything in the area that would be seriously affected if there are problems with the task?
- Has the external as well as the work environment been considered?

Step 4 – Actions to Eliminate / Control the Hazardous Situation

Making an improvement check is simply determining if the work being considered can be done in a better way (change). When change is introduced with structure, planning, innovation, the workers involvement, change can be good. This contributes to improvements in safety, quality, productivity and cost control.

To conduct an improvement check, start with; Who – What – When – Where – Why questions. For example:

1. Who is best qualified to do it?
2. Where is the best place to do it?
3. When should it be done?
4. What is the purpose of this step?
5. Why is this step necessary?
6. How can it be done better?

Analyze the work in terms of Safety and how it interacts with the People, Equipment, Materials and Environment involved.

Step 5 – Making Changes

Determine actions and precautions that will prevent a potential loss from occurring or minimize its effect if it were to occur. Ideas for controls will naturally have been generated throughout the previous exercises, keeping in mind that controls should be directed to the individual or individuals doing the task, by telling them how to avoid, eliminate, or reduce the loss exposures.

Control Methods:

Engineering Controls

- _ Isolation (protect the worker from the hazard)
- _ Dilution/Removal (proper ventilation around chemicals)
- _ Process Modification/Redesign (eliminate hazards found in tasks)
- _ Substitution (replace the hazardous material with less toxic material)
- _ Shielding/Barriers (placing a barrier between the workers and hazardous sources)

Administrative Controls

- _ Education (education in all aspects of workplace safety and health)
- _ Job Rotation (worker's exposure is limited by the time they do a particular task)
- _ Work Assignments (workers are reassigned should exposures reach levels above the standard)

Personal Protective Equipment

- _ ***Last Resort***
- _ Workers must be trained about use, maintenance, and limitations.

Evaluation:

Ensure that all control measures you implement are evaluated to ensure they are effective.

In addition to these basics, when we discuss assessing the safety of a farm job for a senior to perform (or for that matter anyone) we have added two additional columns:

1. Minimum ability to safely perform the task. This means what abilities does a person have to have in order to safely do the task.
2. Personal risk factors. This refers to conditions that an individual may have which could make an otherwise safe activity dangerous. For example if the

individual does not have the strength to move or activate a control - can they safely perform that task?

TABLE II
Job Safety Analysis
Job Description
Feeding large round hay bales to cattle in a pen using a tractor with front-end loader

Specific Task	**Minimum Ability to Safely Perform Task**	**Hazards of Task**	**Personal Risk Factors** (to be completed by individual familiar with operator)	**Action Plan** (to be completed by farm manager)
Mounting / starting up tractor	- knowledge of controls & machine capabilities - dexterity - strength / flexibility to operate controls	- slip / fall from machine - loss of control of machine	*e.g. occasionally losses balance, has limited strength in one arm / leg*	*e.g. training if physical limitations can not be managed - assign a less dangerous job*
Driving to hay storage area	- same as to start and operate, plus - good eye sight	- loss of control of machine	e.g. *limited range of motion - can't turn head to look back over shoulder when backing machine*	*e.g. installing rear view mirrors*
Picking up bale	- spatial perception - sense of balance	- improper spearing of bale (could fall off or make tractor off balance) - knocking over other bales	e.g. *limited eye sight*	*if physical limitations can not be managed - assign a less dangerous job*
Driving into pen	- as above	- slip / fall when leaving tractor to open / close gate		*e.g. additional hand grabs, extra step*
Positioning bale	- as above	-		
Removing twine	- control cattle crowding in to eat - management of twine	- falling tripping on ground materials / twine - being knocked down / trampled by cattle		*if physical limitations can not be managed - assign a less*

				dangerous job
Positioning bale feeder over bale	- as above - if done manually then physical strength to lift / maneuver feeder	- damage to feeder with loader - manually - strains / crushes if feeder drops		*if physical limitations can not be managed - assign a less dangerous job*
Exiting pen	- same as entering pen	- same as entering pen		

Job Description

Clear manure from loose housing livestock barn with front-end loader

Specific Task	**Minimum Ability to Safely Perform Task**	**Hazards of Task**	**Personal Risk Factors** (to be completed by individual familiar with operator)	**Action Plan** (to be completed by farm manager)
Conduct pre-operational check / start-up	- knowledge of controls & machine capabilities - manual dexterity - strength / flexibility to operate controls	- slip / fall from machine - loss of control of machine	e.g. *limited range of motion - can't turn head to look back over shoulder when backing machine*	- familiarize everyone with equipment
Attach manure fork to front end loader	Good eye sight, spatial perception, multi tasking Physical ability to move fork	- slip / fall - strain - loss of control		- two people req'd.
Drive to barn	Peripheral vision Knowledge of yard obstacles	- collision with support walls		-
Enter barn and load fork	Spatial perceptions, peripheral vision, ability to adjust to different light levels	- damage to structure / equipment		- improve lighting
Lift load	Good sense of balance / equilibrium Depth perception	- overloading / upset - damage to building		-
Back out of barn	Body range of motion (look	- damage to building /	Bi-focal glasses, arthritis	- rear view

	over shoulder) Depth perception Able to adjust from dark to light	equipment - upset of loader		mirrors - improve lighting
Drive to spreader / pile	Spatial perceptions / sense balance of machine	- loss of control - upset of loader		- identify obstacles
Raise loader / dump load	Sense balance of machine, peripheral vision, spatial perception	- collision with other equipment - loader overturn		
Back away / repeat	Body range of motion	- damage to equipment		

Job Description

Working with large animals in a corral

Specific Task	**Minimum Ability to Safely Perform Task**	**Hazards of Task**	**Personal Risk Factors** (to be completed by individual familiar with operator)	**Action Plan** (to be completed by farm manager)
Entering pen / corral	Good eyesight / balance	Kick / stepped on / charged		
Herd animals to pre-determined site	Good eyesight / balance / quick on legs	Trips / falls		
Segregate animal(s) from group	Quick on legs / able to multi task			
Move animal(s) to chute or other pen(s)	As above	As above plus backing over by animal		
Secure individual animal in squeeze chute for treatment / work	Quick reactions / multi - tasking	Pinches, as above		
Administer treatment(s)	Good eyesight / steady hands (needle control)	Needle sticks		
Release animal	Chute experience quick reflexes	Struck by chute parts		

General considerations

a) have experience
b) be agile good and quick on feet
c) know your subject animals bulls/ cows / heifers / steers
d) being charged upon / kicked or stepped on
e) segregation or sort certain types requires experience
f) close quarters chutes / alleys crowding area are places of close contact results in kicking / charging / run by kicks
g) needle work requires experience, quickness ability to not give yourself a shot.
h) chute - break fingers / arm / hands

Job Description

Operating self-propelled equipment on slopes

Specific Task	**Minimum Ability to Safely Perform Task**	**Hazards of Task**	**Personal Risk Factors** (to be completed by individual familiar with operator)	**Action Plan** (to be completed by farm manager)
Pre-operational service /inspection of equipment / start-up	- knowledge of controls & machine capabilities - dexterity - strength / flexibility to operate controls	- slip / fall from machine - loss of control of machine	e.g. *limited range of motion - can't turn head to look back over shoulder when backing machine*	
Drive equipment to work location	- good eyesight - spatial perception - ability to hear surrounding noises	- collision with traffic / field objects		
Switch from transport position to operating	- physical ability to move / adjust equipment	- strain - incomplete connections		
Begin working along slope	- sense of balance / judgement - range of body motion - good eyesight / hearing	- overturn - inability to monitor machine performance - failure to notice obstacles		

Job Description

Feed Grinder - operating stationary equipment (rotating shafts)

Specific Task	**Minimum Ability to Safely Perform Task**	**Hazards of Task**	**Personal Risk Factors** (to be completed by individual familiar with operator)	**Action Plan** (to be completed by farm manager)
Hook up tractor to grinder	- knowledge of tractor operation - flexibility to maneuver tractor	- collision - pinches / strains		
Check / service grinder	- knowledge of grinder operation / maintenance - understanding of safety devices / guards	- entanglement		
Position grinder	- ability to drive (back -up) and maneuver tractor with towed equipment - spatial perception	- collision equipment damage		
Run augers	- knowledge of start / stop controls - physical ability to position equipment - good vision / hearing to monitor operation of equipment	- entanglements - lost grain - strains - dust inhalation / disorientation - noise / inability to hear others		
Add supplement(s)	- physical ability to manually handle materials	- strains - entanglements		
Sample mix	- physical dexterity, peripheral vision	- entanglements		
Unload into feeders	- peripheral vision, upper body flexibility to look back - ability to open hatches, position unloading auger	- collision		

Job Description

Operating ATV's

Specific Task	**Minimum Ability to Safely Perform Task**	**Hazards of Task**	**Personal Risk Factors** (to be completed by individual familiar with operator)	**Action Plan** (to be completed by farm manager)
Check machine before starting / secure tools / equipment on racks	- knowledge of operating characteristics - strength to lift / move ATV - flexibility / manual dexterity	- loss of balance - extra tools / equipment falling		
Mount machine	- flexibility / balance - also as above	- slips / falls		
Start engine	- strength to manually start / move ATV - also as above	-		
Drive to work location	- good eye sight - hand - eye coordination	- collision / rollovers		
Perform work	- ability to multi-task			
Return	- same as drive to work			

General Considerations

- varying terrain varies machine stability
- upper body strength is essential to control machine
- NO RIDERS
- Basic personal protective equipment is required at all times
- Working knowledge of machine operation and stability
- Extra lighting, electric start, running boards and automatic transmission help less able bodied persons operate the ATV

AGE-RELATED PHYSIOLOGICAL CHANGES: CONSIDERATIONS FOR OLDER FARMERS' PERFORMANCE OF AGRICULTURAL TASKS

A Report Prepared for
The Seniors Abilities for Agricultural Tasks Project
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EXECUTIVE SUMMARY

Farming is among the most hazardous occupations in Canada, and older adults living on farms are at increased risk for injury. Increased attention is needed to help explain why older farmers are consistently at risk for farm injury. This report reviews literature on physiological changes that older adults experience with age, which may provide some insight into age-related changes that can influence functional status and therefore, performance of many agricultural tasks. In addition, this report reviews the farm-related literature for additional information on how the demands of the farming occupation may affect health status, which may also influence safe performance of tasks.

AGE-RELATED CHANGE IN PHYSIOLOGICAL FUNCTION

While the body undergoes many changes with age, not all changes have a direct impact on functional performance and therefore, performance of agricultural tasks. This report focuses on physiological systems most relevant to performance of activities. Age-related changes in systems and subsequent impact on function are reviewed for the following:

- neurological system
- sensory system
- musculoskeletal system
- cardiovascular system
- respiratory system

Aging is not the only factor that can have an impact on functioning. Many other factors may be just as, or more, influential on physiological function than a person's age, such as disease, lifestyle practices, or medication use. These factors are noted as well. The report focuses on the "normal" pattern of age-

related changes that adults may experience. **However, it is important to be aware that there are often considerable differences among individuals in the rate and extent of change and there is not a normal single pattern of change.**

Age-related changes to the **neurological system** may be experienced, but the neurological function of most healthy adults is maintained, deficits are modest, and there is little impediment in activities of daily living. Nonetheless, studies on cognitive aging have drawn some consistent findings on functional changes to cognitive skills that can be seen with increasing age, such as a decline in cognitive processing. A decline in the rate of cognitive processing has been indicated in farming literature as a possible factor in injury of older farmers. Some older farmers may experience a slowing of information processing, which may impact on quick decision-making and reaction time. While a quick reaction does not eliminate existing hazards, a slower processing of information and subsequent slower reaction can intensify existing hazards and lead to injuries that might not normally occur.

In the **sensory system** of older adults, smell, vision, hearing and touch are likely to experience some decrease in sensitivity (taste is only minimally affected, if affected at all). These decreases may be the result of structural changes in the ear, nose, eye or skin that can occur with age, or the changes of an aging nervous system. Environmental influences, lifestyle, disease or medications can negatively influence sensory function as well, or they may exacerbate age-related sensory decrements. For example, the noise that occurs in many farming environments has been found to be associated with hearing loss. Studies have repeatedly indicated that farmers of all ages suffer from a greater degree of noise-induced hearing loss than the general population. Many of the potential age-related sensory deficits that would most impact task

performance can be compensated for, to some degree, through adaptive devices, such as glasses or hearing aids.

The **musculoskeletal system**, the body's bones, muscles, and joints, is most associated with mobility - one of the most important functions for task performance. Normal age-related changes predispose individuals to musculoskeletal problems and diseases. As well, aspects of a farming occupation may be important factors in musculoskeletal function. For example, the physical demands of farming tasks may be able to offset some of the declines in muscle mass and strength with age. Conversely, it is believed that vibration from tractors and repetitive trauma associated with farm work could be related to back pain and other musculoskeletal disorders often experienced by farmers. The repetitive and hard physical work of farming has been considered to be a factor in the higher rate of arthritis and low back pain often found among farmers.

The functional consequences to the **cardiovascular system** most likely to be experienced with aging are often evident during periods of physical stress, such as shortness of breath and fatigue when undertaking physical activity. Disease has more effect on cardiovascular function than age-related changes, although aging changes can cause an older adult to be susceptible to disease processes. Studies have reported a lower rate in cardiovascular disease among farmers, possibly due to the activity and lifestyle of farmers, although others have found opposite results. If farmers do have an advantage of reduced cardiovascular disease risk, it has been suggested that this advantage could cease as farm work becomes less physically demanding due to mechanical and technological advances.

Aging can affect each component of the **respiratory system**, but these age-

related changes have minimal effect on respiratory function in healthy, non-smoking older adults. Regardless of age, tobacco smoking is the most important factor in impaired respiratory function. However, the farming occupation poses numerous respiratory hazards, which can also impair respiratory function. Among the hazards are organic dusts, gases and vapors, chemicals, and infectious agents. As a result, the prevalence of respiratory conditions is reportedly higher in farmers than in most other workers.

FARMING-RELATED ILLNESSES & DISEASES

The report notes that disease can have a significant influence on physiological function and may be a greater factor than age-related changes. Some evidence suggests that farmers are more likely to continue working with a limiting disability from disease, which has implications for safe performance of agricultural tasks. In addition to the safety risks due to medical conditions, the concurrent medication use might also be related to an increased risk of serious injury. The agricultural occupation poses several major health risks that can lead to illness and chronic conditions. As the average age of the farm population continues to increase, there is increased risk of adverse effects of occupational exposures and certain chronic diseases. Occupational diseases and impairments on farms include respiratory disease, skin disorders, musculoskeletal disorders, certain cancers, zoonoses (diseases transmitted from animals to people), and noise-induced hearing loss. Therefore, it is important to consider the role that disease, illness, and concurrent medication use may have in the injury rate of older farmers. Such factors can exacerbate any functional consequences of age-related change as well as have an impact on function in ways that the aging process may not.

CONCLUSIONS

Age-related physiological changes do have implications for risk of injury among

senior farmers since all of the major physiological systems likely to be involved in performance of agricultural tasks can be affected to some degree by age. However, not all aging changes will have a significant impact on functioning. Reports indicate that among older adults in their sixties, functional limitations are not common. Whether the findings of such reports hold true for older farmers in particular is not clear. A review of the literature for this report revealed that there is insufficient research to address the level of functioning in older farmers. What is needed to advance injury prevention are studies that specifically assess age-related changes in farmers and the impact on functioning in general, and the performance of agricultural tasks in particular. Such research would address the limitation of many of the studies reviewed for this report where prevalence rates of age-related changes or functional consequences were mainly in reference to a general population of older adults and not older farmers specifically. It is not obvious from the limited research whether farmers experience age-related changes at a different rate, due to both the potential positive and negative influences of a farming lifestyle and occupation. The challenge, therefore, remains in translating the existing literature, while keeping in mind its limitations, into useful agricultural-related information for older farmers. Continued research to delineate the role that age-related changes play in injury rates of older farmers, in relation to the many other factors that could be involved, would further aid in the development of injury prevention strategies and greater safety for farmers.

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INTRODUCTION

Unintentional injuries among older adults are a major health problem due to the serious consequences. Older adults are more likely to die from their injuries or take longer to recover, and once recovered, there may be more serious decline in function (Health Canada, 2002). Specific senior populations experience different rates of injury, such as older adults living on farms. Farming is among the most hazardous occupations in Canada, and older adults living on farms are at increased risk for injury. Unlike many other occupations, farming does not have a mandatory or customary retirement age. Farmers can continue to farm as long as they are able, thereby extending their exposure to hazardous situations. Two recent reports have highlighted the significant problem among older adults for farm injury in Canada (Canadian Agricultural Injury Surveillance Program (CAISP), 1998; CAISP, 1999). The reports identified older farmers, in particular males aged 60 and older, as a high risk group for hospitalized farm injuries and farm fatalities. It was recommended that research be undertaken to help explain why older farmers are consistently at risk for farm injury (CAISP, 1999).

Several factors have been proposed for this higher risk of farm injury among older farmers, such as old equipment, repetition of unsafe practices, and decline in functional status (Lago, 1999).

This report focuses on functional status. It reviews the literature[1] on physiological changes that older adults experience with age, which may provide some insight into age-related changes that can influence functional status and

[1] Several methods facilitated the collection of literature reviewed for this report: a literature search for relevant texts and articles in electronic databases (e.g., AgeLine, Agricola, and PubMed: years 1985-2002); personal communication with key informants who work or conduct research in the area of agricultural injury and safety; review of reference lists in key articles; and an Internet search of relevant websites. Appendix B at the end of this report provides an annotated bibliography of aging- and agricultural-related literature referenced in this report as well as additional literature found in the literature search. Appendix C provides a listing of

therefore, performance of many agricultural tasks. In addition, this report reviews the farm-related literature for information on how the demands of the farming occupation may affect health status, which may also influence safe performance of tasks.

agricultural health and safety Internet resources.

AGE-RELATED CHANGE IN PHYSIOLOGICAL FUNCTION

While the body undergoes many changes with age, not all changes have a direct impact on functional performance and therefore, performance of agricultural tasks. This report focuses on physiological systems most relevant to performance of activities. From the perspective of functional performance of everyday activities, Bonder and Wagner (2001) focused on the normal aging process of musculoskeletal, cardiopulmonary, cognitive and sensory abilities. To address the important age-related changes in the body's major systems that impact physical capacity, mobility, and performance, Spirduso (1995) examined the musculoskeletal, cardiovascular and respiratory systems and the central nervous system for motor skills and cognition. Similarly, age-related changes in these same major body systems were considered in terms of injury prevention in the work environment (Coy & Davenport, 1991). Literature that has considered age-related changes that may be involved in farm injury or fatality points to similar functions, in particular neurological, muscular/skeletal, and sensory function (Murphy & Ambe, 1994; Lago, 1999). Given these views, age-related changes in systems and the subsequent impact on function are reviewed for the following:

- neurological system
- sensory system
- musculoskeletal system
- cardiovascular system
- respiratory system

Aging is not the only factor that can have an impact on functioning. Many other factors may be just as, or more, influential on physiological function than a person's age, and those factors are outlined as well. For example, prescription

and over-the-counter medications can affect the function of most of the physical systems reviewed in this report. It is a prominent risk factor at any age, but in older adults[2], medication consumption can have significant functional consequences due to age-related changes that affect actions of medications in the body (Miller, 1999). Disease is another important factor that can have a significant impact on physical function. Moreover, disease adds to the difficulty of identifying true age-related changes since separating aging effects from disease processes is often very difficult. Interpreting data that distinguishes between the two is based on very fine and perhaps arbitrary criteria (Shephard, 1997). Adding to the difficulty of identifying true aging effects are external influences, such as lifestyle and nutrition, which can occur throughout the life span and may have a cumulative effect that is not evident until older age. Separating these effects from age-related changes is also difficult, and more so if the cumulative effect causes negative functional consequences only when age-related changes are present (Miller, 1999). A summary of possible age-related changes, potential age-related functional consequences, and the other factors that can influence function are available in Appendix A.

The following sections focus on the "normal" pattern of age-related changes that adults may experience. **However, it is important to be aware that there is often considerable differences among individuals in the rate and extent of change and that there may not be a normal single pattern of change.** Evidence suggests that aging is a highly individual process; it does not occur at a uniform rate and even within individuals the rate at which physiological systems age also varies (Chodzko-Zajko, 2001; Spirduso, 1995). Research has consistently revealed that chronological age alone is not a good indicator of an individual's function or performance in most areas (Spirduso, 1995). For

[2] Although age categories have not been standardized across the field of gerontology, older adults are typically defined as adults aged 65 and older (Spirduso, 1995; Miller, 1999; Eliopoulos, 2001; Lueckenotte, 2000).

example, people are less alike at age 50 than at age 5 in physiology and functional abilities (Coy & Davenport, 1991). Arking (1998) stresses that we must keep the heterogeneity of the human species in mind.

