Assessment of Occupational Health and Safety Risks of Farmworkers in Colorado

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Background *Migrant farmworkers face a variety of hazards including exposure to pesticides and agricultural chemicals. However, few studies have quantatively evaluated these risks.*

Methods *Hazards were assessed during 32 field surveys conducted in the agricultural fields and 15 surveys at five camps. Observations of 1,461 farmworkers for potential hazards were recorded. Estimated risk was evaluated on a four-point scale (no hazard, minor, serious, and critical). A total of 229 farmworkers were interviewed about field conditions.*

Results *Two out of the five camps did not have safe drinking water. Risks for farmworkers were lower when a manager was living on site. Field surveys estimated higher risk when provision of sanitation was deficient ($P < 0.05$). Farmworkers' responses concerning field conditions differed from the survey findings.*

Conclusions *Risks for farmworkers depended largely on the environment provided. Discordances between survey results and farmworkers' interview responses suggested that self-reported data might have limited validity for this population. Working and living conditions require improvement to decrease occupational risks for farmworkers.* Am. J. Ind. Med. Suppl. 2:19–27, 2002. © *2002 Wiley-Liss, Inc.*

KEY WORDS: farmworkers; health and safety; worker protection standard (WPS); risk assessment; occupational hazards; migrant camp

INTRODUCTION

Agriculture makes up over 15% of US gross domestic product generating $1 trillion in economic activity each year. As Americans have increased their fruit and vegetable consumption during the last 20 years, farmworkers[1] have provided the hands to cultivate and harvest the nation's food supply [USDA National Agricultural Statistics Service website; Villarejo and Runsten, 1993]. Eighty-five percent of the fruit and vegetable crops in the US are handpicked by foreign-born farmworkers mostly from Mexico and Central America (69%). Farmworkers primarily speak Spanish, one out of three are undocumented young men, and four out of ten migrate across national or state borders in search of work. These individuals generally have no more than a sixth grade education and live in poverty [U.S. Department of Labor, 2000].

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[1] Farmworker, refers to workers who migrate from their homes on a seasonal basis to work temporarily in agricultural jobs in one or more states. The term also includes others who work locally in seasonal agricultural jobs but who do not leave their home to travel to other parts of the US.

While the numbers of those hands picking our fruit and vegetables are unclear, estimates of farmworkers varies from one to four million depending upon the definition, time, and place where data are collected [National Agricultural Statistics Service (NASS), 2000]. During the week of October 10–16, 1999, the National Agricultural Statistics Service reported 1.29 million farmworkers on the nation's farms and ranches, a 3% increase over the previous year [NASS, 2000]. Colorado reported approximately 50,000 farmworkers in 1991 [Colorado Department of Public Health and Environment, 1995].

In addition to physical, ergonomic, and psychological factors, farmworkers confront multiple occupational health hazards in the fields as a result of exposure to pesticides, temperature extremes, dust, and noise [Wilk and Holden, 1998]. There are major obstacles to conducting research among farmworkers, who are a highly mobile, largely invisible population. Agricultural work is dependent on weather fluctuations such as rain, hail, or drought. Additionally, they have to travel between fields and from one region to another in a pattern dictated by harvest periods, and face health and safety hazards at their worksite and housing which is often substandard.

In response to these agricultural hazards, agencies of the federal government, such as the Environmental Protection Agency (EPA) and the Occupational Health and Safety Administration (OSHA), have implemented safety regulations. The EPA's Worker Protection Standard (WPS) is a regulation aimed at reducing the risk of pesticide poisonings and injuries among agricultural farmworkers 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, provision of decontamination supplies, and emergency medical assistance. The WPS established criteria for decontamination sites required that emergency medical information be made available to farmworkers, in addition to information about pesticides [EPA, 1993].

