Conferences and Reviews

Epidemiology of Health and Safety Risks in Agriculture and Related Industries

Practical Applications for Rural Physicians

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Epidemiologic studies document that work in the agricultural sector is associated with many occupational health hazards. Exposure to organic dusts and airborne microorganisms and their toxins may lead to respiratory disorders. The burden of exposure-related chronic bronchitis, asthma, hypersensitivity pneumonitis, organic-dust toxic syndrome, and chronic airflow limitation can be diminished by appropriate preventive measures. The contribution of exposures to agricultural chemicals to cancers and neurodegenerative disorders is being investigated. Some studies document that farmers and those in related industries are at higher risk for the development of cancer of the stomach, soft tissue sarcoma, non-Hodgkin's lymphoma, and multiple myeloma. Chronic encephalopathy and Parkinson's and Alzheimer's diseases are being studied in relation to agricultural chemicals. The possible carcinogenicity and neurotoxicity of pesticides emphasize the need to promote the safe use of chemicals. Another area for health promotion programs is disabling injuries and traumatic deaths. Farm accidents are important because of their frequent occurrence among young people and disturbing fatality rates. Other health issues of concern in these industries include skin diseases, hearing loss, and stress.

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Rural physicians have long been aware of illnesses, injury, and premature death among farmers and others in the agricultural industry. A rapidly accumulating body of medical information, however, increases the responsibility of clinicians to be aware of, and to be able to deal with, a variety of serious health and safety risks in the agricultural population.

Over the last decade the issue of health and safety in agriculture has gradually evolved from the existence of sporadic research to a public health priority (Surgeon General's Conference: Agricultural Safety and Health—FarmSafe 2000, A National Coalition for Local Action, Des Moines, Iowa, April 30 to May 3, 1991). Evidence that working in the agricultural sector involves health- and life-threatening circumstances has resulted in the establishment of research centers and in public health initiatives. One is the 1990 Agricultural Initiative, a health surveillance and research program supervised by the National Institute for Occupational Safety and Health (United States Public Health Service).

Health risks in agriculture arise from various exposures, including organic and inorganic airborne dusts and gases, microbes and their toxins, chemicals including fertilizers, insecticides, herbicides, and fungicides, diesel exhaust fumes, physical and mechanical hazards, stress, and behavioral factors. The magnitude of these risks has risen with the increasing industrialization of modern agricultural practices. Two large sectors of agriculture, farming and the grain storage and transporting industry, have been surveyed more comprehensively than other areas. Accordingly, work-related disorders relevant to those occupations will be addressed in the following sections. The major recognized or perceived problems among farming populations include respiratory disorders, cancer, neurologic problems, injuries and traumatic deaths, skin diseases, hearing loss, and stress. The importance of these areas has been documented by several international and national symposia held in the past decade in Canada, Finland, Sweden, and the United States.

Although the scope of this review is limited primarily to epidemiologic issues, it also includes practical points for physicians and other health care professionals. The principal exposures and related medical conditions that we address in this article are summarized in Table 1.

Respiratory Disorders

An excess of respiratory symptoms among farmers has been found in various countries.[1-4] Epidemiologic studies have focused on chronic bronchitis, asthma, hypersensitivity pneumonitis, organic-dust toxic syndrome, and lung function changes. Prevalences of various syndromes are shown in Table 2.[2-14]

Chronic Bronchitis

The prevalence of chronic bronchitis, defined as cough and phlegm lasting for at least two years, ranges from 5.6% to 21.0% (Table 2), almost twice that in nonfarming control subjects[3] and three times higher in nonsmoking farmers than in nonsmoking control subjects.[15] Chronic expectoration is found more frequently in farmers involved in livestock production than in grain farmers[5] and is related to smoking and atopic status.[7] In hog farmers the occurrence of chronic bronchitis is related to the daily duration of work.[16]

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ABBREVIATIONS USED IN TEXT

FEV_1 = forced expiratory volume in 1 second
IARC = International Agency for Research on Cancer
Ig = immunoglobulin

Cross-sectional studies conducted in grain workers show that chronic bronchitis may affect 17% to 49% of workers (Table 2). It is associated with the duration of exposure to grain dust [12-14] and is more frequent than in control subjects. Chronic bronchitis also occurs in nonsmoking grain workers.