NEUROLOGICAL SYSTEM

Cognitive function includes domains such as memory, intelligence, speed of thinking, judgement, problem-solving ability, attention, and mood (Cacchione, 2000; Miller, 1999). Whether cognitive function declines due to age-related changes is an area of great controversy. The complex mechanisms that transform brain activity, and other central nervous system activity, into cognitive processes are not fully understood. Moreover, information on intellectual abilities is based on psychometric tests, although the validity of such tests for older adults has been questioned (Miller, 1999; Riley, 2001). With these limitations in mind, the following summary presents the neurological age-related changes, as they are currently understood, and the possible effects on neurological and cognitive function. It is important to keep in mind the diversity among older adults and the possibility that the individual older adult may not experience any of these cognitive changes.

Potential Age-Related Changes

The human brain often loses mass with age as both the number and size of neurons in the brain decrease (Arking, 1998; Miller, 1999; Roussel, 1999; Wagner & Kauffman, 2001). Some regions of the brain may be affected to a greater degree while other regions may not be affected at all (Hampton, Craven, & Heitkemper, 1997). Changes in brain mass are often evident when a person is in their sixties (Arking, 1998; Cacchione, 2000). Whether this decrease in mass has any functional significance is not known. The neuron loss could represent the removal of unused or unnecessary material (Arking, 1998). The number of dendrites (the route for incoming nerve impulses into the neuron (Arking, 1998)), and dendrite branches, often decrease in number with age as well, and similar to neuron loss, dendrite loss varies in the regions of the brain (Arking, 1998; Cacchione, 2000; Wagner & Kauffman, 2001). The aging brain can

experience a decrease in neurotransmitter activity (Arking, 1998; Miller, 1999). Neurotransmitters aid in the transmission of nerve impulses from one neuron to another. The decrease in dendrites and neurotransmitters are considered important changes to cognitive function (Arking, 1998).

Due to changes in arteries with age, cerebral blood flow may diminish (Eliopoulos, 2001; Shephard, 1997; Wagner & Kauffman, 2001). The rate of cerebral metabolism may decrease in aging brains, which can also influence cognitive function (Arking, 1998). A fat-containing pigment, called lipofuscin, accumulates in neurons with age (Hampton et al., 1997; Roussel, 1999). It has been suggested that this pigment may interfere with neuron activity and even lead to neuron death, but there is inconclusive evidence to support such claims (Arking, 1998; Hampton et al., 1997). Similarly, regions of the brain may see an increase in neurofibrillary tangles (tangled neuron fibers in the cell) and senile plaques (masses of mixed material outside the neuron) (Hampton et al., 1997; Miller, 1999; Wagner & Kauffman, 2001) but again the impact of the tangles and plaques on neuron activity is not clear. The brain also can undergo change in electrical activity with age. The speed of nerve conduction slows (Eliopoulos, 2001; Roussel, 1999; Wagner & Kauffman, 2001).

Other central nervous system changes that may have an impact on cognition in older adults include sensory abilities. Cognitive processes are affected by decreases in sensory function, such as poorer vision or hearing, since the quality and quantity of information that the brain is receiving from the environment may be diminished (Miller, 1999). The brain does not function properly without constant sensory input and perceptions (Arking, 1998). A section later in the report deals specifically with age-related changes to sensory function.

Possible Functional Consequences

Despite the reported potential age-related changes, neurological function of most healthy adults is maintained, deficits are modest, and there is often little impediment in activities of daily living (Miller, 1999; Riley, 2001). Nonetheless, studies on cognitive aging have drawn some consistent findings on functional changes to cognitive skills that are seen with increasing age.

Intelligence

Crystallized intelligence is the accumulated practical skills and acquired knowledge of the individual. Healthy older adults show no decline and may display improvement in this cognitive skill. Conversely, most older adults do experience a gradual decline in fluid intelligence, which involves the ability to adapt and use new information or acquire new concepts (Cacchione, 2000; Miller, 1999; Riley, 2001). Fluid intelligence is believed to peak individuals are in their twenties and decline thereafter (Cacchione, 2000).

Memory and Attention

For a memory to be formed, an individual must focus on and attend to the information to be remembered. Some evidence suggests that there may be a decrease in attentional resources with age and a decline in the ability to separate out relevant and irrelevant material (Riley, 2001). Primary memory, or working memory, provides a link between attention and formation of memories. Primary memory is of short duration and small capacity and serves as a holding tank for information to be held for a short period or to be transferred into long term storage. Study results are not conclusive regarding changes to this memory function with age (Miller, 1999), although decreases have been reported (Riley, 2001; Shephard, 1997).

The greatest and most consistent age-related declines in memory have been reported in secondary (long-term) memory (Miller, 1999; Riley, 2001). Secondary memory is believed to store an unlimited amount of information, transferred from primary memory, for nearly any length of time. Deficits in this memory are in retrieving information from its store (Shephard, 1997) and less effective coding strategies when transferring into the memory storage (Riley, 2001). Tasks that require a higher level of memorization may be affected in some older adults, but educating older adults on more effective strategies for memorizing information, as well as increasing the meaningfulness of information to be remembered, can minimize age-related memory deficits (Riley, 2001).

Cognitive Processing

Increasing age appears to bring a decline in the rate of cognitive processing (Cacchione, 2000; Riley, 2001). The speed at which information is processed is slower. This slowing has been suggested as accounting for some of the age-related changes in cognitive function, particularly memory (Miller, 1999). Some studies indicate that the speed and efficiency of problem solving may decline with age (Riley, 2001). Older adults may be more cautious in their responses (Miller, 1999). Increased cautiousness can adversely affect performance of some tasks, but it also may result in more accurate job performance (Spirduso, 1995). The pace of learning can become slower (Miller, 1999; Shephard, 1997), but adoption of appropriate learning strategies by older adults can alleviate decreases in learning performance (Arking, 1998). Slowed central processing may also be a primary cause of slowed reaction times in older adults (Riley, 2001; Roussel, 1999), although sensory deficits and musculoskeletal changes will also have an impact on reaction time (Cacchione, 2000; Shephard, 1997). Slowing of response is particularly noticeable if there are multiple stimuli or the

task is complex (Eliopoulos, 2001; Roussel, 1999; Shephard, 1997). Deficits in reaction time or decision making can adversely impact many abilities, such as driving ability (Riley, 2001). Speed of processing may begin to slow early after age 50 (Riley, 2001).

A decline in the rate of cognitive processing is what the farming literature has pointed to as a possible factor in injury of older farmers. Some older farmers may experience a slowing of information processing, which, as noted, may impact on quick decision-making and reaction time. Freeman and Schwab (2000) suggest that a quick reaction does not eliminate existing hazards, but a slower processing of information and subsequent slower reaction can intensify existing hazards and lead to injuries that might not normally occur. What was previously a "close call" may now become an injury event (Lago, 1999).

Posture, Gait, and Balance

Changes to neurotransmitter activity, along with other neurological and physiologic changes, can affect the older person's ability to control body movements (Cacchione, 2000; Shephard, 1997). Postural stability, gait and balance can be adversely affected due to diminished proprioception and kinesthetic senses and vestibular changes (Cacchione, 2000; Eliopoulos, 2001; Roussel, 1999; Shephard, 1997; Wagner & Kauffman, 2001). Such changes, along with slowed reaction speed, can contribute to falls (Shephard, 1997; Wagner & Kauffman, 2001). Changes in proprioception and motor activity can result in an inability to avoid obstacles quickly or respond with quick movement (Cacchione, 2000). However, many of the balance problems and gait disorders seen in older adults are likely the result of pathology rather than age-related changes (Wagner & Kauffman, 2001).

Thermoregulation

The brain is involved in thermoregulation, which is the maintenance of a stable core body temperature in varying environmental temperatures. Defects in thermoregulation can occur with age but whether these deficits are due to impaired physical response to central nervous system signals or impaired detection by the central nervous system has not been fully identified (Arking, 1998). However, less effective thermoregulation by the brain is likely involved (Roussel, 1999). The functional consequences of age-related changes to thermoregulation is that older adults may be less perceptive to environmental temperatures, less efficient in their physiologic response to hot or cold environments (e.g., shivering, sweating), and therefore, more disposed to hypothermia (drop in blood temperature) or hyperthermia (rise in blood temperature) (Miller, 1999; Shephard, 1997). Healthy older adults in comfortable environments will experience minimal, or no, functional consequences from impaired thermoregulation, but even moderately hot or cold temperatures may lead to development of hypothermia or hyperthermia (Miller, 1999). The presence of additional predisposing factors, such as certain medication use, diseases, and overexertion in warm environments, will increase vulnerability to blood temperature changes. If hypothermia or hyperthermia is not noticed or interventions are not taken early, the conditions can progress to the point of impairing cognition. If the conditions are not reversed, they will lead to death. Age-related changes affecting thermoregulation may begin around age 50, but thermoregulation is most affected in individuals in their seventies or eighties (Miller, 1999).

Sleep

A region of the brain is also primarily responsible for the regulation of sleep and wakefulness. Age-related neurological change, therefore, can affect sleep patterns (Eliopoulos, 2001; Roussel, 1999). Age-related sleep changes that can occur among older adults, compared to younger adults, include:

- a longer time to fall asleep
- more easily and frequently awakened at night
- a reduction in deep sleep
- increased early morning waking (Aud, 2000; Bahr, 1999; Miller, 1999; Shephard, 1997).

As a consequence of these changes, older adults may experience daytime sleepiness and periods of reduced alertness (Aud, 2000; Hampton et al., 1997), and work performance can be affected by disruptions in sleep patterns (Bahr, 1999). Short-term sleep loss can lead to fatigue, confusion, irritability, poor concentration, and additionally in prolonged sleep loss, disorientation, attention deficits, and impaired perception (Miller, 1999; Bahr, 1999). These effects, such as fatigue and reduced alertness, could have serious implications on occupational safety.

Most changes in sleep patterns and daytime fatigue are the result of factors other than age-related changes alone, in particular:

- underlying disease
- medication side effects
- psychosocial problems (e.g., depression)
- pain and discomfort
- environment (e.g., noise)
- dietary influence (e.g., caffeine)
- sleep disorders
- alcohol
- lack of daytime stimulation/activity (Aud, 2000; Miller, 1999; Shephard, 1997).

Additional Factors That Can Influence Cognitive Function

At any age, cognitive function can be significantly influenced by numerous factors. Level of education is one of the most important factors that can affect

cognitive performance (Miller, 1999; Shephard, 1997). As well, motivation and relevance of information can influence memory and learning (Miller, 1999; Riley, 2001). Mental health disorders, in particular anxiety and depression, can also be factors. With anxiety, excessive self-focus and worry can impair cognitive performance. In depression, there may be inability to concentrate, attention deficits, and negative expectations (Miller, 1999). Changes to neurotransmitter activity with age may be involved in the occurrence of depression in older adults (Cacchione, 2000), although these changes show wide variability (Roussel, 1999). Other factors that can influence cognitive performance include:

- physiologic disorders and disease
- medications (e.g., sedatives)
- alcohol
- health status
- nutritional status
- sensory impairment
- self perception and expectations
- intellectual skills
- task demands
- sociocultural background
- stress (Cacchione, 2000; Miller, 1999; Shephard, 1997).

Summary

The degree of age-related change in cognitive function is significantly less than societal stereotypes would suggest. There is substantial stability in cognitive abilities throughout the life span. However, many older adults may experience minor decreases in memory, fluid intelligence, cognitive processing, and motor control, and changes in thermoregulation and sleep patterns. Nonetheless, in terms of vocational performance, age-related cognitive change may have

minimal impact on healthy older adults. Cognitive changes significant enough to affect job performance are reported to more likely occur after age 65 or 70 and cognitive changes that may have a functional impact on normal daily activities may not occur until after age 75 (Riley, 2001). However, the impact on performance in a farming occupation is not specifically reported. Again, it is important to stress that there is tremendous variability in cognitive change that is experienced by older adults. As well, vocational experience and accumulated knowledge with age can preserve vocational competence to a large degree (Riley, 2001; Spirduso, 1995). Changes in neurological and cognitive function that may be seen in older age can be due to many other factors other than increasing age. Therefore, any changes should not be immediately considered as normal consequences of aging.

SENSORY SYSTEM

Sensory receptors in the nervous system receive information about the environment and make sensation possible. From the receptors, the information is sent to the central nervous system where it is comprehended. Impairment in the sensory systems will have an impact on how the environment is perceived and will reduce the quality of the information sent to the brain. Age-related changes can occur in all five senses - vision, hearing, taste, smell, and touch - although taste is only minimally, if at all, affected by age (Shephard, 1997). Again, the changes vary drastically by individual. The senses most important to safe performance of tasks are vision and hearing and to a lesser extent, touch (tactile sensation) and smell. As a result, only these four senses are reviewed here.

VISION

In the farm environment, safety is dependent upon good visual acuity, the ability to clearly recognize objects at varying distances and in varying light conditions, and the ability to distinguish colors (Freeman & Schwab, 2000; Murphy and Ambe, 1994). However, most adults experience some age-related change in vision that can begin by their forties or fifties (Hooper, 2001; Miller, 1999). Changes can occur in the eye itself and in the visual pathway to the brain. Therefore, age-related changes may impair how visual stimulation is perceived and/or how visual information is understood by the brain. While non-disease changes are gradual and may have only a limited impact on older adults, changes in vision can affect safety and performance of many activities, particularly if there is no compensation through visual aids or changes in the environment. However, the most serious visual impairments experienced by older adults are usually the result of diseases that are more likely to occur later in life.

Potential Age-Related Changes

Cornea and Lens

The cornea (the translucent covering over the eye) is where light first enters the eye (Hooper, 2001). The cornea is responsible for most of the eye's refraction of light and focusing abilities (Arking, 1998). As the cornea ages, it can become more opaque and yellowed, which interferes with the amount of light, particularly ultraviolet light, that reaches the retina (Hooper, 2001; Miller, 1999). Most importantly, with age (after age 60 to 65), the curve of the cornea flattens and reduces its refractive power (Arking, 1998; Hooper, 2001).

The lens of the eye is also involved in refraction. The lens never stops growing, thus with age and cellular changes, it increases in size and becomes thicker, stiffer and more opaque. By 70 years of age, the lens can triple in mass (Arking, 1998; Miller, 1999). Light transmission and focusing abilities are affected as a result. In fact, refractive power decreases considerably with age (Arking, 1998; Hooper, 2001). Such changes in the lens lead to less light being transmitted into the eye (Arking, 1998; Eliopoulos, 2001; Hooper, 2001). Extreme opaqueness of the lens can lead to development of cataracts. Cataracts give the eye a cloudy appearance, further reduce light transmission, blur vision, and decrease night vision (Eliopoulos, 2001; Hooper, 2001). However, cataract formation can be caused by factors other than age, such as some medications, disease, lifestyle and environmental factors (Miller, 1999). The muscle responsible for changing the shape of the lens (the ciliary muscle) may begin to deteriorate after age forty and by age sixty, it can be less functional due to atrophy and stiffness (Miller, 1999).

Pupil and Iris

Changes in the iris and pupil can also reduce light transmission. The iris muscle

controls pupil size and therefore, the amount of light entering the eye. Degeneration in the iris with age leads to increased weakness, rigidity and atrophy (Arking, 1998; Hooper, 2001). Decrease in pupil size can begin in a person's thirties and continue up until their seventies (Miller, 1999).

Vitreous

The vitreous, the gelatinous inner substance of the eye, begins to decrease near or after age 50, and the eye fills with more liquid. Such changes can cause blurred or distorted vision and reduce the amount of light reaching the retina (Eliopoulos, 2001; Miller, 1999).

Retina and Retinal Pathway

Neural impulses pass from the retina to the optic nerve and through to the brain's visual cortex. Cells in the retina responsible for color perception and acuity may begin to decline in number after age 20. The number and quality of brain cells in the visual cortex tend to decline with age and visual perception can be affected as a result (Miller, 1999).

Possible Functional Consequences

Changes in the eye and/or visual pathway can affect vision in a number of different ways. The consequences of the changes may be serious for farmers; a study of older farmers in Kentucky found that vision impairment might increase the risk of farm-related injury (Browning, Truszczynska, Reed, & McKnight, 1998). The following outlines the functional consequences of age-related changes to visual structures.

Accommodation

Miller (1999) defines accommodation as 'the ability to focus clearly and quickly on objects at various distances (p.208)." The rate of the eye's accommodation to changes in distance is usually slower in older adults (Shephard, 1997). Loss of

accommodation is often one of the earliest changes in vision and causes most adults to need corrective lenses (Eliopoulos, 2001). Loss of near vision (presbyopia) usually occurs after age 40 or 50 (Eliopoulos, 2001; Miller, 1999). Consequently, as near vision declines, the closest point at which a small object can be seen will become further away from the eye. By age 60, the lens' refractive power can degenerate to the point where many individuals cannot focus on objects at a close distance (Arking, 1998). However, presbyopia can be corrected quite successfully with proper corrective glasses (Hensel, 2000).

Acuity

The ability to discern detail and discriminate objects is best around 30 years of age and then gradually declines. Age-related changes that interfere with transmission of light to the retina are a factor in diminished acuity since a threefold decrease in the amount of light reaching the retina can be experienced from about age 20 to age 60. By age 60, the retina may only receive about one-third of the white light and only one-ninth of the blue light that the retina of a young adult receives (Shephard, 1997). Low or poor lighting will exacerbate acuity problems; therefore, night vision may be impaired. Older adults typically need more light to see adequately and consequently, they may experience difficulty seeing in dim areas or at night (Eliopoulos, 2001). Acuity is impaired to a greater extent with moving objects and worsens as the object's speed increases. Task performance in low illumination or involving moving objects may be hindered (Miller, 1999). As a result, many older adults experience a decline in ability to drive at night.

Adaptation to Light

Being able to adapt to dim lighting or the dark can begin to decline around age 20 and decreases more significantly after age 60. Older adults experiencing this visual change require more time to adapt to changes in lighting when moving

from brighter to darker environments (Gallman & Elfervig, 1999; Hensel, 2000). Moreover, the older adult may be impaired in adapting to high levels of illumination and need a longer time to recover from glare and bright lights, such as headlights while driving at night.

Color Perception

Since color perception relies on the type and amount of light reaching the retina, age-related changes interfere with accurate color perception and differentiation. While the ability to discriminate between all colors may be impaired, shades of green, blue and violet can be particularly affected (Arking, 1998; Coy & Davenport, 1991; Hensel, 2000). Blue-colored objects may appear darker and white light can take on a yellowish hue. Impaired color perception is exacerbated by poorly or low lit environments (Miller, 1999). Most daily activities tend not to be affected by alterations in color perception, although implications for color coding are evident.

Depth Perception

Accurate depth perception is required to maneuver safely around one's environment. Depth perception declines with age and may contribute to trips and falls if the distance and height of objects, for example, curbs or steps, is not judged accurately (Eliopoulos, 2001).

Visual Field

The visual field is the scope of visual information that a person can see while staring straight ahead. Miller (1999) notes that a person's visual field is instrumental to activities that require a broad perception of the environment and moving objects, such as driving a vehicle or walking in a crowd. There is a

steady reduction in the visual field with age. The visual field has been found to begin a slight narrowing after age forty with continued decline after that point (Shephard, 1997; Miller, 1999). Narrowing of the visual field makes peripheral vision more difficult and adds to alterations in depth perception (Eliopoulos, 2001; Hensel, 2000).

Glare

Glare sensitivity and recovery time from glare begins to increase for many adults while in their fifties. For the older adult, glare can cause pain and hamper object identification (Hensel, 2000). Environments with bright lighting and highly reflective surfaces may pose a safety hazard for older adults adversely affected by glare. Problems with glare can have a negative impact on driving at night as well (Miller, 1999).

Critical Flicker Fusion

Age-related changes in the retina and retinal pathway can interfere with critical flicker fusion, the point at which a flickering or flashing light is perceived instead as a continuous light (Eliopoulos, 2001). Low levels of light exacerbate aging changes and further interfere with critical flicker fusion. Therefore, older adults may have difficulty in perceiving flashing lights on emergency vehicles or warning signs on the road, particularly at night (Miller, 1999).

Visual Information Processing

Due to changes in the retinal pathway, older adults have been found to be slower in processing visual information and require greater time to search their visual memory when performing tasks (Hooper, 2001; Miller, 1999). Visual perception can be affected which impairs image judgement. Such changes

increase difficulty in recognizing moving objects, complex objects or items that quickly move in and out of light (Hooper, 2001). Task performance impaired by these changes includes walking, driving, and watching television (Hooper, 2001). However, age-related changes in visual information processing are minimal when undertaking familiar or frequently performed tasks (Miller, 1999).

In summary, Miller (1999) reports there are five visual performance tasks that are most likely to be impaired in older adults:

- visual processing speed (e.g., reading speed)
- light sensitivity
- dynamic vision (e.g., reading something that is moving)
- near vision
- visual search (e.g., locating an object)

Additional Factors That Can Influence Vision

Miller (1999) cites several risk factors that can exacerbate age-related changes in vision:

- ultraviolet sun rays - exposure is associated with cataract formation and loss of cones in the retina
- medication
- disease

The retina can be affected by disease processes, such as retinopathy or age-related macular degeneration (ARMD). ARMD causes loss of vision in the central field (Hooper, 2001). The optic nerve is not susceptible to many age-related changes, but it can be damaged through a group of diseases called glaucomas, which can lead to loss of peripheral vision (Miller, 1999).

