

Pesticide-related Illness among Migrant Farm Workers in the United States

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Surveillance data show that pesticide-related illness is an important cause of acute morbidity among migrant farm workers in California. A few categories (organophosphates and carbamates, inorganic compounds, and pyrethroids) account for over half of the cases of acute illness. Skin effects dominate the illnesses, although ocular and systemic effects are also common. Exposures occur in various ways (e.g., residues, drift), suggesting that the use of pesticides creates a hazardous work environment for all farm workers. The health care system provided through the Migrant Health Program appears to be underutilized, partially due to barriers to health care access. Pesticide hazards should be ranked based on acute toxicity, chronic toxicity (including reproductive risks), carcinogenic potency, volume applied, and magnitude of worker poisonings. Current surveillance effort should be supported. Risk prevention should focus on substitution of safer compounds, establishing effective protections, and ensuring that these measures are enforced. Improved education for health care providers should be a priority. Growers should be educated about alternative forms of pest control and incentives should be provided to encourage their use. *Key words:* pesticides; migrant farm workers; risk prevention.

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In spite of improvements in working conditions in many industrialized nations, agriculture has repeatedly been shown to be among the most hazardous industries in the United States.¹ Labor-intensive agricultural practices have yielded significant increases in crop production and a heightened demand for workers.² At the same time, there has been a trend for hired farm labor to replace family operations.³ Estimates of the numbers of hired farm workers in the United States range from 1.8 to 2.5 million.^{4,5} While injuries play a considerable role in the risks posed by farm work, pesticide-related illnesses affect a large number of workers each year. The importance of pesticide-related health problems in farm workers has been addressed by sev-

eral authors.^{2,3,6} However, it has also been noted that there is a paucity of research involving farm-worker populations. One study concluded that it was not possible to accurately determine the nature and extent of occupational pesticide illness on farms.⁷ Pesticide-related illness and injury have been recommended for placement under surveillance by the National Public Health Surveillance System, although the focus of this initiative has not specifically been on farm workers.⁸ An expert panel convened by the National Institute for Occupational Safety and Health (NIOSH), part of a congressionally mandated agricultural health and safety initiative, recently ranked pesticide-related illness among farm workers as the second of nine priority areas to be targeted for surveillance (musculoskeletal conditions received the highest ranking).²

While there is insufficient information to fully describe the magnitude and consequences of pesticide-related illness among U.S. farm workers, this article presents current data to characterize this issue. The National Agricultural Workers Survey (NAWS) describes the farm-worker population; existing surveillance systems illustrate aspects of pesticide illness among farm workers. Finally, effective implementation of existing regulations and other strategies are suggested for the prevention of pesticide-induced illness.

FARM WORKERS IN THE UNITED STATES: THE NAWS

Farm workers are at increased risk for pesticide-related illness because they are more likely than other workers to be exposed to pesticides. The NAWS data illustrate other factors that may account for U.S. farm workers' high risk for pesticide-related illness. Cultural and language differences among the farm-worker population may act as barriers to occupational health. Ability to read and understand English may be needed for pesticide warning signs, educational materials, and training to be effective. Training may not be appropriate for the educational level of most farm workers. Adverse effects of pesticide exposures may be of special concern for young workers and for families of farm workers who may be poorly trained. Farm-worker migration may be detrimental to health because workers may not be familiar with the hazards of their ever-changing work-

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places. Migration may also result in inconsistent access to and quality of health care, as well as lack of continuity in care for chronic conditions. Poverty may compound the problems of poor general health status. Finally, farm workers who lack legal immigrant status may be unwilling to seek health care, especially for work-related illnesses. The NAWS is the only nationally representative survey of crop agricultural workers and is carried out by the U.S. Department of Labor, taking into account the seasonality and distribution of agricultural work done in the United States.⁹ The survey has been done in three cycles yearly since 1989, and its database has more than 27,000 farm-worker interviews.⁵ The U.S. Departments of Labor, Agriculture, and Health and Human Services have different purposes for estimating how many farm workers there are, and therefore have different definitions for farm workers, and for migrant farm workers. The U.S. Department of Labor estimates the number of crop agricultural workers in the United States at approximately 1.8 million.