Asthma

Although the prevalence of asthma in farmers has not been clearly defined, the symptom of wheezing, often considered an epidemiologic marker of asthma, is common (Table 2). In Saskatchewan, the prevalence of wheeze was 27.4% in farmers and 9.9% in control subjects.[3] In Iowa wheezing and shortness of breath were found in 12.8% of retired farmers compared with 3.9% of retired nonfarmers,[1] and wheezing was present in 12% to 30% of swine farmers.[16,17]

Among grain elevator workers, wheezing is found in 24%

TABLE 1.—*Rural Physicians' Primer for Health and Safety in Agriculture*

Organ System or Disorder	*Principal Exposures*	*Possible Medical Manifestations*	*Rural Physicians' Role*
Lungs	Organic dust, microbes, molds, fungi, endotoxins, allergens	Chronic bronchitis, asthma, hypersensitivity pneumonitis, organic-dust toxic syndrome	Recognition, environmental control, appropriate treatment, life-style changes (stop smoking)
Cancer	Herbicides, insecticides, fungicides, fumes, sunlight, diet, unknown	Non-Hodgkin's lymphoma; Hodgkin's disease; multiple myeloma; soft-tissue sarcoma; leukemias; skin cancer; cancer of prostate, stomach, pancreas, testicle; glioma	Early recognition, public health leadership
Neurologic disorders	Herbicides, insecticides, fungicides, solvents, fumigants	Acute intoxication, Parkinson's disease, peripheral neuritis, Alzheimer's disease, acute and chronic encephalopathy	Immediate treatment, diagnosis, public health leadership
Accidents	Tractor rollovers, machine injuries, animal injuries, farmyard injuries	Suffocation, crushing, amputations, eye injuries	Community action, emergency treatment, public health leadership
Hearing loss	Motor noise, animal noise	Deafness	Hearing conservation, diagnosis, treatment
Skin	Pesticides, fuels, fungi, sun, mites, parasites	Dermatitis, dermatophyte infections, cancer	Prevention, diagnosis, treatment
Stress and well-being	Isolation, intergenerational problems, violence, substance abuse, incest	Depression, suicide, poor coping	Accurate diagnosis, counseling skills, community leadership, empowerment

TABLE 2.—*Chronic Respiratory Symptoms in Farmers and Grain Workers—Results of Representative Cross-sectional Studies*

Source	*Occupation and No. of Subjects*		*Chronic Disorders*				*Comments*
			Chronic Bronchitis, %	*Chest Wheeze, %*	*Hypersensitivity Pneumonitis, %*	*Organic-Dust Toxic Syndrome, %*	
Morgan et al, 1975[2]	Farmers	296	11.5-21.0	21.7-26.0	0.12-0.13	--	Hypersensitivity pneumonitis (HP) defined by symptoms (% of clinical diagnoses: 0.02% to 0.05%)
Dosman et al, 1987[3]	Farmers	1,824	11.1*	27.4	--	--	Excess of symptoms in each age category compared with controls
Warren et al, 1987[4]	Farmers	424	--	--	--	15.0	Organic-dust toxic syndrome defined as "flulike symptoms"
Vohlonen et al, 1987[5]	Farmers	7,573	5.6-8.2	--	1.5	--	More bronchitis among livestock farmers; HP defined by symptoms
Malmberg et al, 1988[6]	Farmers	390	--	--	0.4	6.1	HP based on clinical diagnosis; organic-dust toxic syndrome = "febrile reaction"
Iversen et al, 1988[7]	Farmers	1,175	23.6†	16.3†	--	--	Pig farming was a risk factor for bronchitis and asthmatic symptoms
Stanford et al, 1990[8]	Farmers	406	--	--	0.5-15.0	--	Estimation depended on the criteria (less stringent criteria could include organic-dust toxic syndrome)
Marx et al, 1990[9]	Farmers	1,510	--	--	0.4	--	Diagnosis of HP based on extensive clinical evaluation
Chan-Yeung et al, 1980[10]	Grain work	610	34.0‡	32.0‡	--	--	Symptoms related to smoking
Cockroft et al, 1983[11]	Grain work	80	32.5	--	--	16.2	Organic-dust toxic syndrome defined as "flulike episodes"
Cotton et al, 1983[12]	Grain work	390	17.0*‡	28.0*‡	--	--	Symptoms related to smoking and exposure
doPico et al, 1984[13]	Grain work	310	49.0*	42.0	--	32.0	Symptoms related to smoking and exposure
Yach et al, 1985[14]	Grain work	582	35.4*	24.5*	--	--	Symptoms related to exposure and smoking