Along with proper eyeglasses, many adaptations in the visual environment can

diminish the changes in vision that may occur with age such as proper illumination, glare control, color contrasts, and large print size (Hooper, 2001). The environment can be a significant factor in farming since farmers often work in situations with inadequate light, such as in fields at dusk or night, on overcast days, or in dimly lit sheds or barns (Freeman & Schwab, 2000; Murphy & Ambe, 1994).

HEARING

Hearing is instrumental to performance of many activities, particularly where carrying out verbal instructions or auditory signals are involved, and also to safe movement in environments that require accurate perception of sounds (Miller, 1999). The auditory system can undergo many changes with age, both in the ear and in the auditory nervous system. The changes are gradual, yet progressive, with the effect that hearing loss is common in older adults.

Age-Related Changes

External Ear

Structural changes in the external ear, such as longer, thicker hair and dryer skin, can encourage cerumen (wax) build up in the ear. Atrophy of cerumen glands cause cerumen to become drier (Hensel, 2000). A higher level of keratin in cerumen that occurs with age also contributes to build up (Eliopoulos, 2001).

Middle Ear

Tissue change and degeneration in surrounding muscles and ligaments can result in a less resilient and elastic ear drum and impaired sound transmission. Reduction in strength and flexibility of the middle ear muscles and ligaments may affect the ability to contract in response to noise. As a result, the acoustic reflex may be diminished, less sound is filtered out and the inner ear is less protected (Eliopoulos, 2001; Miller, 1999; Shephard, 1997).

Inner Ear and Auditory Nervous System

The inner ear contains the sensory organs for hearing and balance (vestibular system). Auditory stimuli are transmitted from the inner ear to the brain via the auditory nerve pathway. Hearing loss due to age-related changes in the inner ear is called presbycusis (Eliopoulos, 2001). Age-related changes to the inner ear can include loss of, or damage, to hair cells and nerve cells, decreased blood supply, and rigidity in the basilar membrane (Eliopoulos, 2001; Hooper, 2001; Miller, 1999). Vestibular neurons may decrease in number and size (Spirduso, 1995). The auditory nerve pathway can undergo its own age-related atrophy, but it is also adversely affected by changes in other structures (Miller, 1999). The central nervous system can change with age, which may also affect the processing of auditory stimuli (Shephard, 1997).

Possible Functional Consequences

Hearing loss can occur from age-related changes. In addition to hearing problems, degeneration of the inner ear's structures can alter equilibrium (Eliopoulos, 2001). Hearing loss is reported as a significant risk factor for sustaining a farm injury. Hwang et al. (2001) found that the presence of hearing loss nearly doubled the odds of having a severe farm injury among adult farmers in New York State. Similarly, Browning et al. (1998) reported that older male Kentucky farmers (age 55+) with hearing loss but not wearing hearing aids were at four times the risk for farm injury. Hearing loss can be categorized into conductive, sensorineural or mixed (both conductive and sensorineural), depending on the area of impairment.

Conductive Hearing Loss

Conductive loss is usually due to problems in the external or middle ear that

block proper sound conduction. Age-related changes in the external or middle ear can lead to cerumen build up in the auditory canal, fluid accumulation in the middle ear, or diminished bone movement in the middle ear. The effect of these changes is blocked sounds or sound conduction through an obstruction such as wax or fluid. Intensity or loudness of sound is reduced, as is the ability to hear low-pitched tones. Cerumen build up is the most common cause of conductive hearing loss in older adults. However, cerumen build up is easily preventable and treatable. Conductive problems can often be treated and corrected by cleaning the ear, medication or surgery (Hooper, 2001). However, conduction loss alone is not the most common cause of hearing impairment in older adults.

Sensorineural Hearing Loss

Sensorineural loss is usually due to impairment in the inner ear that affects the sensory or neural structures. Inner ear changes result in hearing impairment called presbycusis, the most common form of hearing loss in older adults (Hensel, 2000). The sensorineural structures are involved in hearing sensitivity and speech comprehension. Hearing sensitivity changes with age; this is the earliest and most common hearing change that is experienced. Changes in hearing level can begin around age thirty. The most notable difficulty is in detecting higher frequencies (pitches) and sibilant sounds or consonants (those that make a whistling noise, such as ch, f, ph, s, sh, g, and z) (Eliopoulos, 2001; Miller, 1999). In addition to changes in threshold sensitivity, aging changes can affect pitch discrimination and auditory reaction time. Ability to detect small changes in pitch may start to decline by age 40 and then decrease at a rate proportional to increase in age later in a person's fifties. Loss of this skill impairs understanding of both speech and music (Hooper, 2001). Auditory reaction time can increase with age, likely due to aging changes that reduce the amount of auditory stimuli that reach the brain and/or impaired cognition involved in decision making (Hooper, 2001). Problems hearing auditory stimuli may also be due to tinnitus

(a ringing, buzzing, or humming in the ears, generated due to degeneration in the inner ear and auditory pathway), but most often it is due to other factors such as noise or damage to the inner ear (Hensel, 2000; Shephard, 1997).

One of the most significant effects of age-related sensorineural decrements is increased difficulty with speech comprehension. This complex skill relies on speech reception, speech discrimination, and understanding speech in stressful listening conditions. Speech reception and recognition may decrease with age in association with a decrease in hearing sensitivity. The filtering out of high-pitched and sibilant sounds diminishes speech discrimination, since words and sentences become distorted and incoherent. As sensorineural impairments advance, the ability to hear explosive consonants, such as b, d, k, p, and t, will also decline (Miller, 1999). Rapid, slow or slurred speech further can interfere with older adults' speech discrimination abilities (Hooper, 2001; Miller, 1999).

Difficulty in hearing speech when in stressful listening conditions is common in older adults, which compounds deficits due to sensorineural hearing loss. Examples of stressful conditions include rooms with background noise, poor acoustics or echoing; in an automobile; and, group speaking events (Hooper, 2001; Miller, 1999). It should be stressed that even though most older adults experience a decrease in speech comprehension in stressful listening conditions, there is much variation in the degree of difficulty experienced. Moreover, the degree of difficulty may vary by each particular stressful condition (Hooper, 2001). Sensorineural loss is not correctable, but hearing aids can be used for compensation (Hooper, 2001).

Sense of Balance

The vestibular system (inner ear) is one of the major systems involved in balance by providing information about movement of the head and the head's

position with respect to gravity. Study of vestibular function in older adults has drawn inconclusive results (Spirduso, 1995), but it has been suggested that the aging vestibular system may become less able to sense body position and movement, which can increase risk of falls (Murphy & Ambe, 1994). On a farm, dizziness or loss of balance poses particular safety threats around moving or unguarded parts of farm machinery. Moreover, such disorders have implications for driving and safe mobility (Murphy & Ambe, 1994). Nevertheless, even if there is a general decrease in vestibular sensitivity with age, dizziness or balance disorders should not be considered a normal consequence of aging (Hensel, 2000).

Additional Factors That Can Influence Hearing

Hearing loss can be caused by factors other than older age. Disease, medication and noise exposure are the most commonly cited risk factors for hearing impairment (Hooper, 2001; Miller, 1999).

Disease

Otosclerosis, a hereditary disease, often begins at younger ages but it may not be detected until later in life when age-related changes in the ear compound the disease's effects (Miller, 1999). Diseases that affect the auditory system include Ménière disease and acoustic tumors. Systemic diseases include diabetes, kidney disease, hypothyroidism, syphilis, heart disease, vascular disease, and Paget's disease. Other disorders that can cause some degree of hearing impairment include high fevers, head injury, meningitis, and viral infections such as mumps and measles (Hensel, 2000; Miller, 1999).

Medication

Medications that cause or contribute to hearing impairments by damaging the ear's structures are called ototoxic medications. Ototoxicity more commonly

occurs in older adults since they are more likely to be taking one or more ototoxic medications, and potentially on a long-term basis as well.

Noise Exposure

Extensive exposure to noise can cause permanent damage to the auditory system. Occupational noise in particular has been found to be associated with hearing loss, which is a particular consideration for farming. Studies have repeatedly indicated that farmers of all ages suffer from a greater degree of noise-induced hearing loss than the general population or most other occupations (Beckett et al., 2000; Brackbill, Cameron, & Behrens, 1994; Purschwitz, 1997). For example, years of exposure to noise from farm machines (e.g., grain dryers, tractors, power tools), animal confinement structures, ototoxic chemicals, firearms, and/or feed unloading areas can lead to loss of hearing (Beckett et al., 2000; Kirkhorn & Schenker, 2001; Purschwitz, 1997). Studies indicate that more than half of the farm population may be affected by hearing loss (Kirkhorn & Schenker, 2001). Hearing loss may interfere with the ability to hear warning signs of approaching hazards (e.g., a charging animal), the sound of an automobile horn, or the yell of a co-worker (Freeman & Schwab, 2000; Murphy & Ambe, 1994).

SMELL

Smell is a chemical sense that serves to inform us of both the dangers and the pleasures in our environment. The ability to smell involves perception of stimuli by the sensory cells in the nasal lining and the central nervous system processing the information (Miller, 1999).

Potential Age-Related Changes

Older adults experience a decrease in the number of sensory cells in the nasal lining and the olfactory bulb of the brain (Eliopoulos, 2001).

Possible Functional Consequences

Detection of scent reaches peak sensitivity around age 30, but by age 80, detection of scent can decline in sensitivity by almost 50% (Eliopoulos, 2001; Miller, 1999). Older adults may also have impairment in identifying and discriminating scents. Age-related declines in detection and identification of scents are mainly experienced after age 60 (Miller, 1999). Functionally, age-related changes have little impact on performance of most tasks. However, older adults with olfactory impairment may not be aware of certain dangers in their environment that smell might normally alert them to. For example, there may be an increased risk of overexposure to hazardous chemicals that might otherwise be detected by smell (Hooper, 2001).

Additional Factors That Can Influence Sense of Smell

Several risk factors can compound the age-related decrements in sense of smell:

- medications (e.g. antihistamines)
- disease (e.g., periodontal and upper respiratory disease; diabetes)
- head trauma
- environmental influences (e.g., factory work; prolonged exposure to toxic fumes)
- smoking (Arking, 1998; Hensel, 2000; Hooper, 2001; Miller, 1999)

Sense of smell also differs by gender, with women having better olfactory abilities than men for both detection and identification of scents (Arking, 1998).

TACTILE SENSATION

Tactile sensations provide valuable cues about our environment that facilitate safe performance of tasks. Tactile sensitivity undergoes changes with advancing years that could increase safety risks.

Potential Age-Related Changes

Sensory receptors in the skin responsible for sensations of light touch, pressure, vibration, and temperature experience changes. The receptor cells experience structural changes and decline in number, usually starting in the thirties. A degeneration in associated nerve fibers may also occur, which slows down nerve conduction speed (Hooper, 2001; Shephard, 1997). There are conflicting reports on whether there are age-related changes to sensory receptors for pain perception (Hampton et al., 1997; Hooper, 2001; Miller, 1999; Shephard, 1997).

Possible Functional Consequences

In response to age-related changes, there is a progressive deterioration in sensitivity to light touch, vibration, and pressure and a reduced ability to differentiate temperatures (Eliopoulos, 2001; Hensel, 2000; Shephard, 1997). The body's extremities, particularly the hands, may show the earliest and greatest decrements in tactile sensitivity with advancing years. Central regions of the body are less and more gradually affected (Arking, 1998; Hooper, 2001). It is reported that there is no change in the threshold for pain (Miller, 1999; Shephard, 1997), or only minimal alterations in terms of a small increase in the threshold for pain stimuli applied to the skin (Hampton et al., 1997; Hooper, 2001). However, pain perception involves much more than touch with regards to nervous system involvement, but also other factors such as personality, psychological and cultural factors, and use of pain (analgesic) medications (Arking, 1998; Hampton et al., 1997; Hooper, 2001). These confounding factors make it difficult to assess true age-related changes in pain perception.

Aging changes in tactile sensitivity can cause older adults to misperceive their environment, which can pose significant risks to safety. An increased risk of scald burns from hot water due to a decreased ability to discern extreme water

temperatures is one example of the negative functional consequences of diminished tactile sensitivity (Miller, 1999).

Additional Factors That Can Influence Sense of Touch

The following factors can compound age-related changes in tactile sensitivity:

- medications (e.g., analgesic medications or medications that affect perception can interfere with pain sensitivity)
- cerebrovascular accidents
- peripheral vascular disease
- skin disease (Hampton et al., 1997; Hensel, 2000; Hooper, 2001).

Farmers are in an occupation with one of the highest risks of skin disease due to factors such as working outdoors in harsh hot and cold environments; high exposure to sunlight; contact with irritating plants; and, repeated exposure to farm chemicals (Burke, 1997). Therefore, an older farmer may have further decrements in tactile sensitivity if a skin disorder is also interfering with sense of touch.

Summary

In older adults, smell, vision, hearing and touch are likely to experience some decrease in sensitivity. These decreases may be the result of structural changes in the ear, nose, eye or skin that can occur with age, or the changes of an aging nervous system. Environmental influences, lifestyle, disease or medications can negatively influence sensory function as well, or they may exacerbate age-related sensory decrements. For example, farming hazards can pose additional risk to hearing, due to occupational noise, and sense of touch, if farm-related skin disorders are present. Many of the potential age-related sensory deficits that would most impact task performance can be compensated for to some degree through adaptive devices, such as glasses or hearing aids. Moreover, perception

can become a learned and automatic response over a lifetime, which may aid in maintenance of functional skill when sensory deficits occur (Hooper, 2001).

MUSCULOSKELETAL SYSTEM

The musculoskeletal system changes with age, although the rate of change and the effect on function varies greatly between individuals. The body's bones, muscles, and joints are the structures most associated with mobility - one of the most important functions for task performance. Although they are aided by powerful machines, farmers still require adequate muscle strength and mobility to safely perform tasks. As well, flexibility and good posture are important functional criteria for farm safety (Freeman & Schwab, 2000; Murphy & Ambe, 1994). Normal age-related changes predispose individuals to musculoskeletal problems and diseases. As a result, musculoskeletal problems commonly occur in older adults (Lamb & Cummings, 2000; Shephard, 1997).

BONE

Bones not only create a framework for the musculoskeletal system, but they also store calcium, produce red blood cells, and provide a source of support and protection to organs and tissues. There are two types of bone: the hard outer layer is called cortical or compact bone and the softer inner bone is called trabecular or spongy bone. Both types of bone can undergo age-related changes.

Potential Age-Related Changes

To maintain a steady level of calcium in the blood, calcium is absorbed from bone and then redeposited to form new bone. This process, called remodeling, continues throughout one's lifetime. The rate of calcium absorption remains unchanged with age but the rate of new bone formation decreases with age. Consequently, older adults experience a loss of total bone mass (Patillo & Stanley, 1999). The bone's structure is further changed by a decrease in the number of functional marrow cells, as marrow is replaced with fat cells with age (Miller, 1999). The pattern of bone loss with age differs by bone type. In compact bone,

bone loss may begin around the age of 40 years with a lifetime accumulative loss of about 35% for women and 23% for men (women experience accelerated bone loss after menopause). In spongy bone, bone loss may begin about a decade earlier, with an accumulated loss of about 50% for women and 33% for men from their young adult levels (Arking, 1998; Miller, 1999). The gender differences in bone loss are substantial since at every age, men have a greater bone mass than women (Arking, 1998).

Osteoporosis, a bone disorder, is mentioned here because it is considered an exaggerated version of the normal age-related process of bone loss that has been exacerbated by additional factors (Arking, 1998). Osteoporosis is characterized by a decrease in bone mass and loss of bone strength. Due to gender differences in bone loss, women are more susceptible to osteoporosis (Lamb & Cummings, 2000).

Possible Functional Consequences

Age-related changes to bone cause the vertebrae to shorten and spinal disks to shrink, which leads to a decrease in the length of the spinal column. By age 70, height can decrease by an average of two inches from the maximum height reached as a young adult (Eliopoulos, 2001). However, the most significant consequence of age-related bone changes is loss of bone strength. Functionally, this change predisposes older adults to fractures as the level of trauma required to produce a fracture is decreased, even in the absence of additional risk factors (Miller, 1999). The most common sites of fractures are the hips, vertebrae, wrists, and forearms (Patillo & Stanley, 1999; Shephard, 1997). As well, the bones are more likely to snap into a "clean" fracture, which are less likely to heal (Arking, 1998). With osteoporosis, a fall to the floor from standing position can cause a bone to break, and in advanced cases, even a cough or muscular contraction can lead to a fracture (Miller, 1999; Shephard, 1997). There often

are no symptoms of osteoporosis until a fracture occurs, but back pain or fatigue may be present. The fatigue is caused by an increased demand on muscles to keep the body upright in light of decreased bone mass (Lamb & Cummings, 2000).

Additional Factors That Can Influence Bone Remodeling and Bone Loss

A number of intrinsic and extrinsic factors can affect the process of bone remodeling and bone loss. Miller (1999) notes that the following factors, which are common in older adults, can specifically affect bone remodeling:

- hyperthyroidism
- decreased activity levels
- chronic obstructive lung disease
- calcium and vitamin D deficiencies
- certain medications, such as glucocorticoids and anticonvulsants

Bone loss is a well-established consequence of bed rest and immobility. Factors that influence development and maintenance of peak bone mass, such as genetic factors and nutritional intake, may also determine who is more susceptible to bone loss (Patillo & Stanley, 1999; Shephard, 1997). Body fat is a factor since obese individuals experience a lower rate of bone loss. Individuals who are carrying extra weight are supporting a larger body mass when performing activities, which can decrease the rate of bone loss (Eliopoulos, 2001). Also, body fat is an important site for estrogen creation, a hormone that can protect from bone loss. This relationship helps to explain why rate of bone loss accelerates in women at menopause, a point when estrogen levels decline (Arking, 1998). The rate of bone loss can be slowed by interventions and preventative strategies such as weight-bearing exercises, even at older age (Miller, 1999; Shephard, 1997).

The factors that increase or decrease risk of bone loss also increase or decrease the risk of osteoporosis. Additional factors that can increase the risk of osteoporosis are:

- female gender
- decreased testosterone in men
- smoking
- alcohol and caffeine
- medications
- disease (Miller, 1999; Patillo & Stanley, 1999, Shephard, 1997)

MUSCLE

The body has three types of muscle: skeletal (voluntary) muscle, smooth (involuntary) muscle, and cardiac muscle. Discussion of muscle changes predominantly focus on skeletal muscle since this type of muscle constitutes the majority of muscle mass and much more is known about aging changes to it. Skeletal muscle is one of the major determinants of movement and therefore, is involved in performance of all tasks. Skeletal muscles are controlled by motor neurons, which are nerve cells along which the brain sends instructions, through electrical impulses, to the muscles.

Potential Age-Related Changes

Several potential age-related changes can have an impact on muscle function. Primarily, the size and number of muscle fibers decrease, which leads to loss of muscle mass. As muscle fibers deteriorate, they are replaced by fibrous connective tissue and fat tissue (Lamb & Cummings, 2000; Patillo & Stanley, 1999; Shephard, 1997; Wagner & Kauffman, 2001). Muscle fibers that do not atrophy may undergo metabolic changes (Arking, 1998). The muscle cell membranes may deteriorate and the decline in the number of motor neurons that can occur with age also can affect muscle function. Degeneration of motor

neurons leads to weakness and wasting of muscles (Arking, 1998; Miller, 1999; Shephard, 1997; Wagner & Kauffman, 2001). Not all muscles experience the same rate of decline. Moreover, it is difficult to determine what amount of loss of muscle mass is due to true aging or is a consequence of decreased physical activity with age. In very active individuals, little loss of muscle mass has been found with age (Shepard, 1997; Wagner & Kauffman, 2001).

Possible Functional Consequences

As a result of age-related changes in skeletal muscle, there may be a decrease in muscle mass, tone, strength and flexibility (Arking, 1998; Lamb &Cummings, 2000; Miller, 1999; Shephard, 1997; Wagner & Kauffman, 2001). Muscle endurance and coordination can also be affected (Miller, 1999; Shephard, 1997). Muscle strength can begin to gradually decrease around the age of 40. The rate of strength loss may increase between the ages of 50 to 70 and then accelerate even further between 70 to 80 years of age (Patillo & Stanley, 1999; Wagner & Kauffman, 2001). There is a greater decline in strength in the lower extremities than in the upper extremities (Miller, 1999; Wagner & Kauffman, 2001). Weakness in the lower extremities increases risk of falls (Miller, 1999; Shephard, 1997; Wagner & Kauffman, 2001).

Decreased strength in older age can impede physical performance and can lead to a decline in motor function. Loss of strength reduces the load that an older adult can lift, slows walking speed, and shortens the length of their strides (Wagner & Kauffman, 2001). Older adults may experience muscle fatigue after shorter periods of activity (Miller, 1999; Wagner & Kauffman, 2001). The slowness in, and uncoordination of muscle contractions increases reaction time and leads to more sluggish movement. Skeletal muscle weakness can lead to postural changes as well. Since balance relies in part on the coordination of muscle groups and the force of muscle contractions, muscle changes can impair

balance. Each of these changes alone in reaction time, posture, or balance, can increase risk of falls in older adults (Lamb & Cummings, 2000; Miller, 1999; Shephard, 1997; Wagner & Kauffman, 2001).