U.S. farm workers are predominantly Mexican-born. In 1997–1998, more than three fourths (77%) of the farm workers working in crop agriculture had been born in Mexico. Of the remainder, 4% were foreign-born in countries other than the United States, and 19% were U.S.-born Hispanic, often children of farm workers. The agricultural labor force has included a large percentage of Mexican nationals ever since World War II created labor shortages and later, in 1951, when the “Bracero” or manual laborer program inviting Mexicans to work in U.S. agriculture was authorized by Public Law 78.¹⁰ Even considering this, the percentage of U.S.-born workers has decreased consistently since the NAWS began, from 39% in 1989 to 19% in 1997–1998. In addition to Mexico, workers also come to the United States from Central America and the Caribbean.² Almost a third (32%) of the foreign-born farm workers have been in the United States two years or less, and a little more than a fourth (27%) have been living in the United States for 15 years or more.⁵

One in five farm workers had less than three years of schooling; the median number of years of school completed was six. Few farm workers (15%) had completed 12 years of formal education. As is to be expected from their country of birth, the native language of 84% of farm workers is Spanish; English as a native language was spoken by only 12%. Less than 5% of foreign-born Hispanic farm workers reported that they could read and speak English well. Of the farm workers who said they could speak English well, 95% had lived in the United States for five years or more; 87% of those who reported they could read English well had lived in the United States five years or more.⁵

More than half (56%) of all farm workers travel to find work. Some (17%) travel from crop to crop during the season, finishing one agricultural job and moving on to the next. This is probably how most Americans

think of migrant farm workers. More commonly, farmworkers leave their home bases where they are settled, go to other places to work in the fields, and at the end of their employment, return to their homes. A little less than two fifths of these “shuttle” farm workers have their home bases outside the United States. Shuttle migrants, especially international shuttle migrants, may also be new farm workers who are coming to the United States for the first time, and because of that they have their homes in Mexico and jobs in the United States. Forty-four percent of the workers are settled and do not work more than 75 miles from their homes.⁵

Half of all farm workers in the United States are less than 29 years of age. Approximately 6% are 14 to 17 years of age. Only 15% of the workforce is more than 45 years of age, although a few workers do manage to continue to work to quite an old age. In 1997–1998 as many as 180,000 farm workers in the United States were 55 years old or older.⁵

Male farm workers comprise 80% of the agricultural workforce in the United States. This percentage has also risen since the NAWS began collecting data on farm workers, from 72% in 1989 to 80% in 1997–1998. This may be due to stricter U.S.–Mexican border enforcement, which allows only those willing to take extreme risks to cross, risks that may preclude women with small children. Approximately half of farm workers are married, but only 45% of those who are married, or one fourth of farm workers, were living with spouses at the time of the interview. Farm-worker women were more likely to be living with their children than were farm worker men, 91% versus 42%.⁵

Approximately 10% of farm workers were paid less than the U.S. federal minimum wage, taking into consideration the increases that occurred in the minimum wage during this time. In comparing different types of farm work, only supervisory positions were compensated more than the average wage. Fifty percent of farm-worker families earned wages that placed their incomes below the poverty level.⁵

Even with incomes below the poverty level, only about one in five farm workers (17%) used government needs-based services, such as Temporary Assistance to Needy Families (TANF), welfare, publicly provided housing, or medical and nutritional assistance such as Women, Infants, Children (WIC), food stamps, or Medicaid.⁵ More than one third (35%) felt that health care was difficult to obtain in the United States; they felt that it was too expensive and that the staff did not speak their language.¹¹

Most U.S. farm workers are underemployed and work without legal authorization. For the 12 months preceding the survey, farm workers interviewed in 1997–1998 had spent an average of 47% of the year employed in farm work, 24% living outside the United States, 19% unemployed in the United States, and 8% in non-farm employment. Generally, the number of weeks of farm work in a year dropped in all sectors, from 28 weeks in

1990–1992 to 25 weeks in 1996–1998 for foreign-born farm workers, and for U.S.-born farm workers from 24 weeks to 23 weeks in the same time period. The majority of farm workers (60%) had held just one farm job during the previous year. Another 33% had had two or three jobs. Most of those with disruptions in their work had left jobs because they were laid off, or the season ended, or for other reasons beyond their control. More than half of farm workers interviewed in 1997–1998 reported that they did not have work authorization and were citizens of countries other than the United States. About a fifth (22%), were citizens, and a fourth (24%) were legal permanent residents.⁵

SURVEILLANCE FOR PESTICIDE-RELATED ILLNESS

Surveillance involves the timely, ongoing, systematic collection and assessment of a health endpoint and is crucial for the identification and prevention of illnesses.^{12,13} While surveillance for pesticide-related illness has been conducted in some parts of the United States for some time, only recently has a nationally uniform system been initiated. The National Institute for Occupational Safety and Health (NIOSH) has led this coordinated endeavor for pesticide-related illness surveillance. To the extent possible, standardized data collection, abstraction, and case classification procedures are followed.¹⁴ Currently, eight states (Arizona, California, Florida, Louisiana, New York, Oregon, Texas, and Washington) participate to varying degrees in this national surveillance effort.^{15,16} The United States Environmental Protection Agency (U.S. EPA) also supports this program. Most states that have active surveillance programs have mixtures of state and federally funded programs. Although none of these surveillance programs is specific for farm workers, the NIOSH and U.S. EPA programs focus on agricultural pesticide-related illnesses.