*Significantly larger than in control group.
†Nonstandard definitions of chronic bronchitis and asthmatic symptoms.
‡Calculated from data in the text.

to 42% of subjects (Table 2).[10,13,14] The prevalence of asthma in these workers, however, is low and likely reflects the selection of susceptible workers out of the industry.[12,18] Symptoms may be allergic or nonallergic in origin as grain dust can induce the direct release of mediators of bronchoconstriction and inflammation, such as histamine, leukotrienes, and interleukin.[19-21]

Grain dust is a complex substance composed of plant debris, insect parts, silica, chemical residues, molds, fungi, and bacteria and their metabolites including endotoxins. Approximately 40% of particles are less than 5 μm in mean aerodynamic diameter and therefore represent a respirable fraction that can penetrate the terminal bronchioles.[22] The complex composition of the dust makes risk assessment difficult, particularly as many constituents of airborne dust in the agricultural environment are recognized as potent allergens.[23,24] In addition, multiple exposures may contribute to dysfunction. For example, we have recently described a possible association between pesticide use and asthma.[25]

Hypersensitivity Pneumonitis

Exposure to antigens from organic dusts may be associated with immunoglobulin (Ig) G and IgA antibody and cell-mediated hypersensitivity, resulting in hypersensitivity pneumonitis (extrinsic allergic alveolitis),[26,27] which is reported to affect 0.1% to 15.0% of farmers (Table 2). Clinically confirmed cases do not appear to be common, however.[9,28,29] Hypersensitivity pneumonitis with its acute or insidious course may present a diagnostic problem—recurrent influenzalike episodes or chronic nonspecific respiratory symptoms—and may lead to chronic respiratory impairment with all the features of pulmonary fibrosis. The principal environmental risk factors for extrinsic allergic alveolitis (farmer's lung) are actinomycetes such as *Micropolyspora faeni,* fungi, and animal proteins present in a variety of agricultural environments.[30,31] The prevalence of hypersensitivity pneumonitis in the grain industry is not known, but because of unfavorable conditions for growth of the offending agents, its occurrence is likely infrequent.

Organic-Dust Toxic Syndrome

The organic-dust toxic syndrome is an acute response to inhaling organic dust, usually characterized by a delayed onset of fever, malaise, and chest tightness[32] without evidence of immunologic involvement and an apparently benign course without persistent respiratory impairment.[23,33] Possible mechanisms include a toxic reaction to endotoxins, mycotoxins, or proteinase enzymes of moldy plant materials.[34] The syndrome may be common, occurring in about 6% to 15% of farmers[4,6] and 10% to 30% of swine growers.[35] The prevalence of acute febrile episodes in grain workers, sometimes called "grain fever," is similar, ranging between 16% and 32% (Table 2).[11,36] Organic-dust toxic syndrome is related to dust level[14] and can be reproduced in subjects experimentally exposed to high concentrations of grain dust.[37]

Lung Function Changes

Acute lung function changes in farmers may be a result of occupational asthma. Some farmers, however, particularly those working in livestock confinement units who do not have clinical asthma, experience across-shift declines in spirometric variables, including forced expiratory volume in one second (FEV_1) and forced vital capacity.[38] These across-shift declines in lung function are associated with increased bronchial responsiveness to inhaled histamine or methacholine. The exact mechanism of acute changes is unclear, but a dose-effect relationship between the inhalation of endotoxins and lung function is possible.[39] In grain workers, in addition to across-shift changes that follow an exposure-response pattern,[40] a decline in the FEV_1 can be observed over the workweek,[41] and a cessation of exposure is associated with an improvement in lung function.[42]

The risk of chronic airflow limitation is likely more common in farmers than in nonfarmers.[3] In swine producers the degree of functional defect relates to the duration of exposure, dust or ammonia concentrations, and endotoxin levels.[16] Data from workers employed in the grain industry indicate an approximately equal effect on long-term airflow limitation of smoking and grain dust.[43] An obstructive respiratory profile is not the only type of impairment found in grain workers, however. The prevalence of a restrictive defect ranges from 7.8% to 9.8%,[8,44] and recent evidence points to the possibility of a restrictive defect as a grain-specific type of respiratory impairment.[45]

The clinical evaluation of agricultural workers possibly having organic dust-related respiratory disorders should include a high index of suspicion. Patients should be interviewed for the relation of symptoms to specific exposures. The occurrence of symptoms during or after certain exposures will assist in the early diagnosis of organic-dust toxic syndrome, asthma, and hypersensitivity pneumonitis.[46] A chest x-ray film, detailed pulmonary function tests, use of the peak flow meter on and off the job, nonspecific and specific bronchial provocation testing, and an immunologic assessment will help to verify the diagnosis and to assess the degree of respiratory impairment.