The Field Sanitation and Temporary Labor Camps Standards are part of the federal regulations by OSHA and those standards apply to any agricultural establishment where eleven or more workers are engaged in field hand-labor operations [U.S. Department of Labor, 1987]. The standard specifies that potable drinking water be supplied to all field workers and that toilet and handwashing facilities must be within one-quarter-mile of the place of work. The primary hazards addressed are heat stroke and heat exhaustion due to insufficient intake of potable water, urinary tract infections due to inadequate availability of toilets and consequential urinary retention, agrochemical poisoning resulting from lack of hand washing facilities, and infectious and other communicable diseases from microbial and parasitic exposures. The Temporary Labor Camps standard contains requirements about general environmental controls for the design and conditions of migrant camp facilities.

Farmworker's safety also depends on appropriate environmental conditions in fields and camps particularly adequate fields and housing facilities, and decontamination sites are essential to enable farmworkers to lower their personal exposure to agricultural chemicals, pesticides, and other contaminants. Sanitation and housing facilities may be associated with safety facilities and worker safety activities. Despite the fact that regulations are in place to ensure that workers are provided with facilities and equipment to protect their health and safety, little research has been conducted on the actual work practices and conditions at fields and camps in order to originate meaningful recommendations and interventions. Control of farmworkers' hazards needs to be realistic and cost-effective. This study aims to provide a systematic risk assessment of field and camp conditions for farmworkers using occupational hygiene walk-through surveys as the method of data collection.

MATERIALS AND METHODS

In 1996, the High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) initiated a comprehensive program to provide health and safety education to farmworkers in Colorado to reduce their risks related to pesticide exposure and to other occupational hazards. This report is part of the larger study into the effectiveness of this newly implemented risk reduction program. In addition to assessment of post-test changes in knowledge and risk perception, the evaluation also quantitatively assessed hazards in the fields and camps, which is the focus of this report.

Occupational risk assessments for farmworkers were conducted through 32 field safety walk-through surveys. These surveys included observation of 1,407 workers in the normal course of their work, and 54 workers at the camps. During camp surveys, most of the farmworkers were in the fields. The central location evaluated for all agricultural employer establishments was defined as the place where pesticide information is accessible to farmworkers. (By accessible, EPA means that the information must be in a location where it can be readily seen and read and must be unrestricted in that it need not be requested.) If there is not one central location that is accessible to all workers because of the size of the establishment or physical distance of the workforce, then the employer is required to provide more than one central posting. The information must also remain reasonably accurate during the 30 days after the Restricted Entry Interval, or if none, for 30 days after the application, so that a worker will be able to determine which pesticides may be present in areas she/he will enter [EPA, 1993].

In this study, we gathered data concerning work and living environments of farmworkers in North-East and East-Central Colorado. Participation by agricultural employers[2] and farmworkers was obtained through clients served by HI-CAHS where the pesticide risk reduction program was provided. Before walk-through surveys or group interviews were conducted, the investigators obtained written consent from each of the four employer participants and from each farmworker consenting to interview. This study was approved by the Institutional Review Board at Colorado State University. A cross-sectional design was used employing checklists as recording tools. Walk-through survey tools were based on the Association of Farmworker Opportunity Programs surveys (A. Deeny, personal communication). Two investigators with formal training in industrial hygiene recorded their observations independent of each other onto each checklist. Investigators also repeated their assessments every other survey to test intra-investigator reliability on a random basis and scores were compared.

The main crops harvested at the time of this study were onions, cucumbers, zucchini, green chilies, green beans, lettuce, and broccoli. Farmworkers were observed at least twice per group in their fieldwork environment, including the safety walk-through surveys conducted at one of the agricultural employers' warehouses. The field walk-through survey protocol required the investigators to record all safety related observations during observation periods of 45–60 min. Data collection at camps, central locations, and employers' warehouses was also recorded directly onto checklists with periods of observation ranging from 20–40 min. For quantitative analysis of safety-related behaviors and conditions, items from the checklists associated with specific regulatory requirements were selected to determine appropriate indicators of risks that farmworkers face. For all general environmental conditions at camps and in the fields, pertinent aspects were used from OSHA and EPA standards (Tables I and II). In addition, the industrial hygiene safety walk-through survey protocol included the evaluation of risks related to hazardous materials, hazardous physical agents, fire prevention, and overall safety at work.