California's pesticide-related illness surveillance system is the oldest in the United States.¹⁷ California law requires physicians to report both suspected cases of occupational illness or injury and pesticide-related illness. Under a statute enacted in 1971 and amended in 1977, health care providers are mandated to report pesticide-related illnesses by telephone to the local health officer within 24 hours of examining affected patients.¹⁸ Occupational illnesses are required to be reported within five days to the workers' compensation insurance claims administrator.¹⁹ Pesticide-related illness incident investigations supplement surveillance activities and theoretically serve to decrease pesticide-related adverse effects to health and the environment through (1) citations and fines issued to employers that may deter future infractions, (2) adjustment of regulations, such as restricted entry intervals, buffer zones, or requirements for use of personal protective equipment, and (3) recommendations of strategies, such as substitution

of less toxic compounds, engineering controls, or other policy changes, to prevent similar incidents from recurring.²⁰ The majority of these investigations are carried out by the County Agricultural Commissioners, and their focus is on regulatory violations, rather than on the health hazards of farm workers.

While surveillance is vital to the prevention of illnesses and injuries, its efficacy is reduced because pesticide-related illness incidents are undercounted. The California system, which is large and complex, illustrates why surveillance may fail to capture many cases of pesticide-induced illness. If the association with pesticides is recognized, large-scale incidents, hospitalizations and deaths may enter the California surveillance system by direct reporting to county and state authorities. However, for the majority of pesticide-related illnesses to be detected by the California surveillance program, the individual must seek medical care, the health care provider must recognize that the illness may be related to occupational or environmental exposure to pesticides and report the illness on the appropriate forms, and the forms must make their way to the appropriate agencies. If a breakdown occurs during any step of this process, illness cases may not be detected.

Although quantitative results are lacking to directly assess the number of cases lost during each step of the reporting process, evidence exists to suggest that the pesticide-related illness surveillance data are incomplete. Many studies suggest that undiagnosed cases outnumber diagnosed cases.^{21,22} A study in California showed that approximately 40% of workers whose pesticide-related illnesses were reported to a surveillance system indicated that coworkers involved in the same exposure incidents had not sought medical treatment.²³ Pesticide-induced illnesses are undercounted partly because farm workers may not seek medical care for them, or they may seek it abroad. A recent survey documented the poor health status of farm workers in this state.²⁴ Nearly a third (31.8%) of male farmworkers and 12% of females surveyed had never been to a doctor or clinic. Of those who had sought medical care, 18% had done so in Mexico. Multiple factors, including lack of transportation and insurance benefits, language barrier, cost, clinic hours that conflict with working hours, and ongoing shifts in location, may result in poor care in general as well as decreased recognition of pesticide-induced illness.^{5,24–28} Occupational illnesses may not be recognized or reported by workers and clinicians alike. In the California survey, 18.5% of farmworkers reported having had workplace injuries at some point in their farm careers that had been compensated by payments to them under the California Workers Compensation Insurance System. While this survey did not assess the proportion of occupational illness claims that were compensated, lack of insurance coverage or lack of awareness about such coverage may have contributed to these farm workers' reluctance to seek medical care.²⁴

Insufficient training for clinicians results in decreased recognition, treatment, and prevention of pesticide illnesses. Although U.S. medical school training in environmental and occupational issues in general has improved over the past decade, the majority of clinicians do not receive specific training relevant to the potential adverse health effects and management of pesticide exposures.^{29,30} Lack of training and awareness may result in frequent misdiagnoses of pesticide poisonings as other common illnesses, such as viral gastroenteritis.⁶ Without training, clinicians may be unable to adequately assess the need for and availability of work modifications or removal from work, resulting in continued occupational exposures to pesticides. Unfamiliarity among health care providers regarding state-specific illness reporting requirements also contributes to underreporting of pesticide-related illnesses.