Rural physicians should be able to provide information concerning exposure hazards, type and availability of respiratory protective equipment, and knowledgeable advice on the appropriate use of devices. For examples of the type of information available, see the Agricultural Respiratory Hazards Education Series, American Lung Association of Iowa, 1986, The Easter Seal Society of Iowa, PO Box 4002, Des Moines, Iowa 50333.

Cancer

The use of herbicides, insecticides, and fungicides in agriculture is now common, and some of these chemicals are known to possess at least low levels of carcinogenic activity in animals.[47] The carcinogenicity of pesticides for humans was reviewed in 1980 by the International Agency for Research on Cancer (IARC) with the following conclusions[48]:

- "The following pesticides and adjuvants are carcinogenic for humans—arsenic and certain arsenic compounds, asbestos, benzene, soots, tars, and mineral oils";
- "The following pesticides are probably carcinogenic for humans—amitrole, carbon tetrachloride, and ethylene oxide";
- "The following pesticides could not be classified as to their carcinogenicity, but require further investigation—chlordane-heptachlor, DDT, dieldrin, and HCH-lindane."

More recently the IARC has concluded that there was sufficient evidence from studies of animals to incriminate dioxin, an impurity in the early production of phenoxyacetic acid herbicides.[49] The experimental evidence suggests that

the possible carcinogenicity of these agents would be through their effect on the immune system. The literature associating pesticide exposure, farming and forestry as occupations, and other farm-related exposures to neoplasms is vast. Table 3 summarizes a selection of articles that confirm these relationships[50-58]; numerous other studies do not.

When all cancer sites are considered, farmers are at significantly lower risk than the population at large.[59] This is especially true of those cancer sites that have been associated with life-style—cigarette smoking and alcohol consumption. As a group, farmers are less likely than people in other occupations to drink alcohol or smoke cigarettes in excessive quantities.[60] The lower prevalence among farmers of cancers of the lung, esophagus, and pancreas has been found in different countries.[61-64]

Farmers and those in related industries appear to be at higher risk for cancers of the stomach and prostate as well as certain rare tumors including soft tissue sarcoma, non-Hodgkin's lymphoma, brain tumors, hematopoietic neoplasms, and cancers of the skin and lip.[50-58] Contradictory results in studies of cancer in farmers may have resulted from imprecision of the definition of exposure, including exposure to pesticides. Many previous studies of cancer and farming used broad categories of exposure such as current occupation (farmer, nonfarmer), pesticide exposure (herbicides, insecticides, biocides), or residence (farm, nonfarm) rather than specific exposures. Many different chemical classes of compounds are used as pesticides, and the type of product used varies with the type of crop grown, weather conditions, farmer preference, and the kind of pest infestation. Additional potentially hazardous exposures that should be evaluated include mycotoxins, fuels, diesel exhaust fumes, gases, lubricants, and organic solvents.

Other factors related to individual exposure include the latency and duration of the use of pesticides, the use of protective clothing, masks, and respirators, and accidents. A study in Saskatchewan showed that fewer than one in three men with occupational exposure to pesticides used protective clothing, one in four used a mask or respirator, one in two had spilled a pesticide on his hands or clothing, and one in two had inhaled a pesticide directly into his lungs.[61]