Additional Factors That Can Influence Muscle Function

As noted previously, it is difficult to discern the effect of inactivity in older age from age-related changes in skeletal muscle mass. Age-related changes affect muscle function, but the functional consequences can be compensated for through activity. Regular exercise helps to maintain muscle strength and tone while reducing some of the negative consequences of aging muscles (Eliopoulos, 2001). A person's present level of activity and patterns of exercise throughout life can influence strength at any age (Miller, 1999). Older adults who remain physically active have been found to experience only moderate losses in skeletal muscle mass and even undertaking a training program in later life can improve skeletal muscle strength (Wagner & Kauffman, 2001). The physical demands of farming occupations may be able to offset some of the decline in muscle mass and strength with age. Studies of Ontario dairy farmers found that farmers aged 60 and older had higher muscle mass, higher grip strength, and less of a decrease in strength with age, than non-farming peers in their age group (Pfeiffer et al., 1984; Moore & Pfeiffer, 1987).

While exercise and physical activity can help stimulate growth of skeletal muscle, inactivity, malnutrition, or denervation will cause muscles to atrophy and will further complicate the aging process. Similarly, circulatory changes that may be experienced by older adults can lead to further reduction in muscle function (Arking, 1998).

JOINT AND CONNECTIVE TISSUE

Numerous age-related changes affect the tissues involved in the function of

musculoskeletal joints. The musculoskeletal system relies on bones, muscles, and joints to function but unlike the bones and muscles, which benefit from activity, joints are harmed by continued use (Miller, 1999). Problems in the joints are one of the most common complaints of older adults.

Potential Age-Related Changes

Degeneration of the joint's collagen leads to loss of collagen's resilience (Shephard, 1997). Capillary supply to tendons decrease with age. The tendons shrink and harden, which decreases tendon jerks (Eliopoulos, 2001; Shephard, 1997). Cartilage on the surface of joints deteriorates (most notably at weight-bearing joints), cartilage elasticity decreases, the cartilage becomes thinner, and it is prone to fraying, cracking and shredding as a result (Miller, 1999; Patillo & Stanley, 1999; Shephard, 1997). Bone and scar tissue may form at the joint surface and in connective tissue (Miller, 1999; Patillo & Stanley, 1999). In the synovial lining of the joints, cartilage develops in the synovial membrane and synovial fluid decreases in viscosity (Miller, 1999; Shephard, 1997). Changes to tendons, ligaments and synovial fluid can begin in an adult's thirties and joint function, therefore, begins to decline at that point (Miller, 1999).

Osteoarthritis, a joint disease, is mentioned here because it may be considered an extreme progression of age-related changes in joints, although distinguishing between age-related and disease-related change is difficult (Miller, 1999). Nonetheless, the wear and tear on joints with age is believed to play a major role in the development of osteoarthritis (Patillo & Stanley, 1999). The non-inflammatory joint disorder particularly affects weight-bearing joints. It is characterized by progressive deterioration of joint cartilage and the formation of new bone in the joint (Lamb & Cummings,2000; Patillo & Stanley, 1999).

Possible Functional Consequences

The age-related changes to the joint and connective tissue interfere with joint flexion, extension, range of motion, and mobility. In particular, there may be decreased motion in the upper arms and decreased flexion in the lower back and the joints of the lower extremities. Decreased flexion in the lower body can lead to potential difficulty in activities such as climbing stairs (Miller, 1999).

Stiffening of the joints and ligaments increase risk of injury, in particular strains, sprains, and tendon rupture with activity (Patillo & Stanley, 1999; Shephard, 1997). The decrease in tendon jerk lessens reflexes in the arms and abdomen (Eliopoulos, 2001). Joints such as hips, knees, vertebrae, neck, elbows, and wrists may become mildly flexed. The joint may become inflamed, painful and deformed (Patillo & Stanley, 1999). Stiffness of the joints will occur most after periods of inactivity and in the case of the knee, such inactivity can lead to loss of stability if the joint cannot be locked in full extension (Shephard, 1997). With osteoarthritis in particular, there is aching joint pain with activity and stiffness after periods of inactivity (Lamb & Cummings, 2000).

For farm activities, problems in knees or hips can create difficulty in mounting and dismounting tractors and other farm machinery. From a survey of aged tractor operators (age 65+) in Pennsylvania, Ambe and Murphy (1995) found that about 40% of the operators experienced difficulty in their knees when mounting or dismounting a farm tractor. As well, nearly a third of the older operators reported stiffness, weakness, or limited joint movement after operation of their tractors. The farmers specifically identified pain and stiffness occurring in the back or neck and to a less extent, in the joints of the hands, forearms, and arms. If the joints of the fingers, hands, or arms are affected, manipulating tractor or machinery controls could become difficult (Freeman & Schwab, 2000). Reduced range of motion that affects the ability to turn the head or neck could impact safe monitoring of pulled machinery or checks for traffic on the

highway when changing lanes or turning a vehicle (Murphy & Ambe, 1994).

Additional Factors That Can Influence Joint Function

Degeneration of the joint and connective tissues may not be due to aging alone. Several risk factors have been reported to speed the rate of joint degeneration and predispose individuals to osteoarthritis:

- joint trauma
- previous acute joint disease
- genetic predisposition
- repeated heavy loading and overuse of the joint
- obesity, particularly for increased risk of osteoarthritis in the knee
- autoimmune reaction (Lamb & Cummings, 2000; Shephard, 1997)

Aspects of the farming occupation may be important factors as well, since studies indicate farmers have a higher prevalence of musculoskeletal disorders (Purschwitz, 1997; Von Essen & McCurdy, 1998). Joint disorders frequently reported include chronic low-back pain, hip joint pain, and osteoarthritis (Brackbill et al., 1994; Kirkhorn & Schenker, 2001; Purschwitz, 1997; Stiernstrom, Holmberg, Thelin, & Svardsudd, 1998). It is believed that vibration from tractors and repetitive trauma associated with farm work could be related to back pain and other musculoskeletal disorders often experienced by farmers (Brackbill et al., 1994; Runyan, 1993). The repetitive and hard physical work of farming has also been considered to be a factor in the higher rate of arthritis and low back pain often found among farmers (Brackbill et al., 1994; Purschwitz, 1997; Xiang, Stallones, & Keefe, 1999).

Summary

For farming activities, strength and flexibility are needed to lift, carry, or load objects; to climb up or down tractors, machinery, ladders, and stairs; and, to feed

and care for livestock (Freeman & Schwab, 2000). Changes to skeletal muscle that may occur with age can lead to loss of strength to perform such tasks in later life or quicken muscle fatigue when undertaking the activities. Muscle strength into older age can be maintained by exercise, and potentially the physical activity of farming, but exercise may not be beneficial to the body's joints, which experience stiffness and decreased range of motion due to aging changes and a lifetime of wear and tear. Farming activities may be exacerbating the wear and tear on the musculoskeletal system since farmers have been found to be at higher risk for chronic and acute musculoskeletal disorders. Muscle weakness and slowed contraction speed, combined with joint stiffness and reduced range of motion, can put an older farmer at a safety risk in some situations and increase the risk for falls. Given the decrease in bone mass that is experienced by many older persons, increased risk for falls may also result in increased risk for fractures.

CARDIOVASCULAR SYSTEM

The cardiovascular system consists of the heart and blood vessels - arteries, veins and capillaries. The cardiovascular system circulates blood, provides life-sustaining oxygen and nutrients to all the body organs and tissues, and removes carbon dioxide and other waste products. Even though this system may undergo change with age, it has the capacity to adapt to these changes, and changes are not experienced uniformly by all adults. As a result, healthy older adults may not notice significant changes in cardiovascular performance (Miller, 1999). However, age-related changes coupled with other factors can reduce efficiency of cardiovascular function, which can affect all other systems (Stanley, 1999).

Potential Age-Related Changes

Heart

Heart size experiences minimal change with age but the wall of the left ventricle of the heart may gradually thicken and increase in mass between the ages of 30 and 70 (Eliopoulos, 2001; Hampton et al., 1997; Miller, 1999). The heart tissue can become fattier with age as well as increase in collagen content and decrease in elastin levels in the tissue (Dean, 2001; Stanley; 1999). In the presence of such changes, the heart muscle will lose its contraction strength, which decreases cardiac output (the amount of blood pumped by the heart), especially under physiologic stress (Eaton, 2000; Eliopoulos, 2001). The maximum possible heart rate also decreases throughout life (Hampton et al., 1997). The heart valves may accumulate fat, form ridges, and become thicker and stiffer. These changes can impair blood flow across the valves and decrease the efficiency of the heart's pumping action (Dean, 2001; Hampton et al., 1997; Stanley, 1999). The area in the heart around the sino-atrial node often thickens and increases in fat (the sino-atrial node is the pacemaker for the heart cycle (Hampton et al., 1997)) and the number of pacemaker cells in the heart

decreases (Eliopoulos, 2001; Stanley, 1999). These structural changes affect the electrical activity and conduction of the heart and can lead to abnormal or irregular heart rhythm (Dean, 2001; Eliopoulos, 2001; Stanley, 1999).

Vessels

The arteries tend to become thicker and lose elasticity with age (Eaton, 2000; Miller, 1999). The artery walls can accumulate fat, calcium, and cellular material (Eliopoulos, 2001; Miller, 1999). The aorta and other major arteries dilate (Eliopoulos, 2001; Stanley, 1999). Loss of elasticity in arteries contributes to an increase in systolic blood pressure (the pressure in arteries during the contraction of the heart) (Eaton, 2000; Hampton et al., 1997; Miller, 1999). The veins also can become thicker, less elastic, more dilated and swollen (Hampton et al., 1997; Miller, 1999).

Blood pressure is regulated, in part, by baroreceptors (pressure receptors) in the walls of certain arteries (Arking, 1997). Baroreceptors modify heart rate and vascular tone in response to increases or decreases in pressure in the arteries. These receptors are affected by age and can lose sensitivity, which can contribute to a gradual increase in systolic blood pressure with age (hypertension), as well as episodes of low blood pressure (hypotension), particularly during postural changes (Eliopoulos, 2001; Miller, 1999; Shephard, 1997; Stanley, 1999).

Possible Functional Consequences

Age-related changes to the cardiovascular system can predispose older adults to cardiovascular disease. Cardiovascular disease accounts for many of the negative functional consequences in the cardiovascular system that can affect older adults (Eaton, 2000; Miller, 1999). Nonetheless, age-related changes can have functional consequences as well, even in healthy older adults without cardiovascular disease.

Most healthy older adults will experience a decrease in cardiovascular function only during periods of physical activity. Due to a lower maximum heart rate during strenuous activity and decreased cardiac output, healthy older adults may be less able to supply sufficient oxygenated blood to muscles and less able to adapt to physical stress than younger adults (Arking, 1998; Eaton, 2000; Miller, 1999). When the cardiovascular system cannot supply the body with an adequate amount of oxygenated blood or effectively remove metabolic waste products, the individual will experience difficulty breathing and fatigue (Stanley, 1999). These consequences may result in a decrease in the maximum workload of older adults. Activities with low energy demand may now be perceived as physically demanding, and demanding activities may no longer be able to be performed or may require more and longer rest periods while carrying them out (Arking, 1998; Dean, 2001).

Age-related changes to the cardiovascular system that affect blood pressure can also have functional consequences. High blood pressure can predispose a person to a number of serious conditions such as cardiovascular disease and cerebrovascular disease (Hampton et al., 1997; Miller, 1999). However, drops in blood pressure also can have significant consequences. Age-related changes in the cardiovascular system may render blood vessels unable to constrict efficiently in response to sudden changes in position. Therefore, suddenly moving to an upright position when lying down, or standing from a sitting position can lead to a marked drop in blood pressure (postural hypotension) (Shephard, 1997). Dizziness, weakness, confusion, and lightheadedness can accompany postural hypotension with the possible consequences of difficulty walking, falling, or fainting (Miller, 1999; Shephard, 1997). A marked drop in blood pressure can also occur within 1 hour of eating a meal (postprandial hypotension) with the same possible consequences (Miller, 1999). Abnormal or

irregular heart rhythm that can result from age-related changes to electrical activity in the heart can pose similar risks as hypotension, such as dizziness, falls, or change in mental status (Stanley, 1999).

Additional Factors That Can Influence Cardiovascular Function

Other than cardiovascular disease, lifestyle factors can significantly affect cardiovascular performance, such as stress, smoking, poor dietary habits, lack of physical exercise, medication use, and psychosocial factors (Dean, 2001; Miller, 1999). These same lifestyle factors can also increase the risk of cardiovascular disease, as will the following risk factors:

- obesity
- family history
- male gender
- elevated blood cholesterol levels
- diabetes
- hypertension (Eaton, 2000; Miller, 1999; Stanley, 1999).

Postural hypotension can affect healthy older adults, due to age-related changes, but there is an increased likelihood of its occurrence in older adults with additional risk factors, such as:

- dehydration
- prolonged bed rest
- alcohol use
- protein malnutrition
- medications, such as antihypertensive medications
- disease-related conditions (e.g., hypertension, diabetes, Parkinson's disease, stroke, and anemia) (Hampton et al., 1997; Miller, 1999; Shephard, 1997)

Studies have reported a lower rate of cardiovascular disease among farmers,

possibly due to their activity and lifestyle (Stark, Chang, Fitzgerald, Riccardi, & Stone, 1987; Stiernstrom, Holmberg, Thelin, & Svardsudd, 2001), although others have found opposite results (Brackbill et al., 1994). If farmers do have a lower cardiovascular disease risk, it has been suggested that this advantage could cease as farm work becomes less physically demanding (due to mechanical and technological advances) and healthy eating habits are not adopted (Brackbill et al., 1994).

Summary

Disease has more effect on cardiovascular function than age, although age-related changes can cause an older adult to be susceptible to disease processes. Age-related cardiovascular changes may manifest themselves as fatigue and shortness of breath during strenuous activity. Some tasks may be perceived as more physically demanding and require more rest during their performance. Physical activity throughout the life span, as well as in older age, can offset many changes to the cardiovascular system. Safe performance of tasks becomes an issue when irregular heart rhythms or hypotension are present since these conditions can cause weakness, dizziness, and falls.

RESPIRATORY SYSTEM

The primary function of the respiratory system is to supply oxygen to the blood and remove carbon dioxide. This gas exchange is essential for supplying all body organs and tissues the oxygen they need. Aging can affect each component of the respiratory system, which includes the airways, lungs, chest wall and respiratory muscles (Dean, 2001). However, these age-related changes have minimal affect on respiratory function in healthy, non-smoking older adults (Miller, 1999). Most changes to the respiratory system that can be associated with aging are gradual and subtle and, if experienced, older adults have the capacity to compensate for many of the changes (Blair, 1999; Miller, 1999). Respiratory performance is the physiologic function in older adults that appears to be least affected by age-related changes and most able to adapt to changes that do occur (Miller, 1999).

Potential Age-Related Changes

With age, the chest wall can become less elastic. Mainly, the cartilage in the joints between the ribs and vertebrae become calcified, which stiffens the joints, and the ribs become osteoporotic and lose elasticity (Hampton et al., 1997; Miller, 1999; Shephard, 1997). The respiratory muscles, like the other muscles in the body, may lose strength, tone, and flexibility (Eliopoulos, 2001; Miller, 1999; Weilitz, 2000). Chest stiffness and muscle weakness can impede respiratory efficiency, as the lungs may not be able to expand to their full volume (Arking, 1998; Blair, 1999; Miller, 1999). However, these age-related changes can be compensated for, to a certain extent, by relying more on other muscles, such as the diaphragm, to maintain efficiency (Hampton et al., 1997; Miller, 1999; Shephard, 1997).

Age-related increase in collagen and decrease in elastin in lung tissue leads to loss

of lung elasticity and reduces the ability of the lungs to recoil, an important mechanism for expiration (Dean, 2001; Hampton et al., 1997). Age-related changes to the lung parenchyma (the area where gas exchange takes place) lead to a loss of surface area for gas exchange. Along with changes to blood vessels in the lungs, the effect is a diminished ability to oxygenate blood sufficiently (Arking, 1998; Blair, 1999; Dean, 2001; Weilitz, 2000). Changes to both the chest wall and lung recoil can diminish lung volumes and air flow rates, which will also hamper effective gas exchange (Dean, 2001; Eliopoulos, 2001; Miller, 1999).

Possible Functional Consequences

In the presence of age-related changes in respiratory function, older adults can be more susceptible to respiratory infections (Blair, 1999; Eliopoulos, 2001; Hampton et al., 1997; Miller, 1999; Weilitz, 2000). However, in the absence of infection, disease, or other factors, older adults will experience minimal, if any, negative functional consequences that affect their daily activities (Arking, 1998; Miller, 1999). Nonetheless, as a result of age-related changes, older adults experience an increase in the amount of work to breath (Arking, 1998; Weilitz, 2000). Therefore, age-related changes in respiratory function are most evident under periods of physical stress. Under such conditions, the older adult may have difficulty breathing and become easily fatigued (Arking, 1998; Miller, 1999; Shephard, 1997).

Additional Factors That Can Influence Respiratory Function

Factors, other than age, such as lung disease, can impair respiratory function. The following can affect respiratory function and can predispose an individual to lung disease, at any age:

- tobacco smoking
- passive smoking (exposure to tobacco smoke in enclosed settings)

- air pollution
- occupational exposure to toxic substances
- immobility or inactivity
- obesity (Arking, 1998; Dean, 2001; Eliopoulos, 2001; Hampton et al., 1997; Miller, 1999; Weilitz, 2000)

Regardless of age, tobacco smoking is the most important factor in lung damage, impaired respiratory function, and increased risk for lung disease (Miller, 1999; Weilitz, 2000). Conversely, it has been well established that remaining active and exercising can minimize the negative functional consequences of age-related changes to the respiratory system (Eliopoulos, 2001; Hampton et al., 1997; Miller, 1999; Weilitz, 2000).

Unfortunately, the farming occupation poses numerous respiratory hazards, which can also impair respiratory function. Among the hazards are organic dusts, gases and vapors, chemicals, and infectious agents (Gitelman, 1997; Meggs and Langley, 1997; Von Essen & Donham, 1997). As a result, the prevalence of respiratory conditions is reportedly higher in farmers than in most other workers (Brackbill et al., 1994; Purschwitz, 1997; Von Essen & McCurdy, 1998). Predominantly reported respiratory diseases reported by farmers include hypersensitivity pneumonitis, organic dust toxic syndrome, bronchitis, and asthma-like syndrome (Gitelman, 1997; Purschwitz, 1997; Von Essen & Donham, 1997).

Summary

Respiratory function remains relatively stable with age due to adaptive responses that can compensate for age-related changes. Nonetheless, older adults may experience shortness of breath and tire more quickly when challenged by physically demanding tasks. Factors other than age may play a larger role in

impeding respiratory function and increasing the risk of lung disease. For example, the many respiratory hazards found on a farm can increase the risk of respiratory disease in farmers. Keeping active and minimizing exposure to risk factors are helpful in maintaining respiratory function for task performance.

FARMING-RELATED ILLNESSES & DISEASES

It is evident from the previous sections that disease can have a significant influence on physiological function and may be a greater factor than age-related changes. Some evidence suggests that farmers are more likely to continue working with a limiting disability from disease (Brackbill et al., 1994). Yet, medical conditions can influence how safely an older farmer can complete work tasks. For example, a study of principal farm operators in Iowa found that operators who were restricted in their work due to a health impairment more than doubled their risk for farm injury (Lewis et al., 1998). Conditions, such as cancer, respiratory disease, and cardiovascular disease, can reduce strength and endurance, which can interfere with an older farmer's safe performance of physically demanding tasks (Freeman & Schwab, 2000). In addition to the safety risks due to medical conditions, the concurrent medication use might also be related to an increased risk of serious injury. Over-the-counter and prescription drugs prescribed for many diseases and conditions can further interfere with safety in the farm environment. Medications can have a negative effect of sedation and may reduce alertness, impair balance and reaction time, or interfere with task performance in many other ways (Murphy & Ambe, 1994; Xiang, Stallones, & Chiu, 1999). In a study of male farmers older than age 45, a significant relationship was found between agricultural injury and use of heart or circulatory medications (Pickett, Chipman, Brison, & Holness, 1996) while a study of older male farmers in Colorado (age 60+) found the use of prescription medication significantly increased the risk of agricultural injury (Xiang, Stallones, & Chiu, 1999).

The agricultural occupation poses several major health risks that can lead to illness and chronic conditions. As the average age of the farm population continues to increase, there is increased risk of adverse effects of occupational

exposures and certain chronic diseases (Kirkhorn & Schenker, 2001). As previously noted, occupational chronic diseases and impairments on farms include respiratory disease, skin disorders, musculoskeletal disorders, and noise-induced hearing loss. Other diseases to add to that list include certain cancers and zoonoses (diseases transmitted from animals to people) (Brackbill et al., 1994; Purschwitz, 1997). Study results on cancer and farming are inconsistent, although it appears that farmers may have a lower risk of common cancers, such as lung and colon cancer, and alcohol-related cancers (Kirkhorn & Schenker, 2001; Von Essen & McCurdy, 1998) and an elevated risk of other cancers, such as leukemia, Hodgkin's disease, and cancer of the skin, lip and prostate (Brackbill et al., 1994; Von Essen & McCurdy, 1998). Repeated exposure to agricultural chemicals and prolonged exposure to the sun while working outdoors may be factors involved in the elevated risk of some cancers (Brackbill et al., 1994; Purschwitz, 1997; Von Essen & McCurdy, 1998).