Adverse reproductive health outcomes and certain cancers and neurologic disorders are some health conditions that have been associated with pesticide exposures, although few studies have focused on U.S. farm workers, whose exposures may be quite different from those of other groups.³¹⁻³⁶ Surveillance systems fail to capture these and other chronic health effects, for several reasons. Clinicians may be unaware of potential associations between occupation, low-level pesticide exposure, and illness due to lack of training. They may also feel unqualified to determine etiology in an individual case if the literature is inconsistent, as it may be with chronic pesticide-related health effects.³³ Making links between specific classes of pesticides and chronic effects is limited by exposures to multiple agents, inadequate exposure assessment, and difficulty in long-term follow-up.^{37,38} Finally, the resources available to determine the causes of chronic illnesses in individual farm workers (time, expense, tertiary referral centers) may be limited.

PESTICIDE ILLNESS IN CALIFORNIA FARM WORKERS

California, the top agriculture-producing state in the United States, provides an optimal example to illustrate the role of pesticides in farm-worker health.³⁹ Mild weather in most parts of the state allows year-round agriculture. Furthermore, significant amounts of pesticides are used to maintain high-volume agricultural production in this state. Over 200 million pounds of pesticide use was reported in California in 1999, of which over 90% (186 million pounds) was in production agriculture.⁴⁰ During this period, over 60 million pounds of the pesticides used (30% of total reported use) were on California's list of chemicals known to cause cancer or reproductive harm. Finally, large numbers of farm workers are required to maintain labor-intensive agricultural production. Pesticide-related illness among farm workers is an especially important issue in California because of the number of farm work-

ers in this state and the volume of pesticides used. One third of all farm workers in the United States, between 0.6 and 0.75 million, depending on the estimate, work in California, creating a very large population of workers at risk for pesticide poisoning.^{5,41}

While California farm workers are similar to their national counterparts in many respects, some differences exist. A greater proportion of California farm workers are foreign-born (95% vs. 81% nationally). Most (91%) are from Mexico and communicate in Spanish (95%).⁴² Four in ten California farm workers do not have legal authorization to work in the United States. California farm workers, like those nationally, are hired laborers. While the majority of California crop workers are hired directly by growers and packing firms, nearly a third are employed by farm labor contractors. Employees of California farm labor contractors are less likely than are those hired directly to be aware of mandatory employment benefits, such as coverage by the unemployment insurance system (46% vs 61%) and worker's compensation coverage for work-related illnesses and injuries (83% vs 93%).

Although incomplete reporting most likely results in underestimation of the magnitude of pesticide-related illness, surveillance data serve to illustrate that pesticide-related illness continues to pose a significant occupational hazard for California farm workers. The California Department of Health Services (CDHS) participates in a multi-state standardized occupational pesticide-related illness surveillance system funded by NIOSH and U.S. EPA, as described above. Reports filed by health care providers, including poison control centers, under the mandatory reporting requirements in this state^{18,19} and supplemental medical records form the basis of this passive surveillance system.¹⁵ Information for these cases is coded and classified according to a standardized system developed by NIOSH.¹⁴

For the two-year period 1998-1999, 1,156 non-disinfectant occupational pesticide-related illnesses were reported to the CDHS system. The agricultural industry accounted for the largest fraction (54.3%) of these cases.⁴³ For the same time period, agricultural workers accounted for nearly half (48.7%) of all pesticide-related illness cases. Farm workers accounted for 486 of these illnesses (85% of agricultural workers and 42% of all pesticide-related illnesses). These farm workers were predominantly Hispanic (85% of all farm-worker cases), young adult (mean age 34.7) males (79.6%) (Table 1). Farm workers were defined as those performing any tasks related to crop production, and included supervisors. Livestock workers were excluded.

The most common causes of farm-worker illnesses reported to the CDHS surveillance system in 1998-1999 were the cholinesterase-inhibiting pesticides, e.g., the organophosphates, and N-methyl carbamates (20.2%), followed by inorganic compounds such as sulfur and copper compounds (13.6%) and pyrethroids (8.0%).

Most farm-worker pesticide-related illness cases where the pesticides were identified (75.9%) reported exposures to single pesticides. The remaining cases involved exposures to two or more pesticides. The reporting health care providers most commonly obtain information about the numbers and types of pesticides involved in suspected illness incidents from the patients. Since farm workers, particularly field workers, may not have complete information about the pesticides to which they have been exposed, these data may underestimate the number of pesticides associated with illness incidents.

Farm-worker illnesses most commonly involved dermatologic symptoms or signs (44.2%), followed by those related to the nervous (38.7%), gastrointestinal (38.1%), ocular (32.5%), and respiratory (23.7%) systems (Table 1). Signs and symptoms involving more than one organ system were reported in nearly half the cases (46.5%). Nearly a third of the farm workers reported to the CDHS system (29.2%) lost eight hours or more from work as a result of pesticide-related illness. The etiology of time lost from work is multifactorial, and depends on diagnosis, illness severity, subjective judgment by clinicians, and worker reluctance to miss work due to fear of lost wages.