There are differences in cancer rates for rural versus urban women. The analysis of 1,956 responses to an occupational exposure survey among women with newly diagnosed cancer showed a significantly increased risk for cancer of the corpus uteri among farm dwellers compared with nonfarm dwellers (S. Fincham, Alberta Cancer Board, oral communication, January 1992). As well, significantly low risks for tumors of the cervix uteri, lung, and respiratory tract were found among farm dwellers. McDuffie reported preliminary results of two studies (H. H. M., unpublished data, January 1992). One documented occupational exposure to herbicides (19%), insecticides (29%), grain dust (47%), and diesel exhaust fumes (21%) among rural-dwelling women of middle age. The other, involving a ten-year cancer incidence record review, showed that the rural-to-urban ratio was high for multiple myeloma (1.56; 95% confidence interval [CI] 1.01 to 2.42) and non-Hodgkin's lymphoma (1.53; 95% CI 1.2 to 2.0). Vineis and co-workers have shown an increased risk of soft tissue sarcomas in female but not male rural dwellers exposed to phenoxyherbicides.[65] Donna and associates have shown an association of ovarian tumors with exposure to herbicides.[66] Hoar-Zahm reported an increased risk of multiple myeloma among women who had ever lived on a farm that was equivalent to that of women who had had exposure to insecticides or herbicides (S. Hoar-Zahm, PhD, National Cancer Institute, Bethesda, Md, oral communication, 1991). The sex-related urban:rural ratio invites speculation on the possible role of sex-related differences in the retention of fat-soluble pesticides, but the studies that have attempted to correlate serum and tissue levels of pesticides to disease status or residence in urban or rural areas have produced contradictory results.[67-69]

The contribution of exposure to agricultural chemicals to cancer is difficult to assess. Difficulties ensue with the measurement of exposure, which has to take into account past

TABLE 3.—*Summary of Case-Control Studies Supporting Relationship of Pesticide Exposure and Cancer in Men*

Source	*Cancer Site*	*Exposure and Occupation*	*Odds Ratio*
Hardell and Sandström, 1979[50]	Soft tissue sarcoma	Phenoxyacetic acid	5.3
		Chlorophenols	6.6
Hardell et al, 1981[51]	Hodgkin's and non-Hodgkin's lymphoma	Phenoxyacetic acid	4.8
		Chlorophenols	8.4
		Organic solvents	2.8
Gallagher et al, 1983[52]	Multiple myeloma	Agricultural workers	2.2
Hoar et al, 1986[53]	Non-Hodgkin's lymphoma	Farmers	1.6
		Phenoxyacetic acid	6.0
Woods et al, 1987[54]	Non-Hodgkin's lymphoma	Farmers	1.3
		Herbicide applicators	4.8
		Chlorophenols (>15 years)	1.7
		DDT	1.8
		Organic solvents	1.4
Zahm et al, 1988[55]	Non-Hodgkin's lymphoma	2,4-dichlorophenoxyacetic acid (2,4-D)	1.5
		2,4-D use >20 days/year	3.3
		Chlorinated hydrocarbons	1.4
		Carbamates	1.8
		Organophosphates	1.9
Balarajan and Acheson, 1984[56]	Soft tissue sarcoma	Farmers and gardeners	1.7
Blair et al, 1983[57]	Lung cancer	Pesticide applicators	135*
	Brain cancer		200*
Brownson et al, 1989[58]	Prostate cancer	Farmers	1.3

*Standardized mortality ratio.

exposures and changing agricultural practices. Results of experiments in animals and a number of epidemiologic findings in agricultural populations suggest a link between cancer and pesticides. Rural physicians and public health nurses have important roles as advocates of safe usage practices of chemicals among farmers and users of other chemicals.

Neurologic Disorders

Interest in the neurologic effects of repeated or long-term exposure to agricultural chemicals stems from the toxicologic properties of pesticides, solvents, and other substances commonly used by farmers and from increasing awareness of the sensitivity of the human nervous system to environmental toxins.[70] Two major groups of pesticides, organophosphorus ester insecticides (organophosphates) and contact herbicides (paraquat and its analogues), attract the most attention because of their widespread use and established or presumed biologic activity. Organophosphates and certain carbamates inactivate acetylcholinesterase, an important neuromediator. Paraquat is chemically similar to methylphenyl-tetrahydropyridine, a substance that destroys dopaminergic neurons and causes clinical symptoms of parkinsonism.[71,72]

Other groups of established neurotoxic chemicals, such as the chlorinated hydrocarbon insecticides, mercurial fungicides, and fumigants, may be more of historical interest or they are used by a relatively small group of licensed personnel under controlled circumstances. From an epidemiologic aspect, however, the assessment of past exposures to those chemicals is important in an investigation into the cause of chronic nervous system dysfunction. Current regulations concerning the application of highly toxic chemicals do not eliminate the possibility of secondary exposure. Recognized neurotoxic effects of repeated exposure to hydrocarbon insecticides, carbon disulfide, compounds used as fumigants, or manganese-based fungicides include neurobehavioral dysfunction, peripheral neuropathy, and encephalopathy.[73(p118)-75]