Surveys conducted at all five camps included the interpretation of drinking water testing performed by the Weld County Health Department, recorded availability of posted pesticide information and emergency medical phone numbers for farmworkers, at all locations, and checked the condition of portable toilets, drinking water, and decontamination sites including the availability of water, soap, and single-use towels. Wearing of personal protective equipment (PPE), including work clothes, and safety behaviors were recorded at camps and in the fields, such as washing hands before and after using the portable toilet, eating, or smoking. (Agricultural employers usually do not provide work clothes to farmworkers.)

Hazards were assessed according to their risk factor and the ''Priority for Action'' in accordance with the Australian Agricultural Health Unit [Australian Agricultural Health Unit, 1997]. Hazards were classified on a four-point scale; No hazard = 0, minor hazard = 1, serious hazard = 2, and critical hazard = 3, according to their potential for causing personal injury. Critical hazard was considered a condition or practice likely to cause permanent disability, loss of life or loss of a body part. Serious hazard was a condition or practice likely to cause serious injury or illness, resulting in temporary disability or property damage (disruptive but not extensive). Minor hazard was a condition or practice likely to cause minor, non-disabling injury or illness. A ''Priority for Action'' table was used to rate the safety hazards encountered as high, moderate, or low, using the outcome of type of hazard and the frequency of exposure to the hazard [Australian Agricultural Health Unit, 1997].

A total of 214 farmworkers participated in the interviews about the field working conditions. Interviews were conducted in groups of 10–20 farmworkers in their native language which is Spanish. Questionnaires were passed out and answered by farmworkers during lunch break or after work in groups, at the fields or camps. Investigators read the questions aloud and provided assistance to those who could not read or write. At the time the group interview was conducted, the agricultural employer was present only at the warehouse site (Employer 4). Foremen were present and participated as study subjects during interviews conducted at Employers 4 and 2. No employer representatives or foremen were present during interviews conducted at Employers 1 and 3. In previous years, Employers 1, 3, and 4 were HICAHS recipients of services such as water testing, WPS education, and safety walk-through evaluations of camps.

Farmworkers were employed at Weld County in Colorado by five different agricultural employers, one being a labor contractor. A total of seven field groups of farmworkers were observed, with four of those groups employed by one agricultural employer. Each employer site was visited up to six times. The total number of observations (n) was recorded for each site based on the farmworkers present at the time of the visit to the field or camp. Therefore, some farmworkers were observed more than once. Overall estimated risks were calculated by multiplying hazard scores by the total number of workers exposed to the specific risk.

RESULTS

The response rate of agricultural employers that were previous or new clients served by HI-CAHS was 71%; 85%

[2] Agricultural employer means any person, corporation, association, or other legal entity that: owns or operates an agricultural establishment; contracts with the owner or operator of an agricultural establishment in advance of production for the purchase of a crop and exercises substantial control over production; or recruits and supervises employees or is responsible for the management and condition of an agricultural establishment (OSHA 29 CFR. 1928.110).

TABLE I. Determinants for Score Assignment of the General Environmental Controls at Temporary Labor Camps, Field Sanitation, and Walk-Through Surveys Among Farmworkers in Colorado