Over a fourth of the farm-worker illnesses reported to the CDHS surveillance system in 1998–1999 occurred from exposures while mixing, loading, or applying pesticides (28.6%) (Table 1). Most of the illnesses were incurred while the farm workers were performing "routine activities" (except for mixing, loading, and applying), primarily working in the fields. In 1999, the most commonly reported route of exposure for farm workers with pesticide-related illnesses was dermal (41.3%), followed by inhalation (24.2%) and ocular (11.3%). Exposures in 1999 were most frequently due to direct contact with pesticides (17.5%), followed by contact with treated surfaces (13.8%), direct spray with pesticides (14.8%), and drift away from the site of application (14.4%).

These data show that pesticide-related illness is an important cause of acute morbidity in California farm workers. The magnitude of acute illnesses is most likely underestimated, for reasons described earlier. Many conditions, especially persistent effects due to acute exposures or chronic health effects due to long-term exposures, remain undetected by this system. The acute illnesses reported to the surveillance system are due to many classes of pesticides, but a few well-known categories account for over half of the cases. Skin effects dominate the farm-worker illnesses, although ocular and systemic effects also commonly occur. While application of pesticides remains a high-risk activity, the data suggest that most farmworker pesticide-related illnesses are incurred while they are performing other tasks in the fields. Exposures to pesticides occurred in several ways (e.g., residues, drift), illustrating that the use of pesticides creates a hazardous work environment for all farm workers.

TABLE 1 Selected Characteristics of 486 Farm Worker Pesticide Illness Cases Reported to the California Department of Health Services Pesticide Illness Surveillance System during 1998–1999*

Demographic characteristics	
Hispanic†	413 (85%)
Male	387 (79.6%)
Age mean (range)	34.7 (13–73 years)
Pesticide illnesses by category‡	
Organophosphates	98 (13.1%)
N-methyl Carbamates	54 (7.2%)
Inorganic compounds	102 (13.6%)
Pyrethroids	60 (8.0%)
Thiocarbamates	19 (2.5%)
Organochlorines	40 (5.3%)
Other	243 (32.1%)
Unknown§	137 (18.2%)
Organic systems affected¶	
Dermatologic	215 (44.2%)
Ocular	158 (32.5%)
Nervous system	188 (38.7%)
Gastrointestinal	185 (38.1%)
Respiratory	115 (23.7%)
Other	99 (20.3%)
Time lost from work	
Yes	142 (29.2%)
No	235 (48.4%)
Unknown§	109 (22.4%)
Activity when illness occurred	
Applying pesticides	116 (23.9%)
Mixing or loading pesticides	23 (4.73%)
Routine activity‡	313 (64.4%)
Other	12 (2.5%)
Unknown	22 (4.53%)

*A total of 1,156 cases were reported to the system during 1998–1999. Farm workers were defined by census occupational code. All variables were coded and classified according to criteria developed by NIOSH. See text for details.

†Based on last name. Ethnicity information is not collected on reporting forms.

‡Individuals may be exposed to more than one class of pesticides, so the number of illness incidents is greater than number of farmworkers.

§The variable was not identified from mandatory reporting forms and medical record review.

¶More than one organ system could have been involved for an individual.

‡Routine work activity, not involved with pesticide application; primarily field work.

PREVENTING ILLNESS THROUGH REGULATION

Farm workers have fewer protections under law than do other workers in the United States. Generally, there is a wide array of protections for workers in the United States today. Unfortunately, many of these do not apply to agricultural workers.⁴⁴ While 12 states do offer full coverage of occupational illness or injuries for agricultural workers, 13 states do not offer any coverage. The remaining states offer some coverage, with restrictions that may be related to size of employer, time with the employer, or some other provision.⁴⁵ The Fair Labor

Standards Act excludes some agricultural workers from minimum wage protections and from overtime-pay requirements.^{3,46,47} In agriculture, unlike other industries, children of any age are considered legal to work in some tasks and situations.⁴⁵ Moreover, children may also be employed in work designated dangerous at younger ages than in other industries. Finally, the National Labor Relations Act excludes farm workers from its protections of the right to organize and bargain collectively.⁴⁴