These observations have contributed to the hypothesis that major neurodegenerative disorders may result from an interaction between the host and environmental factors. Exposure to agricultural chemicals has been postulated as a possible risk factor in epidemiologic studies on the occurrence and determinants of Parkinson's disease,[76-87] Alzheimer's disease,[88-90] and chronic encephalopathy.[91-93]

Evidence includes data from a health service register that suggested a correlation between pesticides use and the prevalence of Parkinson's disease in rural areas[76] and the observation that an early onset of Parkinson's disease appears associated with a rural childhood.[77] Case-control studies to investigate relationships between Parkinson's disease and agricultural exposures to organic solvents and pesticides have been inconsistent, however.[78-82] For example, in Sweden, no significant difference in solvent exposure frequency between cases and controls was found for Parkinson's disease,[78] but a marginally increased risk was associated with the previous use of or exposure to herbicides and pesticides in Hong Kong and British Columbia.[79,83] Other studies conducted in China, Kansas, and Quebec found no significant increase in risk associated with exposure to pesticides.[80-82] Recent research conducted in Alberta suggests a herbicide use risk for the occurrence of Parkinson's disease.[84]

In contrast to the toxicologic findings, no specific effects of paraquat or diquat on the human nervous system have been reported in the World Health Organization's report on these chemicals.[85] Nevertheless, further studies on the specific neurotoxicity of agricultural chemicals are warranted by a multifactorial cause of Parkinson's disease, involving rural living among risk factors.[86,87]

Alzheimer's disease is another neurologic disorder of presumed multifactorial origin and increasing public health effects. Although the information about agricultural exposures among risk factors for chronic mental disorders is not available, there are few epidemiologic observations pointing to rural living. Epidemiologic studies addressing regional differences in the prevalence of Alzheimer's disease showed higher rates in mostly rural areas than in other regions of Finland[88] and Italy,[89] possibly as the result of an interaction between aging and the environment in genetically susceptible subjects.[90]

Chronic dysfunction of the central nervous system following acute pesticide poisoning has been documented by case reports and epidemiologic observations.[91,92] Symptoms include headaches, anxiety, fatigue, and disturbed concentration and memory. These symptoms, as well as functional impairment detectable by neuropsychological tests, may reflect the development of chronic encephalopathy as a result of acute intoxication.[93]

A variety of similar nonspecific symptoms of the central nervous system have been reported in studies on the effects of repeated or long-term exposures to organophosphates and fumigants.[94-96] Although the published evidence relates to various occupational groups of agricultural workers, the findings suggest the presence of subtle neurobehavioral changes in subjects with occupational exposure to pesticides. The extent of this problem in agricultural workers and their families, however, remains unknown and is being investigated under the auspices of the World Health Organization and the United Nations.[97]

Investigation into the neurologic effects of long-term exposure to agricultural chemicals is limited by nonspecific and usually subtle symptoms. Except for the symptoms unequivocally related to acute poisoning, describing cause and effect is hampered by unknown exposure-response relationships for nonacute events. Despite the well-known clinical manifestations of acute pesticide poisonings and regulations concerning periodic examination with the measurement of blood cholinesterase activity in workers with regular exposure, case reporting is incomplete.[98] Medical screening by first-contact physicians using a structured interview should facilitate the detection of chronic neurologic sequelae of mild or moderate organophosphate poisonings.

Practicing clinicians should be prepared to recognize both acute and chronic symptoms of exposure and to initiate treatment. This is particularly important in the case of cholinesterase inhibition, where prompt recognition and treatment may be lifesaving.