Therefore, it is important to consider the role that disease, illness, and concurrent medication use may have in the injury rate of older farmers. Such factors can exacerbate any functional consequences of age-related change as well as have an impact on function in ways that the aging process may not.

CONCLUSIONS

Farming is one of the most dangerous occupations and older farmers are at particular risk for injury. Farm machinery (particularly tractors), animals and falls are the major sources of injury to older farmers (CAISP, 1998; CAISP, 1999). If the older farmer is experiencing some of the age-related physiological changes reported, it is evident how the risk of such injuries could increase. All of the major physiological systems likely to be involved in performance of agricultural tasks can be affected to some degree by age. Some older farmers may experience a slowing of information processing, which may impact on quick decision-making and reaction time in the face of hazards. Some older farmers may experience a decline in vision that could impede properly seeing a hazard, or they may experience hearing loss that could impair the ability to hear approaching hazards. Some older farmers may experience muscle weakness and decline in joints' range of motion that could hamper the ability to safely perform some tasks, or they may experience fatigue effects more rapidly and severely due to declines in cardiovascular and/or respiratory function.

In terms of an older farmer's ability to work safely, it is a combination of decreased capabilities that will more likely cause a higher level of risk (Murphy & Ambe, 1994). However, an important point to stress is that adults undergo the aging process at markedly different rates, and not all changes are experienced by all older adults. Moreover, not all aging changes will have a significant impact on functioning. In a profile of the health status of older adults in the United States, Miller (1999) reports that only 9% of adults aged 64 to 69 years require assistance with daily activities. While this percentage increases to 50% among adults aged 85 or older, it is evident that among older adults in their sixties, functional limitations in daily activities are not common.

It is recognized that performance of daily activities, such as shopping, cooking, grooming, or dressing, for the typical older adult is not the same as the performance of demanding agricultural activities. The amount of physical decline that will affect safe performance of agricultural tasks is likely lower than the decline that can be experienced before performance of daily tasks is affected. Unfortunately, agricultural literature to support such claims is not available. A limitation of much of the literature reviewed for this report was that the assessment of age-related changes on functional performance was often from the viewpoint of ability to perform daily activities. What is needed for injury prevention are studies that specifically assess age-related changes in farmers and the impact functioning in general, and the performance of agricultural tasks in particular. Such research also would address the other limitation of many of the studies, where prevalence rates of age-related changes are based on findings in a general population of older adults and not older farmers specifically. It is not clear from the limited research whether farmers experience age-related changes at a different rate, perhaps due to either the potential positive and negative influences of a farming lifestyle and occupation. The evidence does suggest, however, that farmers may experience an increase in some diseases and disorders due to the hazards of a farming environment, which may impose their own functional limitations as well as compound age-related changes.

Due to the lack of appropriate agricultural-related literature, and the limitations in current literature for a farming population, it is difficult to address how the aging process specifically affects older farmers' abilities to safely perform agricultural tasks. The challenge, therefore, remains in translating the existing literature into useful information for older farmers. Continued research to delineate the role that age-related changes play in injury rates of older farmers, in relation to the many other factors that could be involved, would further aid in

the development of injury prevention strategies and greater safety for farmers.

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APPENDIX A:

SUMMARY OF SYSTEMS' POTENTIAL AGE-RELATED CHANGES, POSSIBLE AGE-RELATED FUNCTIONAL CONSEQUENCES, AND OTHER FACTORS THAT CAN INFLUENCE FUNCTION

POTENTIAL AGE-RELATED CHANGES: changes that may be experienced in that particular system with age; an individual older adult may not experience all (or may not experience any) of these changes

POSSIBLE FUNCTIONAL CONSEQUENCES: the possible effect of the aging process on the system's functioning

OTHER POTENTIAL INFLUENCES ON FUNCTION: factors, other than age, that also can have an impact on the system's functioning

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
NEUROLOGICAL	• decrease in brain mass • decline in dendrites • decrease in neurotransmitter activity • diminished cerebral blood flow • decrease in cerebral metabolism • accumulation of lipofuscin in neurons • increase in neurofibrillary tangles and plaques in regions of the brain	• increase in crystallized intelligence • slight, gradual decline in fluid intelligence • decrease in attentional resources • slight decline in secondary (long-term) memory • slower rate of information processing • changes to posture, gait and balance • impaired thermoregulation • changes in sleep patterns	• level of education • lack of motivation • irrelevance of information • mental health disorders (e.g., anxiety, depression) • disease (e.g., Alzheimer's disease, vascular disease) • medication • alcohol • health status • nutritional status • sensory impairment • self perception and expectations • intellectual skills • task demands • sociocultural background • stress

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
SENSORY			
• ***VISION***	• cornea becomes more opaque and yellowed • curve of cornea flattens • lens increases in mass • lens becomes thicker and more rigid and opaque • ciliary muscle atrophies and stiffens • iris weakens, atrophies and stiffens • pupil size decreases • amount of vitreous in the eye decreases • decline in number of retinal cells • blood supply in the retina decreases • brain cells in the visual cortex degenerate	• loss of accommodation; decreased near vision (presbyopia) • decline in acuity • poorer night vision • difficulty seeing moving objects clearly • difficulty discerning objects and detail, particularly complex objects • increased time needed to adapt to changes in light • increased sensitivity to, and recovery time from glare • alteration in color perception • decline in depth perception • decrease in the visual field • difficulty in perceiving flashing or flickering light (interference with critical flicker fusion) • difficulty with night driving • slower processing of visual information	• exposure to ultraviolet sun rays • medication • eye and systemic disease

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
SENSORY (continued)			
• ***HEARING***	• longer, thicker hair and dryer skin in the external ear • atrophy of cerumen glands • increase in keratin in cerumen • muscles and ligaments of the middle ear weaken and lose flexibility • ear drum is less resilient • diminished acoustic reflex • loss/damage to hair and nerve cells • decreased blood supply to inner ear • rigidity in the basilar membrane • atrophy of auditory nerve pathway • slowed processing of auditory stimuli • changes to the vestibular system	• prone to accumulation of cerumen • conductive, sensorineural or mixed hearing loss • decline in hearing sensitivity • difficulty detecting high-pitched frequencies • decline in pitch discrimination • increased difficulty with speech comprehension • decline in auditory reaction time • potential deterioration in balance	• auditory and systemic disease • ototoxic medication • cerumen build up and impaction • extensive exposure to noise
• ***SMELL***	• decrease in sensory cells in nasal lining and olfactory bulb	• impairment in identifying and discriminating scents	• medication • disease • head trauma • environmental influences • smoking
• ***TOUCH***	• sensory receptor cells in the skin degenerate and decline in number • degeneration in associated nerve fibers	• decreased sensitivity to light touch, vibration and pressure • reduced ability to differentiate temperatures • decreased sensitivity to pain	• skin disease • medications • cerebrovascular accidents • peripheral vascular disease

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
MUSCULOSKELETAL • ***BONE***	• loss of bone strength and mass • decrease in number of functional marrow cells	• increased risk of fractures • increased risk of osteoporosis	For bone remodeling: • hyperthyroidism • decreased activity levels • chronic obstructive lung disease • calcium and vitamin D deficiencies • medications For bone loss: • immobility/sedentary lifestyle • genetic predisposition • decreased estrogen • inadequate nutritional intake • weight • lack of weight-bearing exercise
• ***MUSCLE***	• loss of muscle mass • increase in fat and connective tissue in muscle • deterioration of muscle cell membrane • degeneration of motor neurons	• decreased muscle tone, strength, coordination, endurance and flexibility • increase in reaction time • decline in motor function • changes to posture and balance • increased risk of falls	• inactivity • malnutrition • circulatory changes

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
• ***JOINT & CONNECTIVE TISSUE***	• degeneration of joint collagen and cartilage • shrinking and hardening of tendons • bone and scar tissue form in the joint surface and connective tissue • synovial fluid loses viscosity • cartilage develops in synovial membrane	• decreased joint extension, flexion, and range of motion • impaired mobility • impaired stability • presence of joint stiffness, inflammation, and pain • increased risk of strains, sprains, and tendon ruptures • increased risk of osteoarthritis	• joint trauma • previous acute joint disease • genetic predisposition • repeated heavy loading and overuse of the joint • obesity • autoimmune reaction • tractor vibration
CARDIOVASCULAR	• increase in thickness and mass of left ventricle of the heart • increase in fat and collagen and decrease in elastin in the heart • heart valves become thicker and stiffer • decrease in maximum possible heart rate • decrease in cardiac output • changes in electrical activity and conduction of the heart • blood vessels become thicker, more dilated, and lose elasticity • arteries accumulate fat, calcium, and cellular material • baroreceptors in arteries lose sensitivity	• increase in blood pressure • fatigue or difficulty breathing during physical activity • susceptibility to postural and postprandial hypotension • susceptibility to irregular heart rhythm • increased risk of heart disease	• cardiovascular disease • stress • smoking • poor nutritional status • lack of physical exercise • medication use • psychosocial factors

SYSTEM	POTENTIAL AGE-RELATED CHANGES	POSSIBLE FUNCTIONAL CONSEQUENCES	OTHER POTENTIAL INFLUENCES ON FUNCTION
RESPIRATORY	• stiffness of the chest wall • weakened respiratory muscles • loss of lung elasticity and recoil • diminished lung volumes and air flow • less effective gas exchange	• increase in the amount of work to breath • difficulty breathing or fatigue from physical stress • increased susceptibility to lung infections	• tobacco smoking • passive smoking • air pollution • occupational exposure to toxic substances • immobility or inactivity • obesity • lung disease

APPENDIX B:

ANNOTATED BIBLIOGRAPHY OF AGING- AND AGRICULTURAL-RELATED LITERATURE

ANNOTATED BIBLIOGRAPHY

Ambe, F. & Murphy, D. J. (1995). Injury prevention programming for aged tractor operators. *Journal of Agricultural Safety and Health, 1,* 105-116.
Keywords: Adult/Aged/aged tractor operator/behavior/education/Farm/Health/Injuries/Injury prevention/Physical Fitness/Prevention/program development/tractor operators/tractor safety
Abstract: Farm tractor safety and health education programs for adults have often assumed a relatively homogeneous population. Our prior research findings suggest significant differences exist among young adults, middle-aged adults, and aged farm tractor operators in their formal education, years of experience, beliefs, attitudes, and behaviors regarding tractor safety issues, and physical fitness to use farm tractors safely. The authors suggest that it is important to consider these differences and to encourage active participation by tractor operators in program development, implementation, and evaluation to enhance the success and effectiveness of programs.

Ambe, F. & Murphy, D. J. (1993). *Differences among aged, middle aged, and young adult tractor operators in Pennsylvania* (Rep. No. 93-2). Columbia, Missouri: National Institute for Farm Safety.
Keywords: Adult/Aged/farm health and safety/tractor operators
Abstract: A survey of Pennsylvania aged (65 and over) and younger farm tractor operators has been completed and the data analyzed. Results indicating significant and nonsignificant differences among tractor operators concerning exposure characteristics, types of and condition of tractors operated, beliefs and attitudes about important tractor safety issues are presented by age group.

Arking, R. (1998). *Biology of aging: observations and principles*. (2nd ed.) Sunderland, MA: Sinauer Associates.
Keywords: Aging/Aging physiology
Abstract: The text provides an overview of the biological processes underlying aging at the molecular, cellular, organismal, and population levels. The thrust of the book is to answer the question as to why and how we age. The text describes and analyzes human aging within a strong biological and evolutionary context. It treats information on populations thoroughly to differentiate between aging and non-aging populations and to familiarize the reader with the demographic data underlying aging fact and theory, and delves into the links between aging and disease.

Aud, M. A. (2000). Sleep and activity. In A.G.Lueckenotte (Ed.), *Gerontologic Nursing* (2nd ed., pp. 199-216). St. Louis, Missouri: Mosby.
Keywords: Aging physiology/sleep disorders/gerontologic nursing

Abstract: This chapter identifies age-related changes in sleep; factors influencing sleep in older adults and sleep disorders; and the effects of lifestyle changes on sleep and activity.

Bahr, R. T. (1999). Sleep disturbances. In M.Stanley & P. G. Beare (Eds.), *Gerontological Nursing: A health promotion/protection approach* (2nd ed., pp. 335-341). Philadelphia: F.A. Davis.
Keywords: Aging physiology/sleep changes/sleep disorders/Health
Abstract: This chapter defines sleep and sleep disturbances; identifies the five stages of sleep patterns; describes the clinical manifestations of sleep disturbances in older adults; and discusses the primary, secondary, and tertiary management of sleep disturbances in older adults.

Beckett, W. S., Chamberlain, D., Hallman, E., May, J., Hwang, S. A., Gomez, M. et al. (2000). Hearing conservation for farmers: source apportionment of occupational and environmental factors contributing to hearing loss. *J.Occup.Environ.Med., 42,* 806-813.
Keywords: Adult/adverse effects/Age Factors/Agricultural Workers' Diseases/Agriculture/Audiometry/Comparative Study/Cross-Sectional Studies/diagnosis/Environmental Exposure/epidemiology/etiology/Family Health/Female/Health Surveys/Hearing Disorders/Human/Male/Middle Age/Multivariate Analysis/New York/Noise, Occupational/Occupational Exposure/Prevalence/prevention & control/Probability/Regression Analysis/Risk Factors/Sex Factors/Support, Non-U.S. Gov't/Support, U.S. Gov't, P.H.S./United States
Abstract: Those who work on farms continue to have a strikingly high prevalence of hearing loss, despite efforts to promote hearing conservation in agriculture. To develop improved hearing conservation programs, we performed a source apportionment analysis for hearing loss in a large, multiphasic health survey, the New York Farm Family Health and Hazard Survey. We used information from audiometric, otoscopic, and tympanometric examinations; detailed general health and farm exposure interviews; and a second interview that focused on additional potential determinants of hearing loss. Hearing loss on audiometry was significantly associated with increased age, male gender, education through high school or less, lifetime years of hunting with guns, lifetime years of use of a grain dryer, and a history of spraying crops during the previous year. Hearing conservation programs for farmers should thus be directed toward reduction in noise exposure, both from occupational and non-occupational sources. Additional study is needed to evaluate the association seen between crop spraying and hearing loss

Blair, K. A. (1999). The aging Pulmonary System. In M.Stanley & P. G. Beare (Eds.), *Gerontological Nursing: A health promotion/protection approach* (2nd ed., pp. 139-145). Philadelphia: F.A. Davis.

Keywords: Aging/Aging physiology/respiratory function/Health
Abstract: This chapter identifies normal pulmonary changes associated with aging; the pathophysiological process of common pulmonary problems; the clinical manifestations of common pulmonary problems; the pulmonary assessment of the older adult; and the nursing care of the older adult with pulmonary disease.

Bonder, B. R. & Wagner, M. B. (2001). *Functional performance in older adults*. (2nd ed.) Philadelphia: F.A. Davis.
Keywords: Adult/Aging physiology
Abstract: Section 1 of this book deals with normal aging, such as definitions of aging, public policy and aging, biological theories of aging, and the psychosocial meaning of activity. Section 2 of the book deals with the aging process, age-related changes in major physiological systems, and the functional consequences of the aging process. Section 3 deals with specific activities of older adults, such as self-care, work and retirement, leisure, and sexuality in late adulthood. Section 4 of the book looks at factors that contribute to dysfunction in older adults, such as falls, dementia, and depression. Section 5 provides an overview of intervention strategies for older adults, such as community-based services, home care, and rehabilitation. The final section of the book looks at special topics for older adults, such as technology, driving, and end-of-life issues.

Brackbill, R. M., Cameron, L. L., & Behrens, V. (1994). Prevalence of chronic diseases and impairments among US farmers, 1986-1990. *Am.J.Epidemiol., 139,* 1055-1065.
Keywords: Accidents, Occupational/Adult/Aged/Agricultural Workers' Diseases/ Amputation, Traumatic/Cardiovascular Diseases/Chronic Disease/ epidemiology/ etiology/Health/Health Surveys/Hearing Disorders/Human/Male/Middle Age/ Musculoskeletal Diseases/Occupations/Prevalence/Respiratory Tract Diseases/Skin Neoplasms/United States
Abstract: Farmers in the United States suffer disproportionately from certain chronic diseases and impairments. This analysis estimated the prevalence of selected diseases among farmers and compared these rates with those for other US workers. Five years (1986-1990) of National Health Interview Survey data on white male workers were combined to provide a basis for estimating the prevalence of selected conditions and impairments among this subgroup. Crude prevalence rates were significantly elevated for farmers compared with other workers for cardiovascular diseases, arthritis, skin cancer, hearing loss, and amputations. These elevations persisted when farmers were compared with blue-

collar workers. The crude prevalence of orthopedic impairments and chronic respiratory diseases was not elevated among farmers, but the age-adjusted prevalence ratios for cardiovascular diseases, arthritis, and amputations were significantly elevated for farmers as compared with other workers. The prevalence of hearing loss was significantly higher only for farmers older than 65 years. This method of pooling data holds promise for studying disease rates in other small segments of the US population

Browning, S. R., Truszczynska, H., Reed, D., & McKnight, R. H. (1998). Agricultural injuries among older Kentucky farmers: The Farm Family Health and Hazard Surveillance Study. *Am.J.Ind.Med., 33,* 341-353.
Keywords: Accidents, Occupational/Adult/Age Distribution/Aged/Agricultural Workers' Diseases/Agriculture/Animal/Cattle/Confidence Intervals/epidemiology/etiology/Family Health/Farm/Female/Health/Human/Incidence/Injuries/Injury Severity Score/Kentucky/Logistic Models/Male/Middle Age/Odds Ratio/Population Surveillance/Proportional Hazards Models/risk/Risk Factors/Sex Distribution/statistics & numerical data/Support, U.S. Gov't, P.H.S./United States
Abstract: This population-based study reports the cumulative incidence of agricultural injuries during a 1-year period in a sample of 998 farmers aged 55 years and older living in Kentucky. A total of 98 farm-related injuries were reported among 88 older farmers for a crude injury rate of 9.03 injured farmers per 100 farmers (95% confidence interval (CI) = 7.03-11.03) over a 1-year period. The leading external causes of farm injury were falls (24.9%), machinery (22.5%), wood-cutting (14.6%), and animal-related events (14.3%). Farmers working on farms with beef cattle (alone) (odds ratio = 1.90; 95% CI = 1.02-3.55) or farms with beef cattle and tobacco (odds ratio = 2.15; 95% CI = 1.00-4.59) had a statistically significant increased risk for a farm-related injury. Farmers reporting a prior injury that limited their ability to farm were at increased risk for a farm-related injury. Approaches to using farm injury surveillance data for injury control programs in the state are discussed

Burke, W. A. (1997). Skin diseases in farmers. In R.L.Langley, R. L. McLymore, W. J. Meggs, & G. T. Roberson (Eds.), *Safety and health in agriculture, forestry, and fisheries* (pp. 321-352). Rockville, MD: Government Institutes.
Keywords: farm health/Skin Diseases/Health/Agriculture
Abstract: The highest risk of skin disease of any occupation is found for farmers, who are exposed to harsh outdoor environmental conditions, high levels of solar radiation, and contact with irritant or allergenic plants. Working outside poses a risk of bites and stings from arthropods and other animals, with an additional risk of hypersensitivity reactions, zoonotic infections, and toxic envenomation. Farm chemicals including fertilizers, herbicides, pesticides, veterinary products,

and animal feeds as well as their additives can lead to cutaneous irritant or allergic contact dermatitis. Current data on skin diseases of farmers is inadequate, but an expansion of our knowledge base on these disorders is being driven by the economic pressures of increasing medical insurance costs and the need for compliance with OSHA and worker's compensation laws.

Cacchione, P. Z. (2000). Cognitive and neurologic function. In A.G.Lueckenotte (Ed.), *Gerontologic Nursing* (2nd ed., pp. 615-654). St. Louis, Missouri: Mosby.
Keywords: Aging physiology/cognition/neurological function/gerontologic nursing
Abstract: This chapter identifies the normal age-related changes of the neurologic system; functional changes in sensorimotor and motor changes, memory, cognition, sleep patterns, and proprioception that occur with aging; cognitive disorders that most often affect the older adult; and the nursing process when caring for clients with common neurologic conditions.

Canadian Medical Association (2000). *Determining medical fitness to drive: a guide for physicians*. (6th ed.) Ottawa: Canadian Medical Association.
Keywords: automobile drivers/automobile driving/automotive medicine/handbooks/manuals/physical examination/physiological aspects
Abstract: The Canadian Medical Association (CMA) has prepared this handbook to help physicians determine whether their patients are medically fit to drive a motor vehicle safely. This edition of the CMA's guide was designed to serve as a handy resource and user-friendly tool for physicians. The text is supplemented with tables for certain key medical conditions and recommendations. The guide also lists the medical conditions affecting a person's ability to drive, generally in descending order of importance in terms of their association with risk for motor vehicle crashes.