Two sets of regulations, the Field Sanitation Standard and the Worker Protection Standard (WPS), are relevant to pesticide-related health effects in farm workers. These federal regulations are enforced either by state governments or by federal OSHA in states without state-based OSHA plans. The Field Sanitation standard, promulgated by the Occupational Safety and Health Administration (OSHA), specifies requirements for provision of potable water, toilets, and hand-washing facilities.⁴⁸ While this standard is aimed at the reduction of heat-related illness and communicable disease, hand washing may help to reduce pesticide exposures by decreasing exposure by dermal contact and ingestion. Although the Field Sanitation standard does not cover growers with ten or fewer employees nationally, states may impose more stringent requirements. For example, California's Field Sanitation Standard applies to all employers.⁴⁹

The U.S. EPA's WPS for agricultural workers was promulgated in 1992, fully implemented in 1995, and amended in 1996.⁵⁰ The WPS is a regulation aimed specifically at reducing the risk of pesticide poisonings and injuries among agricultural workers and pesticide handlers. The WPS contains requirements for pesticide safety training, notification of pesticide applications, use of personal protective equipment, restricted entry intervals following pesticide application, decontamination supplies, and emergency medical assistance. The WPS states that farm workers who enter an area that has been treated with a pesticide during the preceding 30 days or that is subject to a restricted entry interval must receive pesticide safety training covering specific topics related to pesticide exposure in a language they understand. Workers must be trained before they work more than five days in a treated area; training must be repeated at least every five years. There are additional training requirements for those who work in enclosed areas, such as greenhouses, and for pesticide applicators.

Based on farm-worker surveys, there is considerable regional variation in employer compliance with these regulation implementation of the regulations. A survey of California farm workers showed that 57% of the respondents admitted to receiving training in the safe use of pesticides. In contrast, only approximately a third (35.2%) of North Carolina farm workers had ever received training about pesticide safety.⁵¹ Such training had been brief, with little opportunity for worker interaction.

In addition to training, the WPS has other requirements. An employer must clearly post in a central location as well as at the entrances to treated fields, information about pesticides that have been applied, and the restricted-entry periods. Like training, employer compliance with regulations requiring worker notification of pesticide applications varies. North Carolina farm workers had poor knowledge of the sources of pesticide exposure and methods for preventing exposure. Fewer than half of these workers reported that their employers had told them when pesticides had been applied (48.1%) or posted signs around treated fields (48.3%). Only 37% stated that their employers posted information about pesticide applications in a central location.⁵² Failures to comply with requirements regarding notification of pesticide application and the appropriate restricted-entry interval have resulted in significant morbidity among farm workers.⁵³

Compliance with the Field Sanitation standard is generally higher than compliance with the WPS. In California, toilets were available to 88% of farm workers surveyed, potable water and disposable cups to 79%, and wash water to 82%.²² In North Carolina, drinking water was always or usually available to the majority of farm workers surveyed (89.6%), although disposable cups (69.9%), separate wash water (44.1%), and toilets (28.2%) were not as prevalent.⁵¹ Employer compliance with sanitation requirements does not ensure the protection of farm-worker health and safety. Both farm workers' and employers' beliefs may affect sanitation practices. Employers underestimate the risks of pesticide exposure faced by workers and feel that farm workers do not want to use safety and sanitation facilities provided to them, while farm workers report that employers do not adhere to regulations.⁵² Cultural beliefs and perceptions of lack of control may account for farm workers' reluctance or inability to engage in safe work practices.⁵⁴

In addition to these federal regulations, California has a unique regulation directed at protection of certain agricultural workers. California law requires biologic monitoring of certain workers for cholinesterase-inhibitor toxicity.⁵⁵ Problems with methods and interpretation of cholinesterase tests affect the efficacy of this program.⁵⁶ Moreover, this regulation applies only to agricultural workers who mix, load, or apply U.S. EPA Acute Toxicity Category I or II cholinesterase inhibitors for seven or more days out of a 30 day period. Although the population of workers to whom it applies has not been well characterized, they are likely to be stable, long-term workers. Thus, most farm workers are unlikely to be covered by this biologic monitoring program.

HEALTH CARE FOR FARM WORKERS

The Migrant Health Act, signed into law on September 25, 1962, authorized the delivery of primary and supplemental health services to migrant and seasonal farm

workers. The Migrant Health Program within the Bureau of Primary Health Care, Health Resources and Services Administration, was re-authorized under the Health Centers Consolidation Act of 1996. This Act combined programs for community health centers, migrant health centers, health care for the homeless, and primary care for residents of public housing.⁵⁷ The act provides for the care of migrant and seasonal agricultural workers and their families as well as individuals who were formerly migratory agricultural workers, and their families, but have left farm work because of age or disability.⁵⁸ The Migrant Health Program provides this care through grants to more than 125 public and private nonprofit organizations, which operate approximately 400 clinics in 42 states and Puerto Rico. In 1999, the Migrant Health Program estimated that the clinics served 600,000 migrant and seasonal farm workers.⁵⁹