Injuries and Accidental Deaths

Disabling injuries and accidental deaths represent one of the most disturbing aspects of safety risks in agriculture. Agriculture is the only major industry in the United States that has not shown the marked decline in the number of injuries seen in the mining and construction industries between the years 1962 and 1986. As a result, in 1986 the total number of injuries per 100,000 workers was about 5,400 in agriculture, about 5,200 in mining, and 3,500 in construction.[99]

Agricultural accidents probably claim more lives than do occupational accidents in other industries. In Europe, where about 10 million occupational accidents occur every year (compiled data), mining accounts for 4%, manufacturing for 44%, and agriculture for 9% of all accidents. These industries contribute differently to fatal accidents, however: mining 8%, manufacturing 27%, and agriculture 14%.[100(p47)] In Australia, work-related deaths occur with an estimated annual incidence of 69.8 per 100,000 persons employed in mining, 38.0 per 100,000 in transport, and 22.0 per 100,000 in agriculture.[101]

The annual fatality rate per 100,000 persons engaged in agriculture in the United States, estimated at the level of 52 deaths, exceeds the rate for mining (50 deaths) and construction (35 deaths).[102] The most common cause of death includes tractor-related deaths, followed by those caused by other farm machines—40% to 60% of deaths are related to machinery. Other common causes of death include asphyxiation, falls, felling trees, animal-related, and fire.[99,103]

Reliable data for accidents are difficult to obtain and to compare. The classification of accidents, a reliable estimation of the size of the population at risk, and different statistical methods could be responsible for such differing estimates as 46 deaths and 18 deaths per 100,000 workers, reported for the same year by the National Safety Council and the National Institute for Occupational Health and Safety, respectively.[104]

Farm accidents affect not only farmers themselves but also members of their families. In the United States, in 1981, 73% of all reported farm accidents involved family members, whereas only 22.3% involved hired help.[105] Based on a survey of farm accident victims in Saskatchewan, 44% of accident victims requiring emergency treatment or hospital admission were family members and 34% were farm owners.[106] The highest rates are in young people, with an estimated 23,000 injuries and 300 deaths related to agriculture annually in the United States.[107]

The role of clinicians is twofold: first, rural physicians will be in the frontline for the medical treatment of accidents and should be familiar with current trends in microsurgery and amputated digit-limb reattachment; and, second, rural physicians are in a position to assume a leadership role in prevention.

Skin Problems, Hearing Loss, Stress

Other health and safety risks include skin problems, hearing loss, stress, and mental well-being issues particular to farming and the rural way of life. Skin irritation starts soon after employment commencement and increases to involve more than 60% of workers after four years' employment in the grain industry (P. Pahwa, MSc, Centre for Agricultural Medicine, Saskatoon, Saskatchewan, oral communication, 1991). Skin cancers, dermatophyte infections, and pesticide-related skin diseases are common in farmers. In California, skin conditions account for a high percentage of occupational problems among farmers and other agricultural workers.[108]

Hearing loss is common among farmers. Although little data are available, farmers older than 50 may have as much as 55% hearing impairment,[109] an observation supported by a survey recently conducted in Saskatchewan that showed that a shocking number of farmers, particularly older men, had advanced hearing loss (M. Reesal, MD, Saskatchewan Health, written communication, 1991). Hearing impairment related to noise generated by farm equipment may develop early in life, as suggested by the finding that rural students have a 2½ times greater hearing loss than urban students.[98]

Population-based data are most lacking in the area of stress and psychiatric problems in rural areas. Gross measures such as suicide rates indicate that the number of suicides doubled in Alberta in 1984 compared with 1981, following a serious economic depression—40.6 suicides per 100,000 versus 18.1 per 100,000 in 1981.[110] A similar rate of suicide (48.6 per 100,000) was found in the North-Central states of the United States. This rate was double that for nonfarming white men in the general population.[103] It is likely that these data reflect the tip of the iceberg in an industry that has undergone major economic contraction and social change. Population-based data describing manifestations and intensity of stress among agricultural workers are not available, but there can be little doubt that farming is one of the most stressful occupations in North America.[111]

Summary

Modern agriculture has exacerbated some old and created new risks for the health, safety, and well-being of farm families and others engaged in agriculture and related industries. Farmers, their family members, and others employed in agriculture-related industries should be regarded as an occupational group at risk, particularly for respiratory disorders, cancer, neurologic disorders, injuries, skin problems, hearing loss, and stress. These constitute important areas not only for further research but also for health promotion programs. Epidemiologic evidence, although incomplete, helps to evaluate health risks that are specific to agriculture. Rural physicians should focus on the proper assessment of the agricultural environment in considering etiologic factors. Increased public awareness of the relationships between the environment and health and recent public health initiatives have created an opportunity for comprehensive programs aimed at the assessment of agriculture-related health risks, the initiation of preventive measures, and the evaluation of the effectiveness of such programs.

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