Chodzko-Zajko, W. J. (2001). Biological theories of aging: Implications for functional performance. In B.R.Bonder & M. B. Wagner (Eds.), *Functional performance in older adults* (2nd ed., pp. 28-41). Philadelphia: F.A. Davis.
Keywords: Adult/Aging/functional performance/older adults/theories
Abstract: Chapter Two provides an overview of: definitions of aging; biological theories of aging; the structural and functional consequences of aging; individual differences and aging; and lifestyle interventions and aging.

Coy, J. A. & Davenport, M. (1991). Age changes in the older adult worker. *Work, 2,* 38-46.
Keywords: Adult/Aged/Injuries/Prevention
Abstract: Musculoskeletal injuries are responsible for a large portion of lost work time. As a result, developing preventive techniques for the work place are important. Because the work force is aging, it is essential to consider the

physiological and functional effects of aging to facilitate development of more precise prevention strategies. The focus of this article is on the aging process and its implications for injury prevention among aging workers.

Dean, E. (2001). Cardiopulmonary development. In B.R.Bonder & M. B. Wagner (Eds.), *Functional performance in older adults* (2nd ed., pp. 86-120). Philadelphia: F.A. Davis.
Keywords: Aging/cardiovascular system/functional consequences/functional performance/pulmonary system/older adults/Adult/cardiovascular function
Abstract: Chapter Five provides an overview of: age-related anatomic changes in the cardiopulmonary system and its function; age-related changes in the cardiovascular system and its function; other factors that affect cardiopulmonary and cardiovascular function; functional consequences of age-related cardiopulmonary and cardiovascular changes; functional consequences of fitness in older people; implications for the management of the care of older people; and customizing the environment to maximize function.

Eaton, L. (2000). Cardiovascular Function. In A.G.Lueckenotte (Ed.), *Gerontologic Nursing* (2nd ed., pp. 448-485). St. Louis, Missouri: Mosby.
Keywords: Aging physiology/Cardiovascular Diseases/cardiovascular function/gerontologic nursing
Abstract: This chapter explains the age-related changes in the structure and function of the cardiovascular system; contributing risk factors for cardiovascular disease; the pathophysiology and treatment regimen for cardiovascular conditions common in older adults; and nursing interventions for older clients with cardiovascular conditions.

Ehlers, J. & Palermo, T. (1999). Community Partners for Healthy Farming: involving communities in intervention planning, implementation, and evaluation. *Am.J.Ind.Med., Suppl 1,* 107-109.
Keywords: Accidents, Occupational/Agricultural Workers' Diseases/Community Networks/etiology/Health/Health Promotion/Human/Musculoskeletal Diseases/National Institute for Occupational Safety and Health/prevention & control/Program Evaluation/Risk Factors/Safety Management/Support,U.S.Gov't,P.H.S./United States/Prevention/Injuries/Farm
Abstract: The dynamic aspects of farming require multidisciplinary approaches for prevention of work-related injury on farms. To foster the development of community-based intervention research linking traditional research and surveillance projects to community-based interventions, the National Institute for Occupational Safety (NIOSH) initiated the Community Partners for Healthy Farming (CPHF) surveillance and intervention research

programs. This article describes the community-based intervention research that seven agencies are conducting through CPHF, the progress of the projects and the some of the strengths and barriers to agricultural safety that have been identified.

Ekelman, B. A., Mitchell, S., & O'Dell-Rossi, P. (2001). Driving and older adults. In B.R.Bonder & M. B. Wagner (Eds.), *Functional performance of older adults* (2nd ed., pp. 449-486). Philadelphia: F.A. Davis.
Keywords: Adult/age-related change/disease-related change/driving/older adults/performance/functional performance
Abstract: This chapter provides an overview of the Neurosensory Model of Driving and how the aging process and age-associated conditions may lead to declines in the skill areas needed for driving.

Eliopoulos, C. (2001). *Gerontological Nursing*. (5th ed.) Philadelphia: Lippincott.
Keywords: Aging physiology/Geriatric nursing
Abstract: This edition consists of 38 chapters, divided into four units. Unit I, Foundations of Nursing an Aging Population, offers a framework for understanding today's elders, such as the demographics of aging, age-related changes, and the basics of nursing the elderly. Self-care practices that empower elders and facilitate the fulfillment of needs are provided in Unit II, Health and Wellness. The unique presentation and management of elders' illnesses are reviewed in Unit III, Common Geriatric Conditions, along with integrative approaches that foster holistic care. Unit IV, Gerontological Care Issues, discusses special concerns, including death and dying, legal and ethical issues, family caregiving, care of elders in diverse care settings, and challenges of the future.

Freeman, S. & Schwab, C. V. (2000). *Keep active farmers safe in later life*. Ames, Iowa, Iowa State University, University Extension.
Keywords: Aging/farm health and safety/senior farmers
Abstract: The physical capabilities of older farmers vary by individual. In addition, these physical changes may occur gradually over years, or in a relatively short period of time. Older farmers, however, can continue to be safe and productive members of agricultural operations. The key is the ability of them and their families to recognize age-related risk factors, as well as the willingness to modify expectations and physical activity accordingly.

Gallman, R. L. & Elfervig, L. S. (1999). The aging sensory system. In M.Stanley & P. G. Beare (Eds.), *Gerontological Nursing: A health promotion/protection approach* (2nd ed., pp. 93-101). Philadelphia: F.A. Davis.
Keywords: Aging/Aging physiology/hearing/sensory changes/vision/Health
Abstract: This chapter discusses the normal alterations in sensory responses, with implications for care; the nursing process to explore needs and plan nursing

interventions for older clients experiencing alterations in sensory responses; and psychosocial implications for older clients with sensory changes.

Gitelman, A. (1997). Grain industry health and safety issues. In R.L.Langley, R. L. McLymore, W. J. Meggs, & G. T. Roberson (Eds.), *Safety and health in agriculture, forestry, and fisheries* (pp. 273-290). Rockville, MD: Government Institutes.
Keywords: farm health and safety/grain dust exposure/Health/Respiratory Tract Diseases/Agriculture
Abstract: Grain processing has many potential health and safety hazards. After harvest, grain is moved to farm storage bins, silos, or transferred to elevators. Hazards ranging from silo gases, fires, explosions, and a host of others are present. Grain dust is a serious hazard in the grain handling industry posing explosion, fire, and health hazards. Deaths due to suffocation under grain or from silo gases have also been documented. Other hazards, such as machine entanglements, falls, and electrocutions are also possible in grain handling facilities. Health hazards due to grain dust or other exposures range from asthma, rashes, grain fever, allergic reactions, and eye, nose, and sinus irritations. Guidelines for exposure limits and training requirements for grain handling facilities are presented.

Hampton, J. K., Craven, R. F., & Heitkemper, M. M. (1997). *The biology of human aging*. (2nd ed.) Dubuque, IA: Wm. C. Brown.
Keywords: Aging/Aging physiology/Human
Abstract: This text provides a basic understanding of the biological changes of aging. Most chapters in this text are organized into three sections. The first section provides background information on anatomic structure and physiologic function. This is followed by a section on normal age-related changes that occur in the physiology of the system under study. A final section presents the major dysfunctions related to the system for which the aged have a propensity.

Hartling, L. & Pickett, W. (1998). The Canadian Agricultural Injury Surveillance Program: a new injury control initiative. *Chronic.Dis.Can., 19,* 108-111.
Keywords: Accidents,Occupational/Agricultural Workers' Diseases/Canada/epidemiology/Female/Human/Male/methods/Population Surveillance/statistics & numerical data/Support,Non-U.S.Gov't/Wounds and Injuries
Abstract: The Canadian Agricultural Injury Surveillance Program (CAISP) is a national system, established in 1996, for monitoring injuries among the agricultural community. The program involves ongoing collection, analysis, interpretation and dissemination of injury data. These data are an important tool for the development and evaluation of Canadian farm safety programs. The ultimate goal of the program is to enhance the health and safety of Canadian

farm workers and their families through preventive measures based upon a better understanding of the occurrence of farm injuries. This report provides a brief history of the surveillance system; a description of the program in terms of its objectives and the methods used for case identification and data collection; an overview of products from the initiative; and a discussion of some of the challenges encountered in developing a national surveillance system

Hartling, L., Pickett, W., Guernsey, J. R., Alberg, N., & Brison, R. J. (1998). Injuries associated with the farm harvest in Canada. *CMAJ., 158,* 1493-1496.
Keywords: Canada/Farm/Injuries
Abstract: In this article, the authors analyse agricultural injuries occurring during the harvest season in Canada and provide an overview of the harvest-related injuries resulting in death or admission to hospital, as well as problems treated in the outpatient setting.

Health Canada (2002). *Healthy aging: prevention of unintentional injuries among seniors* Ottawa: Minister of Public Works and Government Services Canada.
Keywords: Aged/Aging/Injuries/Prevention/Seniors
Abstract: This document on the topic of seniors and injury prevention was developed as a background paper for the *Workshop on Healthy Aging: Aging and Health Practices*, organized by Health Canada's Division of Aging and Seniors in November 2001. Following a series of internal investigations, the Division identified four key determinants that play key roles in healthy aging: healthy eating, injury prevention, physical activity, and smoking cessation. The Division convened a workshop to solicit the advice of experts and stakeholders on the development of an action plan on healthy aging, with a specific focus on the four areas noted above. Prior to the workshop, participants were provided with a series of background papers viewing the four determinants through a healthy aging lens. This document is a revised version of the paper on injury prevention, incorporating comments from experts and stakeholders.

Hensel, S. L. (2000). Sensory function. In A.G.Lueckenotte (Ed.), *Gerontologic Nursing* (2ns ed., pp. 695-720). St. Louis, Missouri: Mosby.
Keywords: Aging physiology/hearing/sensory changes/vision/gerontologic nursing
Abstract: This chapter describes the age-related changes in the senses; common sensory disorders; potential hazards for older persons with diminished senses of vision, hearing, and touch; how activities of daily living are affected by sensory changes; and conducting sensory system assessment.

Hooper, C. R. (2001). Sensory and sensory integrative development. In B.R.Bonder & M. B. Wagner (Eds.), *Functional performance of older adults* (2nd ed., pp. 121-137). Philadelphia: F.A. Davis.
Keywords: Aging/functional performance/sensory system/older adults/Adult
Abstract: Chapter Six provides an overview of: vision and functional performance; hearing and functional performance; taste and smell - physical changes and functional performance; somesthesis and touch - physical changes and functional performance; and sensory integration.

Huneke, J. T., Von Essen, S. G., & Grisso, R. D. (1998). Innovative approaches to farm safety and health for youth, senior farmers, and health care providers. *Journal of Agromedicine, 5,* 99-106.
Keywords: farm health and safety/Health/health providers/rural EMS/senior farmers/youth/Agriculture/Rural Health
Abstract: There is a need for safety and health education to reduce the numbers of youth and senior farmers who suffer injury and illness from activities related to production agriculture. The outcomes of the Nebraska Rural Health and Safety Coalition (NRHSC) projects were threefold: awareness of increased on farm health and safety issues for youth and senior farmers, information was provided about farm-related health conditions to health care professional students and rural physicians, and training was enriched for rural prehospital care providers.

Hwang, S. A., Gomez, M. I., Stark, A. D., St John, T. L., May, J. J., & Hallman, E. M. (2001). Severe farm injuries among New York farmers. *Am.J.Ind.Med., 40,* 32-41.
Keywords: Adult/Aged/Agricultural Workers' Diseases/Cohort Studies/epidemiology/Family Health/Female/Human/Incidence/Logistic Models/Male/methods/Middle Age/Multivariate Analysis/New York/Risk Factors/Support,U.S.Gov't,P.H.S./Trauma Severity Indices/United States/Wounds and Injuries
Abstract: BACKGROUND: Data from the telephone interview portion of the New York State Farm Family Health and Hazard Surveillance were used to study the incidence and predictors of severe farm injury. METHODS: One thousand seven hundred and six participants completed two telephone interviews in which they reported all injuries over a 12-month period. RESULTS: Nine percent of participants reported at least one severe farm injury. Using logistic regression the significant risk factors for sustaining at least one severe farm injury are younger age, the presence of hearing loss or joint trouble, working more hours per day, being the owner/operator of the farm, and being from a farm with higher gross sales. CONCLUSIONS: There needs to be continuing education of all farmers as to the risks of injury. However, when resources are limited, we recommend that injury education and interventions in this farming population

should target younger farmers, those who work longer hours, owner/operators, farmers from higher grossing farms, with special attention to farmers who have physical impairments

Ilmarinen, J. E. (2001). Aging workers. *Occup.Environ.Med., 58,* 546-552.
Keywords: Adolescence/Adult/Age Distribution/Aging/Demography/Employment/Human/Middle Age/organization & administration/physiology/psychology/Workload/World Health
Abstract: Chronological aging starts at birth and ends at death. Therefore, anyone in the work force (15-64 years of age) can be considered an aging worker. However, the definition of an aging worker is generally based on the period when major changes occur in relevant work related functions during the course of work life. Functional capacities, mainly physical, show a declining trend after the age of 30 years, and the trend can become critical after the next 15-20 years if the physical demands of work do not decline. On the other hand, workers' perceptions of their ability to work indicate that some of them reach their peak before the age of 50 years, and five years later about 15-25% report that they have a poor ability to work, mainly those workers in physically demanding jobs but also those in some mentally demanding positions. Therefore, the ages of 45 or 50 years have often been used as the base criterion for the term "aging worker". The main reason for the "early" definition of aging among workers from the occupational health point of view is that it gives better possibilities for preventive measures. The need for early action has been emphasized by the low participation rates of workers who are aged 55 years or older and by the early exit of this age group from work life all over the world.

Kirkhorn, S. R. & Schenker, M. B. (2001). Current health effects of agricultural work: respiratory disease, cancer, reproductive effects, musculoskeletal injuries, and pesticide-related illnesses. *Journal of Agricultural Safety and Health, 8,* 199-214.
Keywords: Agricultural Health/Agricultural respiratory disease/Agriculture/Cancer/Exposure levels/Health/Noise-induced hearing loss/Occupational Health/Pesticides/Animal
Abstract: In this article, the authors discuss the progress made in identification of new respiratory syndromes, related to confined animal feeding operations, pesticide-related illnesses, cancers implicating agricultural exposures, and ergonomics in agriculture.

Lago, D. (1999). *Aging and farm safety: a gerontological view.* Unpublished manuscript.
Keywords: Aging/Farm/farm health and safety
Abstract: Aging and farm safety: scope of the problem, sources of the problem,

and intervention strategies are discussed.

Lamb, K. V. & Cummings, M. (2000). Musculoskeletal function. In A.G.Lueckenotte (Ed.), *Gerontologic Nursing* (2nd ed., pp. 721-756). St. Louis, Missouri: Mosby.
Keywords: Aging physiology/bone/connective tissue/joint/muscle/gerontologic nursing
Abstract: This chapter describes the normal structure and function of the musculoskeletal system and the age-related changes in the system; common musculoskeletal disorders in older age; and the treatment and management of common musculoskeletal problems.

Lewis, M. Q., Sprince, N. L., Burmeister, L. F., Whitten, P. S., Torner, J. C., & Zwerling, C. (1998). Work-related injuries among Iowa farm operators: an analysis of the Iowa Farm Family Health and Hazard Surveillance Project. *Am.J.Ind.Med., 33,* 510-517.
Keywords: Accidents,Occupational/Adult/Aged/Aged,80 and over/Agriculture/Cross-Sectional Studies/epidemiology/Family Health/Farm/Female/Health/Human/Injuries/Iowa/Logistic Models/Male/Middle Age/Odds Ratio/Population Surveillance/risk/Risk Factors/statistics & numerical data/Support,U.S.Gov't,P.H.S./United States
Abstract: In 1994, the Iowa Farm Family Health and Hazard Surveillance Project carried out a two-stage, stratified, cluster survey of Iowa farms using a mail survey. With data from this representative sample of Iowa farmers, we examined the associations between farm-work-related injuries and possible risk factors for 390 principal farm operators. Forty (10.3%) of these operators reported being injured while doing farm work. We developed a logistic regression to assess associations between potential risk factors and injury. We found three factors significantly associated with injury: younger age (odds ratio [OR] = 3.1, confidence interval [CI] = 1.1-9.3), having an impairment or health problem that limits work (OR = 2.4, CI = 1.5-3.8), and hand or arm exposure to acids or alkalis (OR = 2.6, CI = 1.1-5.9). In the univariate analysis, safety training did not seem to protect farmers from injuries

Lueckenotte, A. G. (2000). Overview of gerontologic nursing. In A.G.Lueckenotte (Ed.), *Gerontologic Nursing* (2nd ed., pp. 1-19). St. Louis, Missouri: Mosby.
Keywords: Aging/gerontologic nursing
Abstract: This introductory chapter traces the historic development of gerontologic nursing. It discusses the major demographic trends in the United States in relation to the older adult population and the factors responsible for the rapidly growing older adult population. The chapter also describes the effect of functional ability on the overall health status of older adults and how the "aging

of the aged" will affect health care delivery.

May, J. J. (2000). Occupational hearing loss. *Am.J.Ind.Med., 37,* 112-120.
Keywords: adverse effects/diagnosis/Ear Protective Devices/Hearing Disorders/Hearing Loss,Noise-Induced/Human/National Institute for Occupational Safety and Health/New York/Noise/Occupational Diseases/Occupational Exposure/physiopathology/prevention & control/Risk Factors/therapy/United States/United States Occupational Safety and Health Administration/Workers' Compensation
Abstract: Hearing loss is a significant and unfortunately common occupational malady. Over the past several decades both the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) have initiated efforts to better understand and to limit the occurrence of occupational hearing loss, particularly as it relates to excessive noise exposure. This paper briefly addresses the pathophysiology of noise-induced hearing loss and then describes the occupational and non-occupational factors which influence a worker's risk of hearing loss. The primary foci of this discussion are the clinical evaluation, diagnosis, and management of occupational hearing loss. Issues of prevention, OSHA-mandated hearing conservation efforts and compensation are reviewed

Meggs, W. J. & Langley, R. L. (1997). Chemical hazards of farming. In R.L.Langley, R. L. McLymore, W. J. Meggs, & G. T. Roberson (Eds.), *Safety and health in agriculture, forestry, and fisheries* (pp. 249-266). Rockville, MD: Government Institutes.
Keywords: chemical hazards/Farm/farm health and safety/Health/Agriculture
Abstract: The contemporary farm is a highly sophisticated operation in which dozens of chemical products are used. Like all chemical products, toxicity can result from exposures resulting from improper use and accidents. Insecticides and herbicides used to kill insects and weeds are toxic to humans. A variety of toxic rodenticides are used on the farm. Farm equipment requires hydrocarbon products for fuel, lubrication, and cleaning. Fertilizers such as anhydrous ammonia can be very toxic if mishandled. The air in animal confinement facilities can contain endotoxins and other hazardous substances. The decay of hay in silos can produce nitrogen oxides that can have devastating pulmonary toxicity. Asphyxiation can result from collections of gases such as methane in manure pits. The toxic chemicals found on farms are discussed. Mechanisms of toxicity, health hazards of exposures, and strategies to prevent chemical poisonings on the farm are discussed.

Miller, C. A. (1999). *Nursing care of older adults: theory and practice.* (3rd ed.) Philadelphia: Lippincott.

Keywords: Adult/Aging physiology/Geriatric nursing/older adults
Abstract: This text covers all aspects of physical and psychosocial function that distinguish gerontological nursing from other types of nursing. It focuses on age-related changes and risk factors that affect the level of function and quality of life of older adults. Assessment guidelines identify risk factors and functional consequences that can be addressed through nursing care, and interventions are applicable not only in acute care settings but also in home, community, and long-term care settings. In the chapters, each facet of physiologic or psychosocial function is discussed as follows: age-related changes, risk factors, functional consequences, nursing assessment, nursing diagnosis, nursing goals, nursing interventions, and evaluation of nursing care.

Moore, C. D. & Pfeiffer, S. (1987). A cross-longitudinal study of physical fitness in Ontario dairy farmers, aged fifty years and over. *Canadian Journal on Aging, 6,* 189-198.
Keywords: Aged/Dairy farmers/Ontario/Physical Fitness/age-related change
Abstract: To study the effects of occupational activity on age-related changes in fitness, 36 full time dairy farmers, aged 50-68 years, were studied. While initial fitness may be higher in this occupationally active group, the decline in function with age is comparable in magnitude to that seen in less active men.

Murphy, D. & Ambe, F. (1994). *Senior farmers and safety: how changing health affects risk of fatal injury* University Park, PA: Pennsylvania State University.
Keywords: fatalities/Health/Injuries/risk/senior farmers
Abstract: This publication presents a brief overview of issues relevant to senior farmers, including the major findings of a survey of senior tractor operations, information on how aging relates to increased risk of injury, and some thoughts on safety and health education for senior farmers.