The Migrant Health Centers are located throughout the United States and Puerto Rico. California has the greatest number of Clinical Service Sites, with 108, according to the Migrant Health Centers Referral Directory 1998–1999. Texas (66 sites), Florida (59 sites), Washington (45 sites), and South Carolina (37 sites) are in the top five in number of Clinical Service Sites. The other states have between 0 and 28. The migrant clinics provide comprehensive primary and preventive care services to everyone, including the undocumented population, on a sliding-fee-scale basis.⁶⁰ For community health center clinics, farm workers are qualified based solely on their incomes. Legal residence is not required to receive care. Since the programs are administered by the 125 public and private nonprofit organizations, there is not a uniform intake form for determining farm-worker status. Since farm workers travel away from their home bases for their work, continuity of care may suffer. The Migrant Health Program appears to be underutilized by farm workers. Based on NAWS data, while only 26% of farm workers had used any health care in the last two years in the United States, 46% of those who were accompanied by family members had used health care.¹¹ This could include children or wives, and may represent an emphasis of the clinics on prenatal care.

In a study done in California on farm-worker access to health care, many obstacles were mentioned.⁶¹ This was true even though those who were the most unlikely to receive health care, single males, homeless, and households where all members were not documented, were excluded from the study. During peak season, families would lose benefits because a rise in income would disqualify them for the programs. In addition, farm workers found that applying for public insurance programs was difficult and confusing and that even the farm-worker advocates did not know the availability of programs. Compensation for occupational pesticide-related illnesses is equally problematic for farm workers. In addition to the lack of workers' compensation insur-

ance in some states, nationally, awards for agricultural deaths, illnesses, and injuries are substantially lower than in other industries.^{46,62} Finally, one problem with farm workers receiving care for work-related health problems goes beyond access to health care. Inadequate training of clinicians calls into question their ability to recognize and treat problems that are specific to the occupational health risks involved in farm work.²⁹

CONCLUSIONS AND RECOMMENDATIONS

Hired farm workers provide crucial support for U.S. agriculture and in return face hazardous working conditions and receive inadequate protections. The NAWS reports that U.S. farm workers are predominantly Mexican, male, low-paid, and underemployed, with little formal education, and with no legal authorization to work. In addition, even those who do have authorization to work do not have the same protections afforded to non-agricultural workers in the United States in areas such as worker's compensation insurance, overtime pay, restrictions of child labor, and right to organize unions. Pesticides are one of the hazards to which farm workers are exposed during the course of their work. Surveillance programs have the potential to identify crucial issues regarding occupational pesticide-related illness and methods of prevention, but obstacles result in underreporting of illnesses. Nonetheless, surveillance data illustrates that farm workers in the United States are at high risk for pesticide-related illness.

One third of U.S. farm workers work in California. The CDHS surveillance data illustrate the complex nature of pesticide exposures and related illnesses in farm workers. Most non-disinfectant pesticide illnesses in agriculture occur in farm workers. Cholinesterase-inhibiting pesticides continue to cause large numbers of acute pesticide-related illnesses among farm workers, although other pesticide categories also contribute significantly to the illness burden. Consistent with the literature, dermal exposure is the predominant exposure route for California farm workers with pesticide illness.^{63–65} Dermatologic signs and symptoms are the most commonly reported manifestation of pesticide-related illness, although ocular and various systemic effects are also reported. Although mixing, loading, and applying pesticides remain high-risk activities for pesticide-related health effects, the majority of farm workers are exposed while working in the fields. These workers may be exposed following entry of treated fields or through drift of pesticides from neighboring fields. Exposure to residue may occur even in the absence of re-entry violations. Finally, farm workers' families may be exposed to pesticide residues through contaminated items brought into the home.^{66,67} This is of concern to children, the elderly, and those with chronic diseases, who may be particularly vulnerable to adverse health effects of pesticide exposure. Moreover,

unlike many other working populations, farm workers themselves may be in poor general health and may also be more susceptible to pesticide-related effects.²⁴

Farm-worker pesticide exposures are poorly characterized for several reasons. First, pesticides are rarely used alone. Rather, they are typically applied often and in varying combinations.⁶⁸ Lack of consistent chemical combinations and poor data on the effects of multiple simultaneous exposures result in difficulty predicting health effects and attributing them to particular pesticide classes.⁶⁹ In addition to multiple active ingredients, pesticide formulations contain "inert" ingredients, for which toxicity testing is incomplete.^{66,70} Manufacturers are currently not required to disclose the identities of these compounds, although health care providers may obtain this information to fully evaluate potential adverse effects in their patients. Furthermore, farm workers may work for multiple employers and on multiple crops within short time frames, making it difficult to identify the actual pesticide exposures.⁴² In many cases, exposure doses and their physiologic effects may be difficult to ascertain due to several factors, including variable environmental conditions that result in inconsistent deposition and degradation, and limited information about the correlation between exposure measures and physiologic effects.^{69,71-74}

While the U.S. EPA's WPS provides for decontamination or hand-washing facilities for workers who come in contact with certain chemicals regardless of the number of employees, the Occupational Safety and Health Act does not cover growers with ten or fewer employees. This exempts small growers from the requirement to provide such necessities as toilets, drinking water and hand washing facilities at field-work sites.⁴⁷ Cultural and language barriers between employers and farm workers, and variable implementation of requirements by employer account for some of the reduced efficacy of these standards.

Reducing pesticide illnesses among farm workers requires a multifaceted approach. A coordinated strategy has been suggested that includes three major components: 1) risk prevention, 2) risk assessment, and 3) risk management.⁶²

Risk prevention is the most important of the approaches to reduce pesticide-related illnesses among farm workers.⁶² Industrial hygiene principles recommend the removal of contaminants through material substitution as the preferred hazard-control strategy.⁷⁹ The elimination of the use of toxic substances and the substitution of alternative methods is a primary goal of sustainable agriculture.³ Health care providers can act as advocates for farm-worker health by taking a stance against the use of toxic pesticides in agriculture.⁷⁵ There is a need for increased research into alternative methods for pest control that are less harmful to both the environment and human health. In addition, it is crucial to provide education and incentives to growers

to inform them of the availability of these alternatives and to encourage their use.

A risk-assessment approach involves identifying the most hazardous pesticides that need controls. Currently, toxicity risks are ranked independently of each other. Instead, pesticide hazards should be ranked in a matrix based on acute toxicity, chronic toxicity (including reproductive risks), carcinogenic potency, volume applied, and magnitude of worker poisonings. To support this endeavor, current pesticide illness surveillance efforts, especially for work-related conditions, should be supported, and similar measures expanded to states where such programs do not currently exist.⁸ To fully characterize pesticide risks, the U.S. EPA's proposal to require listing of "inert" ingredients on labels should be supported.⁷⁵ Limitations in exposure assessment should be addressed by research methods. Farm workers, especially field laborers, should be included in research on chronic pesticide-related health effects. Although surveillance is important and should continue, assessments of chronic exposures and the resulting health outcomes are currently best addressed by other study designs.^{76,77}

Risk management for farm-worker occupational pesticide risks should focus on high-priority issues identified through risk assessment, establish effective protections, and ensure that these measures are enforced.⁶⁰ First, the risk-assessment process and the precautionary principle should guide full evaluation of pesticides prior to registration, banning, or phasing out pesticides, and regulatory restrictions on use (e.g., use by certified applicators). Enforcement of restricted-entry requirements, the Field Sanitation standard, and the WPS is needed to ensure that current laws protect farmworker health.

Farm workers will benefit from enforcement of the hazard communication and training requirements of the WPS only if these regulations are consistently and appropriately applied and obstacles to implementation are addressed. At this time, the U.S. EPA is conducting a national assessment to determine whether the WPS is meeting its intended goals of addressing risks to agricultural workers. Training should take into account language, literacy, and cultural barriers. Farm workers should also be educated regarding their rights and the availability of services, including their access to preventive medical care and occupational health services. Legal protections, such as worker's compensation coverage, should be extended to states that do not provide them, to ensure that farm workers are provided treatment for work-related illnesses and injuries in all states. Since farm workers do not currently have sufficient power to obtain occupational health and safety protections through collective bargaining, advocates, including health care providers, may need to act on their behalf.⁶³

Education of employers and clinicians is also needed and should address issues of cultural beliefs and practices of all groups involved and how these might affect

medical care and the implementation and efficacy of pesticide safety regulations. Improved education for health care providers regarding occupational health problems faced by farm workers, including pesticides, should be a priority at all levels of clinician training. Clinicians serving the Migrant Health Centers should be specifically targeted for such training. In a recent survey, clinicians working with migrant farm workers cited pesticides as the most important environmental and occupational problem facing farm workers.³⁰ The majority of clinicians surveyed felt that they would benefit from training related to pesticide health effects. Some of these issues are being addressed by federal agencies, nongovernmental organizations, and community-based groups, but involvement of state and local governments and increased collaboration between all groups are needed.²⁹

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