Myers, J. R., Hard, D. L., Snyder, K. A., Casini, V. J., Cianfrocco, R., Fields, J. et al. (1999). Risks of fatal injuries to farm workers 55-years of age and older. *Am.J.Ind.Med., Suppl 1,* 29-30.
Keywords: Accidents,Occupational/Age Factors/Aged/Agricultural Workers' Diseases/Cause of Death/epidemiology/etiology/Female/Human/Male/Middle Age/mortality/Population Surveillance/Risk Factors/United States/Wounds and Injuries
Abstract: Previous studies have identified older workers (generally above the age of 54-years) to be the segment of the agricultural workforce which is at the highest risk for occupational fatalities in the United States. To better understand the characteristics of these fatalities to older agricultural workers, the National Institute for Occupational Safety and Health (NIOSH) analyzed data from two national occupational fatality surveillance systems: the National Traumatic Occupational Fatalities (NTOF) surveillance system, and the Census of Fatal

Occupational Injuries (CFOI) surveillance system. Agricultural workers over the age of 55-years were found to account for the most fatalities in both the NTOF and the CFOI surveillance systems. Farm tractors accounted for most deaths in both systems. These older workers accounted for over 60% of the tractor-related deaths for the agricultural production industry. The results of this analysis confirm previous studies that have shown older workers to be at the highest risk for occupational injuries within the agricultural production industry.

Nordstrom, D. L., Layde, P. M., Olson, K. A., Stueland, D., Brand, L., & Follen, M. A. (1995). Incidence of farm-work-related acute injury in a defined population. *Am.J.Ind.Med., 28,* 551-564.
Keywords: Accidents,Occupational/Acute Disease/Adult/Agriculture/epidemiology/etiology/Female/Human/Incidence/Male/Prospective Studies/statistics & numerical data/Support,U.S.Gov't,P.H.S./Wisconsin/Wounds and Injuries
Abstract: To determine occurrence and sources of farm-work-related injury, we conducted a population-based, prospective study in a large clinic and hospital serving a defined rural area. The population at risk was identified through a unique demographic and medical records linkage system and a special agricultural census. Cases were 510 individuals who sought inpatient or outpatient care from May 1990 through April 1992 from a physician or chiropractor for harm resulting from acute exposure to energy. One per 31 farm residents was treated annually for a farm-work-related injury. Eight percent of these cases were hospitalized. Animals were the most frequent source of injury. Severity did not differ between cases associated with animals, machinery, falls, or chemicals. Thirty-eight percent of farm-work-related injury cases occurred in nonfarm residents. Injury risk was 2.5 times greater among dairy farm residents than among nondairy farm residents, 352.0 vs. 141.0 cases per 10,000 person-years, respectively. Adult male farm residents had 556.9 injuries per 10,000 person-years and 21.3 injuries per million hours of farm work

Park, H., Sprince, N. L., Lewis, M. Q., Burmeister, L. F., Whitten, P. S., & Zwerling, C. (2001). Risk factors for work-related injury among male farmers in Iowa: a prospective cohort study. *J.Occup.Environ.Med., 43,* 542-547.
Keywords: Accidents,Occupational/Adult/Agriculture/Animal/Cohort Studies/Depression/epidemiology/Farm/Health/Human/Incidence/Injuries/Iowa/Male/ Middle Age/Occupations/Odds Ratio/Prospective Studies/risk/Risk Factors/statistics & numerical data/Support,U.S.Gov't,P.H.S./Time Factors/United States
Abstract: Agriculture is one of the most hazardous occupations in the United States. We examined the work-related injury rate and risk factors among 290 Iowa male principal farm operators using a population-based, prospective study. Baseline data were collected between 1991 and 1994, and injury events were

surveyed in the fall of 1995. Cumulative incidence of farmwork-related injury during the previous year was 10.5%. We found that depressive symptoms (odds ratio, 3.22; 95% confidence interval, 1.04 to 9.99) and the number of hours working with animals (odds ratio, 2.14; 95% confidence interval, 1.04 to 4.44) were associated with the incidence of farmwork-related injuries

Park, H., Sprince, N. L., Jensen, C., Whitten, P. S., & Zwerling, C. (2002). Health risk factors among Iowa farmers. *J.Rural.Health, 18,* 286-293.
Keywords: Adolescence/Adult/Aged/Agricultural Workers' Diseases/behavior/Cancer/Chronic Disease/Comparative Study/disease/Educational Status/epidemiology/Farm/Female/Health/Health Services Accessibility/Health Status/Human/Injuries/Insurance,Health/Iowa/Male/Marital Status/Mass Screening/Middle Age/Odds Ratio/Prevalence/Reference Values/risk/Risk Factors/Smoking/statistics & numerical data/Sunburn/Support,Non-U.S.Gov't/Support,U.S.Gov't,P.H.S./Tooth Diseases/United States
Abstract: This study compares the prevalence of the health risk factors for chronic disease and injury among farmers with their prevalence among other workers, using data from the Iowa Behavioral Risk Factor Surveillance System. From January 1999 to December 1999, there were 3,620 adults who participated in the survey. This report focuses on the 2,140 subjects who reported they were working. We calculated the percentage with each health risk factor, the adjusted odds ratio (OR) and the associated 95% confidence interval (CI), comparing the prevalence of health risks among farmers and other workers. Most health conditions and risk factors were similar among farmers and other workers. However, we found that farmers had some protective behaviors. They had better oral health (OR = 0.34, 95% CI 0.20-0.57) and were less likely to smoke (OR = 0.14, 95% CI 0.06-0.29) than other workers. In contrast, we found that farmers reported some high-risk behaviors compared to other workers. They were less likely to have smoke detectors at home (OR = 0.39, 95% CI 0.18-0.82), or to have had stool blood screening for colorectal cancer (OR = 0.41, 95% CI 0.1 7-1.00). These results suggest areas for future research to define targeted preventive interventions in farm communities

Pattillo, M. M. & Stanley, M. (1999). The aging musculoskeletal system. In M.Stanley & P. G. Beare (Eds.), *Gerontological Nursing: A health promotion/protection approach* (2nd ed., pp. 112-119). Philadelphia: F.A. Davis.
Keywords: Aging/Aging physiology/bone/muscle/Health
Abstract: This chapter identifies the normal changes in the musculoskeletal system that result from aging; common musculoskeletal problems in older adults; developing a plan for nursing interventions based on systematic assessment of the older adult.

Pfeiffer, S., Graham, T. E., Webb, R. D., Wilson, B. A., Rivington-

Moss, E. G., & Fisher-Ingram, L. M. (1984). Aspects of physical fitness and health in Ontario dairy farmers. *Can.J.Public Health, 75,* 204-211.
Keywords: Adult/Aged/Agriculture/Canada/Comparative Study/Health/Human/Male/Middle Age/Ontario/Physical Fitness/Rural Health/Sampling Studies/Support,Non-U.S.Gov't/Urban Health
Abstract: A pilot survey to test a field-robust protocol was designed to examine the fitness and health status of farmers. The ultimate objective is to determine whether farmers enjoy certain health advantages over their urban peers. A sample of 106 male dairy farmers, aged 32-67 years, from Wellington County, Ontario, were examined for a range of anthropometric, physiological and psychosensory variables. Results indicate that this sample differs from contemporary urban males within some age groups in ways which are likely to indicate the chronic effects of the farming lifestyle. These deviations include lower estimated percent body fat, very high grip strength values, reduced back flexibility, possible industrially-related hearing loss, certain low pulmonary function values, high energy intake and low HDL:total cholesterol ratio.

Pickett, W., Chipman, M. L., Brison, R. J., & Holness, D. L. (1996). Medications as risk factors for farm injury. *Accid.Anal.Prev., 28,* 453-462.
Keywords: Accidents,Occupational/Adolescence/Adult/adverse effects/Aged/Agriculture/Canada/Case-Control Studies/classification/Drug Therapy/Drug Therapy,Combination/education/epidemiology/Farm/Female/Human/Injuries/Male/Middle Age/Multivariate Analysis/Odds Ratio/Ontario/Questionnaires/risk/Risk Factors/statistics & numerical data/Support,Non-U.S.Gov't
Abstract: A case-control study was used to determine whether cases of farm injury were more likely than controls to have been regularly exposed to certain types of medication including those that cause side effects which may predispose to injury. Persons reporting an injury (n = 176) were identified in a population-based mail survey of people on 1364 Ontario farms, and compared to people without injuries using a 4:1 control: case ratio. Bivariate, stratified, and multivariable analyses were used to quantify the strength of associations between exposures to certain medications and the occurrence of farm injury. Those who regularly used certain types of medication were separated into two groups: people who used the medications in isolation, and those who used the medications in combination with other medications. Response to the survey was 77.3% among cases and 82.6% among controls. Strong and statistically significant increases in risk for injury were observed in association with the regular use of stomach remedies or laxatives by males (OR 2.8; 95% CI: 1.0,7.7), and regular use of heart of circulatory medications by men over the age of 45 (OR 4.2; 95% CI: 1.2,14.7). The identified associations remained after adjustment for age, co-morbidity, tillable farm acreage, education, income,

alcohol consumption and tobacco use. Several possible explanations for the occurrence of the identified associations, other than the etiological hypothesis originally advanced, are discussed

Pickett, W., Hartling, L., Brison, R. J., & Guernsey, J. R. (1999). Fatal work-related farm injuries in Canada, 1991-1995. Canadian Agricultural Injury Surveillance Program. *CMAJ., 160,* 1843-1848.
Keywords: Accidents,Occupational/Adolescence/Adult/Age Distribution/Aged/Aged,80 and over/Agricultural Workers' Diseases/Agriculture/Canada/Cause of Death/Child/Child,Preschool/epidemiology/Female/Human/Incidence/Male/methods/Middle Age/mortality/Ownership/prevention & control/Risk Factors/Sex Distribution/Support,Non-U.S.Gov't/Wounds and Injuries
Abstract: BACKGROUND: Studies from other developed countries have shown that agriculture is among the most dangerous occupational sectors in terms of work-related deaths. The authors describe the occurrence of fatal work-related farm injuries in Canada and compare these rates with those in other Canadian industries. METHODS: The authors present a descriptive, epidemiological analysis of data from the recently established Canadian Agricultural Injury Surveillance Program. The study population comprised Canadians who died from work-related farm injuries between 1991 and 1995. Crude, age-standardized, age-specific and provincial rates of such injuries are presented, as are overall death rates in other Canadian industries. Other factors examined were the people involved, the mechanism of injury, and the place and time of injury. RESULTS: There were 503 deaths from work-related farm injuries during the study period, for an overall annual rate of 11.6 deaths per 100,000 farm population. Modest excesses in this rate were observed in Ontario, Quebec and the Atlantic provinces. High rates were observed among men of all ages and among elderly people. Among the cases that listed the person involved, farm owner-operators accounted for 60.2% of the people killed. There was no substantial increase or decrease in the annual number of deaths over the 5 years of study. The leading mechanisms of fatal injury included tractor rollovers, blind runovers (person not visible by driver), extra-rider runovers, and entanglements in machinery. Compared with other industries, agriculture appears to be the fourth most dangerous in Canada in terms of fatal injury, behind mining, logging and forestry, and construction. INTERPRETATION: Canada now has a national registry for the surveillance of fatal farm injuries. Farming clearly is among the most dangerous occupations in Canada in terms of fatal work-related injuries. Secondary analyses of data from this registry suggest priorities for prevention, continued surveillance and in-depth research

Purschwitz, M. A. & Field, W. E. (1991). Fatal farm injuries to older workers. *Work, 2,* 47-53.

Keywords: Aged/Farm/Injuries
Abstract: This article describes the farm fatality situation of older workers in Indiana. Both work-related and worksite injuries are considered, and factors contributing to those occurrences are described.

Purschwitz, M. A. (1997). Epidemiology of agricultural injuries and illnesses. In R.L.Langley, R. L. McLymore, W. J. Meggs, & G. T. Roberson (Eds.), *Safety and health in agriculture, forestry, and fisheries* (pp. 215-232). Rockville, MD: Government Institutes.
Keywords: Agriculture/epidemiology/Injuries/Health
Abstract: This chapter reviews the epidemiology of injuries that occur on the farm including the agents responsible for the injuries, the ages and sex of the victims, the months of occurrence, and the nature of the injuries. An overview of the various types of illnesses and chronic conditions attributed to farm work is discussed including zoonotic infections, cancer, respiratory disorders, dermatitis, hearing loss, and musculoskeletal disorders.

Riley, K. P. (2001). Cognitive development. In B.R.Bonder & M. B. Wagner (Eds.), *Functional performance of older adults* (2nd ed., pp. 138-152). Philadelphia: F.A. Davis.
Keywords: Adult/Aging/cognition/functional performance/older adults
Abstract: Chapter Seven provides an overview of: cognitive changes in normal aging; other cognitive abilities; and cognition and activities in normal aging.

Roussel, L. A. (1999). The aging neurological system. In M.Stanley & P. G. Beare (Eds.), *Gerontological Nursing: A health promotion/protection approach* (2nd ed., pp. 120-129). Philadelphia: F.A. Davis.
Keywords: Aging/Aging physiology/cognition/neurological function/Health
Abstract: This chapter identifies the normal, age-related changes of the nervous system; clinical manifestations of the neurological deficits seen in older clients from a physical, functional, cognitive, sensory-perceptual, and psychosocial perspective; and outcomes targeted towards primary prevention of neurological problems common among older adults.

Runyan, J. L. (1993). *A review of farm accident data sources and research: review of recently published and current research* (Rep. No. 125). Washington, DC: United States Department of Agriculture.
Keywords: farm health and safety/Agriculture
Abstract: Research on farm accidents centers around causes and severity of illnesses and injuries, health and safety of youth, farm safety education, and improved survey techniques. Examples of research from each of these areas are

discussed.

Schwab, C. V. & Freeman, S. (2001). *Lend an ear to hearing protection.* Ames, Iowa, Iowa State University, University Extension.
Keywords: farm health and safety/Hearing Loss,Noise-Induced/Farm/hearing
Abstract: The noisy farm environment has taken its toll on many farm operators' hearing capabilities. Hearing loss can be prevented with the proper use of hearing protection devices. This publication discusses when hearing protection should be considered and how to select protection.

Semenciw, R. M., Morrison, H. I., Morison, D., & Mao, Y. (1994). Leukemia mortality and farming in the prairie provinces of Canada. *Can.J.Public Health, 85,* 208-211.
Keywords: Adult/adverse effects/Agricultural Workers' Diseases/Agriculture/Alberta/Canada/Cohort Studies/epidemiology/Health/Human/Leukemia/Male/Manitoba/methods/mortality/Occupational Exposure/Risk Factors/Saskatchewan
Abstract: BACKGROUND: An increased risk of leukemia has been previously noted among farmers. PURPOSE: To examine the risk of fatal leukemia according to various farming practices in a large cohort of Canadian farm operators. METHODS: A cohort study of the mortality experience (1971-1987) of male farmers in Manitoba, Saskatchewan and Alberta has been conducted. The census records of 156,242 male farmers identified on the 1971 Census of Agriculture and the corresponding Census of Population were linked to mortality records through 1987. RESULTS: We observed a statistically significant test for trend (p = 0.03) between leukemia mortality and the number of chickens and/or turkeys owned (relative risk for > or = 130 chickens and/or turkeys = 1.32, 95% CI = 0.99, 1.77). No association was observed between leukemia mortality and either insecticide or herbicide use. CONCLUSIONS: Further research is necessary regarding why farmers exposed to chickens may be at an increased risk of leukemia

Shephard, R. J. (1997). *Aging, physical activity, and health.* Champaign, IL: Human Kinetics.
Keywords: Age Factors/Aging/Aging physiology/disease/Health/Physical Fitness
Abstract: The first section of the book deals with demographics, interindividual differences in biological age, and factors that can influence these differences. It presents theories of aging, and details age-related changes in the major physiological systems, with a particular emphasis on those variables that influence the exercise response. The second section of the book explores the interactions between regular physical activity and health in older people. The final two chapters of the book turn to the economic and social consequences of an aging society. They deal with issues presented by aging of the labor force and a

growing demand for medical services.

Spirduso, W. W. (1995). *Physical dimensions of aging*. Champaign, IL: Human Kinetics.
Keywords: Aging/physiological aspects
Abstract: This book discusses how people age physically and how this aging affects other dimensions of life. The book begins with an introduction to the concept of aging in terms of longevity and quality and quantity of life, and individual differences. The book presents information related to four major areas of human movement: energy, work, and efficiency; motor control, coordination, and learning; involvement, interdependence, and skill; and physical performance. The book concludes with a section on how aging affects older adults' physical performance in society.

Standing Senate Committee on Agriculture and Forestry (1993). *Farm stress: its economic dimension, its human consequences*. Ottawa: Minister of Public Works and Governments Services Canada.
Keywords: Farm stress/Human
Abstract: This Report summarized the information received by the Committee from witnesses who shared their expertise and insights on economic conditions, and on the mental and emotional stress, and their physical consequences, being experienced by many Canadian farmers and their families. The recognition that stress must be considered along with the more common physical, chemical and biological hazards faced by farmers was strongly reinforced during the Committee's hearings.

Stanley, M. (1999). The aging cardiovascular system. In M.Stanely & P. G. Beare (Eds.), *Gerontological Nursing: A health promotion/protection approach* (2nd ed., pp. 130-138). Philadelphia: F.A. Davis.
Keywords: Aging/Aging physiology/Cardiovascular Diseases/cardiovascular function/Health
Abstract: This chapter identifies the normal age-related changes in the cardiovascular system of an older adult; the common pathophysiological changes that accompany disease of the cardiovascular system in older adults; components of a primary, secondary, and tertiary health protection plan for an older adult with cardiovascular disease; and alterations in care planning needed for older adults with cardiovascular disease.

Stark, A. D., Chang, H. G., Fitzgerald, E. F., Riccardi, K., & Stone, R. R. (1987). A retrospective cohort study of mortality among New York State Farm Bureau members. *Arch.Environ.Health, 42,* 204-212.
Keywords: Adult/Aged/Agriculture/Cancer/Cause of Death/Cohort Studies/disease/epidemiology/Farm/Health/Human/Male/Middle Age/mortality/New York/Occupational Health/Occupations/Retrospective

Studies/Support,Non-U.S.Gov't/Support,U.S.Gov't,P.H.S./United States
Abstract: A retrospective cohort study was conducted to examine mortality among 18,811 male farm owners and operators in New York State from 1973-1984. Farm Bureau membership lists were used to identify the study population, and vital status was determined through record linkage with death certificate and motor vehicle files. The comparison group consisted of the 1980 United States Census population of men who resided in the same towns as did the farmers. The results indicated that the study cohort experienced fewer than the expected numbers of deaths overall and for each major cause category except accidents. Specific causes with significant mortality deficits included cancer of the lung (standardized mortality ratio [SMR] = 47.0); diabetes mellitus (SMR = 57.5); ischemic heart disease (SMR = 65.3); bronchitis, emphysema, and asthma (SMR = 26.7); and cirrhosis of the liver (SMR = 29.7). The only specific cause with a significantly elevated mortality was accidents other than motor vehicle (SMR = 146.5). The investigation differs from previous research in method, setting, and population, but the pattern of findings is generally consistent with that of other studies

Stark, A. D., Chang, H. G., Fitzgerald, E. F., Riccardi, K., & Stone, R. R. (1990). A retrospective cohort study of cancer incidence among New York State Farm Bureau members. *Arch.Environ.Health, 45,* 155-162.
Keywords: Adolescence/Adult/Aged/Agricultural Workers' Diseases/Cancer/Cohort Studies/Comparative Study/epidemiology/Farm/Health/Healthy Worker Effect/Human/Incidence/Male/Middle Age/Neoplasms/New York/Retrospective Studies/Rural Population/Support,Non-U.S.Gov't/Support,U.S.Gov't,P.H.S./United States
Abstract: Cancer incidence from 1973 through 1983 in 18,811 New York Farm Bureau members was examined using a retrospective cohort study design. The observed number of cancers for all age groups was 72% of the expected, and the major deficits in incidence occurred for lung (52% of expected), gastrointestinal (67% of expected), and bladder (78% of expected). Similar deficits have been reported by other researchers. Unlike other studies, we did not find a significant excess of cancer of any site. Given the healthy worker effect and the small numbers of incident tumors at some sites, the Standardized Cancer Incidence Ratios that were over 100 in value (i.e., lip, melanoma of the skin, prostate, multiple myeloma) merit further investigation.

Stiernstrom, E. L., Holmberg, S., Thelin, A., & Svardsudd, K. (1998). Reported health status among farmers and nonfarmers in nine rural districts. *J.Occup.Environ.Med., 40,* 917-924.
Keywords: Adult/Agriculture/Health/Health Services/Health Status/Health Surveys/Human/Life Style/Male/Middle Age/mortality/Occupational

Health/Rural Population/Support,Non-U.S.Gov't/United States/utilization
Abstract: Farmers appear to have a lower morbidity and mortality rate than other occupational groups. Whether this better health is due to exposure to farming or to the well-known fact that rural populations have better health than urban ones, irrespective of occupation, is not clear. To explore this problem, all male farmers in nine administrative areas and age-matched nonfarmers from the same rural areas were sampled and invited to participate in a survey. 1782 (76%) men responded. We found that farmers had somewhat lower rates of outpatient health care utilization for causes other than trauma and fewer hospital admissions. These differences were independent of the urban-rural factor and could not be explained by traditional determinants of health and health care utilization. Other factors, linked to farming or to farmers' lifestyles, are probably involved

Stiernstrom, E. L., Holmberg, S., Thelin, A., & Svardsudd, K. (2001). A prospective study of morbidity and mortality rates among farmers and rural and urban nonfarmers. *J.Clin.Epidemiol., 54,* 121-126.
Keywords: Adolescence/Adult/Aged/Aged,80 and over/Agricultural Workers' Diseases/Cause of Death/Comparative Study/epidemiology/Health/Hospitalization/Human/Male/Middle Age/Morbidity/mortality/Population Surveillance/Proportional Hazards Models/Prospective Studies/Registries/Risk Factors/Rural Health/statistics & numerical data/Support,Non-U.S.Gov't/Survival Analysis/Sweden/trends/Urban Health
Abstract: Farmers are known to have lower morbidity and mortality rates than the mean for other occupational groups in the general population. Whether this is due to the urban-rural health gradient or to occupational factors related to farming is not clear. To explore this issue, we conducted a prospective study of farmers and matched rural and urban referents. Official hospital admission and mortality data for the years 1989-1996 were obtained. The relative risk of being admitted to hospital were 10% higher among rural and urban referents than among the farmers. The biggest differences were seen for mental and cardiovascular disorders. The odds of dying during follow-up did not differ between the two rural groups but were doubled among urban referents. In conclusion, the lower morbidity and mortality rates among farmers are partly due to the urban-rural health gradient but in addition salutogenic factors linked to farming seem to be active.

Tideiksaar, R. (2001). Falls. In B.R.Bonder & M. B. Wagner (Eds.), *Functional performance of older adults* (2nd ed., pp. 268-286). Philadelphia: F.A. Davis.
Keywords: assessment/factors/falls/older adults/functional performance/Adult
Abstract: This chapter reviews the epidemiology of falls, their complications,

and the various host and environmentally related causes of falls. An approach to clinical assessment of falls and fall risk is described. Rehabilitative and environmental interventions aimed at reducing the risk of falls are highlighted. The fear of falling and alternatives to the use of physical restraints in preventing falls are discussed.

Voaklander, D. C., Hartling, L., Pickett, W., Dimich-Ward, H., & Brison, R. J. (1999). Work-related mortality among older farmers in Canada. *Can.Fam.Physician, 45,* 2903-2910.
Keywords: Accidents,Occupational/Age Distribution/Aged/Agriculture/Biomechanics/Canada/epidemiology/Female/Human/Male/Middle Age/mortality/Population Surveillance/prevention & control/Residence Characteristics/Risk Factors/Seasons/Sex Distribution/statistics & numerical data/Support,Non-U.S.Gov't/Time Factors/trends
Abstract: OBJECTIVE: To describe the frequency and circumstances of work-related, fatal injuries among older farmers in Canada (1991 to 1995). DESIGN: Descriptive, epidemiologic analysis of data from the Canadian Agricultural Injury Surveillance Program. SETTING: Canada. PARTICIPANTS: Farmers aged 60 and older who died from work-related injuries from 1991 through 1995. METHOD: Age-adjusted mortality rates were calculated using the Canadian farm population as a standard for people involved, mechanism of injury, and place and time of injury. MAIN FINDINGS: The 183 work-related fatalities observed produced an overall mortality rate of 32.8 per 100,000 population per year. Higher fatality rates were observed in Quebec and the Atlantic Provinces. Almost all of those who died (98%) were men. Farm owner-operators accounted for 82.8% of the deaths (where the relationship of the person to the farm owner was reported). Leading mechanisms of fatal injury included tractor rollovers, being struck or crushed by objects, and being run over by machinery. Many older farmers appeared to be working alone at the time of injury.
CONCLUSIONS: The data suggest that older farmers died while performing tasks common to general farm work, that most were owner-operators, and that many were working alone at the time of death. Innovative ways to reduce work-related injuries in this population must be found

Von Essen, S. G. & Donham, K. J. (1997). Respiratory diseases related to work in agriculture. In R.L.Langley, R. L. McLymore, W. J. Meggs, & G. T. Roberson (Eds.), *Safety and health in agriculture, forestry, and fisheries* (pp. 353-384). Rockville, MD: Government Institutes.
Keywords: Agriculture/farm health/Respiratory disease/Health
Abstract: Farmers are exposed to a number of environmental agents which can cause respiratory diseases such as organic toxic dust syndrome, acute and chronic bronchitis, occupational asthma, chronic obstructive pulmonary

disease, and hypersensitivity pneumonitis. Hydrogen sulfide gas found in manure pits may be rapidly fatal. Nitrogen dioxide from the decay of silage can cause acute respiratory illness and permanent lung damage. The complex environment of animal confinement facilities can lead to respiratory illness, with overlapping patterns of asthma and bronchitis.

Von Essen, S. G. & McCurdy, S. A. (1998). Health and safety risks in production agriculture. *West J.Med., 169,* 214-220.
Keywords: Agricultural Workers' Diseases/Agriculture/California/etiology/Human/Occupational Exposure/Poisoning/Respiratory Tract Diseases/Risk Factors/Skin Diseases/Support,U.S.Gov't,P.H.S./United States/Zoonoses
Abstract: Production agriculture is associated with a variety of occupational illnesses and injuries. Agricultural workers are at higher risk of death or disabling injury than most other workers. Traumatic injury commonly occurs from working with machinery or animals. Respiratory illness and health problems from exposures to farm chemicals are major concerns, and dermatoses, hearing loss, certain cancers, and zoonotic infections are important problems. Innovative means of encouraging safe work practices are being developed. Efforts are being made to reach all groups of farmworkers, including migrant and seasonal workers, farm youth, and older farmers

Wagner, M. B. & Kauffman, T. L. (2001). Mobility. In B.R.Bonder & M. B. Wagner (Eds.), *Functional performance in older adults* (2nd ed., pp. 61-85). Philadelphia: F.A. Davis.
Keywords: Aging/mobility/musculoskeletal system/functional performance/older adults/Adult
Abstract: Chapter Four provides an overview of: muscle strength and aging; the skeletal system in the older adult; and balance, coordination, and movement and aging. An appendix in this chapter outlines exercises for persons 55 years old and older.

Weilitz, P. B. (2000). Respiratory function. In A.G.Lueckenotte (Ed.), *Gerontologic Nursing* (2nd ed., pp. 486-517). St. Louis, Missouri: Mosby.
Keywords: Aging physiology/respiratory function/gerontologic nursing
Abstract: This chapter describes the anatomic changes in the lungs resulting from the normal aging process and age-related changes in ventilation. It also identifies nursing interventions and outcomes for older adults with various respiratory alterations.

Whitman, S. D. & Field, W. E. (1995). Assessing senior farmers' perceptions of tractor and machinery-related hazards. *Journal of Agricultural*

Safety and Health, 1, 199-214.
Keywords: aged operators/agricultural safety/behavior/risk/senior farmers/tractor fatalities
Abstract: This research utilized a national survey to examine senior farmers' perceptions of tractor and machinery-related risks, as well as safety-related beliefs, major safety influences, and safety information preferences.

Willsey, F. R. (1985). *Protect your hearing*. West Lafayette, IN, Purdue University Cooperative Extension Service.
Keywords: Hearing Loss,Noise-Induced/protection
Abstract: Many farmers and farm workers have suffered some hearing damage. This publication outlines why hearing loss can occur and how to protect against hearing loss.

Xiang, H., Stallones, L., & Chiu, Y. (1999). Nonfatal agricultural injuries among Colorado older male farmers. *J.Aging Health, 11,* 65-78.
Keywords:
Accidents,Occupational/Aging/Agriculture/Colorado/epidemiology/Human/Male/Middle Age/prevention & control/Questionnaires/Risk Factors/statistics & numerical data/Support,U.S.Gov't,P.H.S./Wounds and Injuries
Abstract: OBJECTIVES. This study described characteristics and potential risk factors for nonfatal agricultural injuries among older male farmers age 60 years and older in Colorado. METHODS. A telephone survey was conducted among 113 older male farmers between 1993 and 1995. Agricultural injuries and potential risk factors were evaluated. RESULTS. A total of 27 injuries were sustained. The leading external cause of injuries was livestock, and most of the injuries affected lower and upper extremities of the body. Injured farmers were more likely to be persons who had gone deeply into debt or who were using prescription medications. DISCUSSION. Older farmers are at risk of injuries. The study results support the need to consider physical limitations of aging in developing prevention programs in agriculture

Xiang, H., Stallones, L., & Keefe, T. J. (1999). Back pain and agricultural work among farmers: an analysis of the Colorado Farm Family Health and Hazard Surveillance Survey. *Am.J.Ind.Med., 35,* 310-316.
Keywords: Adult/Agricultural Workers' Diseases/Agriculture/Back Pain/Colorado/Cost of Illness/epidemiology/etiology/Family Health/Female/Human/Male/Middle Age/Population Surveillance/Prevalence/Risk Assessment/Risk Factors/Sex Factors/Statistics/Support,U.S.Gov't,P.H.S./Time Factors
Abstract: BACKGROUND: Back pain is the most prevalent occupational health problem experienced by much of the world's workforce. However, agricultural

work-related back pain occurring among US farmers working on small operations or family farms is usually not included in surveillance. With data collected by Colorado Farm Family Health and Hazard Surveillance Survey, this study reports characteristics of and risk factors for back pain among adult farmers living in eight Colorado counties. METHODS: A stratified probability sample of 500 farms was selected in proportion to the number of farms in study areas. During the 4-year period from 1993 through 1996, 458 farms were enrolled in the study and 759 farmers were interviewed using a questionnaire. Information on self-reported back pain and potential risk factors among 742 white farmers was evaluated and reported here. RESULTS: A total of 194 farmers (26.2%) reported to have had at least one episode of back pain lasting for 1 week or more. Males had a slightly higher prevalence of back pain than females (28.6% vs. 22.5%) and the lower back was the predominantly affected part of body among both males and females. In 45.4% of males and 43.9% of females back pain was brought on by repeated activities. Males' activities at work were more likely to cause back pain while females' activities at home were more likely to cause back pain. Three factors were found to be significantly associated with back pain: being depressed (odds ratio (OR) = 3.68, 95% confidence interval (CI) = 2.23-6.09), farming/ranching as main activities (OR = 1.66, CI = 1.17-2.36), and worked in agriculture for 10 to 29 years (OR = 1.62, CI = 1.14-2.30). CONCLUSIONS: Our analyses indicate that back pain is an occupational health problem among farmers on small operations or family farms and that back pain affected males and females differently. The finding of significant positive associations between depression, farming activities, and back pain warrants further attention

Yesalis, C. E., III, Lemke, J. H., Wallace, R. B., Kohout, F. J., & Morris, M. C. (1985). Health status of the rural elderly according to farm work history: the Iowa 65 + rural health study. *Arch.Environ.Health, 40,* 245-253.
Keywords: Activities of Daily Living/Aged/Agriculture/Anxiety/Blood Pressure/Chronic Disease/Comparative Study/Cross-Sectional Studies/epidemiology/Female/Health/Health Status/Health Surveys/Human/Iowa/Male/Mental Health/Prevalence/Rural Health/Support,U.S.Gov't,P.H.S./Time Factors/United States
Abstract: In a geographically defined survey of 3,097 rural Iowans who were at least 65 yr of age, we examined the association between prior farm experience (greater than or equal to 25 yr) and various measures of current health status; we controlled for age, current working status, and, where appropriate, smoking and alcohol consumption. Health status was indexed by self-reported morbid conditions, symptoms, and physical function. After controlling for smoking behavior, it was found that both men and women with previous farm exposure currently experience a greater prevalence of all nine respiratory symptoms employed in the study relative to non-farmers. Farm men report a lower

prevalence of Parkinson's disease and prostate conditions, but report a greater prevalence of stroke and a lower level of self-perceived health status. Women with a farm work history experience a greater level of physical function and fewer symptoms associated with mental illness. Overall significant benefits as well as risks associated with a history of farm work were identified. However, of those who survived to age 65, extended exposure to farm work did not have a major impact on the overall current health status of men and women

Zhou, C. & Roseman, J. M. (1995). Agriculture-related residual injuries: prevalence, type, and associated factors among Alabama farm operators - 1990. *Journal of Rural Health, 11,* 251-258.
Keywords: Agriculture/Farm/Injuries/Prevalence
Abstract: A population-based, cross-sectional study was conducted to investigate the lifetime agricultural injuries causing traumatic disabilities in a random sample of 1,000 farm operators in Alabama in 1990. The goal of this study was to assess the prevalence, characteristics, and potential related factors of the defined injuries. The prevalence of the residual injuries was 9.3%. Agricultural injuries frequently resulted in traumatic disabilities, including amputation, fracture, and sprain/strain. The leading external causes were machinery, animals, and falls. Farm operators engaged in forestry, poultry, and dairy had higher prevalence rates. The results provide some indications for developing injury control planning programs in rural areas and for future research.

Zwerling, C., Sprince, N. L., Wallace, R. B., Davis, C. S., Whitten, P. S., & Heeringa, S. G. (1996). Risk factors for occupational injuries among older workers: an analysis of the health and retirement study. *Am.J.Public Health, 86,* 1306-1309.
Keywords: Accidents,Occupational/Comparative Study/Cross-Sectional Studies/Educational Status/epidemiology/Female/Health Status/Human/Male/methods/Middle Age/Occupational Diseases/Regression Analysis/Retirement/Risk Factors/Sex Factors/statistics & numerical data/Support,Non-U.S.Gov't/Support,U.S.Gov't,P.H.S./United States/Wounds and Injuries
Abstract: OBJECTIVES: This study examined risk factors for occupational injury among older workers. METHODS: We analyzed data on 6854 employed nonfarmers from the Health and Retirement Study (HRS), a population-based sample of Americans 51 through 61 years old. RESULTS: Occupational injuries were associated with the following: the occupations of mechanics and repairers (odds ratio [OR] = 2.27), service personnel (OR = 1.68), and laborers (OR = 2.18); jobs requiring heavy lifting (OR = 2.75); workers' impaired hearing (OR = 1.60) and impaired vision (OR = 1.53); and jobs requiring good vision (OR = 1.43). Self-employment was associated with fewer injuries (OR = 0.47).

CONCLUSIONS: These results emphasize the importance of a good match between job demands and worker capabilities.

APPENDIX C:

AGRICULTURAL HEALTH AND SAFETY INTERNET RESOURCES

CANADIAN SITES

Canadian Agricultural Safety Program (CASP)
http://www.agr.gc.ca/progser/casp_e.phtml

Farm Safety and Rural Health Program - CASP is a four year four million dollar program with funds from the Canadian Adaptation and Rural Development Fund. The program ends December 31,2003. The CASP objective is to lower the incidence of agriculture related deaths and injuries with the implementation of preventative programs targeted at reducing the risk of injury or fatality. The site provides an extensive list of programs and services available in Canada.

CASA - Canadian Agricultural Safety Association
http://www.ccasrh.org/site/index.html

The Canadian Coalition for Agricultural Safety and Rural Health (CCASRH) has been renamed the Canadian Agricultural Safety Association (CASA). This site has been designed to generate awareness of our organization and to demonstrate how we can be of service within the agricultural industry. The site provides an inventory of Canadian farm safety and rural health programs and research.

The North American Farm and Environmental Safety Project
http://www.nafarmsafety.com/

The Safety Centre in Raymond, Alberta focuses on teaching safe work practices, the benefits of safety, and how we are all part of the safety team. The site=s focus in on safety for farmers, livestock operators, and their families. Articles and fact sheets about many different aspects of farm safety are available on their resources page.

Farm Safety Association Inc.
http://www.fsai.on.ca/

The Farm Safety Association (FSA) website is dedicated to providing the most up-to-date health and safety information to Ontario's Agriculture, Horticulture and Landscaping industries and Agricultural community. The Farm Safety Association Inc. (FSA) was established for the purpose of promoting safety and providing safety education to farm employers. Available on the website is Farmsafe, the quarterly newsletter of the Farm Safety Association. It covers

safety and health topics of interest to the agricultural community.

Atlantic Canada Farm Health and Safety Website
http://www.virtuo.com/farmsafety/index.html

The site is designed for those working in farm safety, including farm managers who are responsible for their health and others working in their operation. This site also focuses on children because of their high risk for farm injury. The site contents contain:

- Farm Safety News - notice board, newsletters, and news on farm safety.
- Farmers as Safety Officers - educational and printable support materials for farm managers responsible for farm safety.
- Taking Care of Your Health - information on health risks that are particular to those working in agricultural production.
- Pesticide Safety - information on various subjects related to the proper storage and handling of pesticides.
- Links to Other Farm Safety & Related Sites
- Farm Safety School Stop - material for teachers who wish to include farm safety in their agri-science or social studies classes; activity pages, real life stories, video resource lists, and sample lesson plans.
- Kid's Safety on the Farm - making the farm a safe place for kids, the Farm Play Safe Program, the Smart Risk Program, and kids and chemicals.
- Farm Health and Safety Resources - Informational fact sheets/brochures and videos.
- Contact Information - Atlantic Provincial farm safety contacts, WEB site sponsors, and project contact information.

Institute of Agricultural Rural and Environmental Health
http://iareh.usask.ca/

I.ARE.H was created in 2001 as the successor to the Centre for Agricultural Medicine, Canada's only organization devoted to health issues in agriculture. Based at Saskatoon's Royal University Hospital at the University of Saskatchewan, the institute provides a comprehensive approach to education, research, and service to the people in rural Saskatchewan and Canada. The site provides information on research conducted, currently and past, and a variety of health and safety promotion materials that can be downloaded.

The Rural Health Extension Program
http://www.usask.ca/medicine/aghealth/ag/home/homeF.html

The Rural Health Extension Program was developed to address agricultural safety issues on a national level. It includes programs such as CANFARMSAFE and the Agricultural Health and Safety Network (in development; see next website).

The Agricultural Health and Safety Network
http://www.usask.ca/medicine/aghealth/ag/network/networkF.html

With the Support from the Saskatchewan Association of Rural Municipalities, the Agricultural Health and Safety Network was formed in 1988 to translate the Centre for Agricultural Medicine's research results into practical, useful information for farmers. Since then, rural councils have enrolled their farm families in the Network, a unique service that provides their ratepayers with occupational health and safety programs and information. A major Network venture is the Saskatchewan Farm Injury Control Program, a cooperative five-year plan to reduce agricultural fatalities and injuries in Saskatchewan. The site provides several of their publications and presentations on agricultural safety issues.

AMERICAN SITES

NIOSH Agricultural Centers Home Page
http://www.cdc.gov/niosh/agctrhom.html

The Centers for Agricultural Disease and Injury Research, Education, and Prevention represent a major NIOSH effort to protect the health and safety of agricultural workers and their families. The NIOSH Agricultural Centers were established as part of a Centers for Disease Control and Prevention (CDC) / NIOSH Agricultural Health and Safety Initiative in 1990. The Centers were established by cooperative agreement to conduct research, education, and prevention projects to address the nation=s pressing agricultural health and safety problems. Geographically, the Centers are distributed throughout the nation to be responsive to the agricultural health and safety issues unique to the different regions.

This site provides links to the NIOSH Agricultural Centers and their related projects, and researchers:

- Pacific Northwest, Washington
- Western, California
- High Plains Intermountain, Colorado
- Southwest, Texas
- Great Plains, Iowa
- Midwest, Wisconsin
- Southeast, Kentucky
- Northeast, New York
- Great Lakes, Ohio
- Southern Coastal, North Carolina

NASD: National Ag Safety Database
http://www.cdc.gov/nasd/

NASD is a national central repository of agricultural health, safety, and injury prevention materials for the agricultural community and especially for agricultural safety specialists. The mission of the NASD project is:
To provide a national information resource for the dissemination of information;
To identify and disseminate prevention information to agricultural workers on occupational hazards associated with injuries, death and illness;
To promote the consideration of safety and health issues into the management of agricultural operations for the purpose of reducing agricultural work-related injuries and illnesses; and

To provide a convenient way for members of the agricultural safety and health community to share educational and research materials with their colleagues.

The Agricultural Safety and Health Home Page for Ohio State University Extension
http://www.ag.ohio-state.edu/%7Eagsafety/

This site provides information on safety statistics, related publications and available resources, and links to other safety-related sites.

National Institute for Farm Safety, Inc.
http://www.ag.ohio-state.edu/%7Eagsafety/NIFS/nifs.htm

NIFS is the leading organization dedicated to reducing accidents in agriculture. NIFS is a non-profit, voluntary organization consisting of safety and health professionals and interested organizations. NIFS was formed in 1962 to provide a structure for the professional development of agricultural safety and health professionals. Its focus is to reduce the agricultural death, injury and illness rate. The site provides a list of numerous publications that can be ordered at NIFS.

Iowa State University Extension's Agricultural Health and Safety Home Page
http://www.ae.iastate.edu/Safety/

On the Iowa State University Extension's Agricultural Health and Safety home page there is current information about:

- Farm Safety Day Camps (2002 information)
- Tractor and Machinery Certification (2002 information)
- Tractor and Machinery Virtual Classroom,
- Farm Safety Publications
- Farm Safety Displays
- The Iowa Farm Safety Council
- Other Internet locations for agricultural safety