Each room used for sleeping purposes shall contain at least 50 square feet of floor space for each occupant.
In camps, where cooking facilities are used in common, stoves (ratio of one stove to 10 persons or one stove to two families) shall be provided in an enclosed and screened shelter. Sanitary facilities shall be provided for storing and preparing food.
In a room, where workers cook, live, and sleep, a minimum of 100 square feet per person shall be provided. Sanitary facilities shall be provided for storing and preparing food.
A shower head for every 10 persons.
Garbage containers shall be kept clean, garbage containers shall be emptied when full, not less than twice a week.
Adequate first aid facilities approved by a health authority shall be maintained and made available in every labor camp for the emergency treatment of injured persons.
Pesticides applied when workers are in the field, restricted entry posted information. Pesticide containers present at fields and camps in addition to pesticide posted information described at Table II.
Potable drinking water shall be provided and placed in locations readily accessible to all workers. The water shall be dispensed in single-use drinking cups or by fountains. The use of common drinking cups or dippers is prohibited.
One toilet facility and one handwashing facility shall be provided for every 20 workers or fraction thereof, except where, due to terrain, it is not feasible to locate facilities as required above. The facilities shall be located at the point closest to vehicular access.
Toilet facilities shall be adequately ventilated, appropriately screened, have self-closing doors that can be closed and latched from the inside, and shall be constructed to insure privacy. Toilet and handwashing facilities shall be accessibly located and in close proximity to each other. The facilities shall be located within a one-quarter-mile walk of each hand laborer's place of work in the field. Toilet facilities shall be operational and maintained in clean and sanitary condition.
Hands washed both before and after using the toilet, eating, or smoking.
Clothes worn by workers: long sleeve shirt, hats, and shoes, and gloves.

of the farmworkers employed by these companies volunteered to participate in this research. Mean duration of observation periods was 55 min (SD = 10 min) for 32 field walk-through surveys, observing a total of 1,407 farmworkers. There was high correlation between the investigators scores (r = 0.97). Fieldwork tasks observed were mainly harvesting. One farmworker was observed driving a tractor and spraying pesticides with a mechanical sprayer. He wore long pants and a long sleeve shirt, but no additional PPE and a respirator was hanging from the tractor at the time he was applying the pesticides.

In 56% (18/32) of safety walk-through surveys, the farmworkers observed were living at camps included in this survey. The five farmworker camps were surveyed at least twice and water testing was carried out for all camps. Table I presents guidelines used to assign estimated risk scores to farmworker camps, and Table II lists pesticide information that must be posted for farmworkers. Table III presents the Estimated Risk (ER) calculated for farmworkers living in camps.

Almost all farmworkers working for Employer 1 were living at Camp D. Some farmworkers observed at camps A, B, C, and E were working for employers not participating in this study. No hazards were found during walk-through surveys of Camp A, which was built in 1997, and was in excellent condition. At Camp B, the general conditions were good, but the fire extinguisher inspection had expired. At Camp C, overflow from the trash containers had accumulated and bathrooms were poorly maintained and very dirty. Camp D had no fire extinguishers, and the laboratory report indicated that the drinking water contained coliforms (both of these hazards were rated as critical). There were two residential buildings at Camp D. According to information provided by farmworkers, the buildings had not been

TABLE II. Pesticide Poster Information Required by the Worker Protection Standard, EPA*

- Avoid getting on your skin or into your body any pesticides that may be on plants and soil, in irrigation water, or drifting from nearby applications.
- Wash before eating, drinking, using chewing gum or tobacco, or using the toilet.
- Wear work clothing that protects the body from pesticide residues (long-sleeved shirts, long pants, shoes and socks, and a hat or scarf).
- Wash/shower with soap and water, shampoo hair, and put on clean clothes after work.
- Wash work clothes separately from other clothes before wearing them again.
- Wash immediately in the nearest clean water if pesticides are spilled or sprayed on the body. As soon as possible, shower, shampoo, and change into clean clothes.
- Follow directions about keeping out of treated or restricted areas.

*A safety poster must be displayed that conveys the following basic pesticide safety concepts that help farmworkers keep pesticides from entering their body. At a minimum, the following points shall be conveyed.

TABLE III. Estimated Risk at Farmworker Camps

Camp	Fire extinguisher	Drinking water (*coliform* present)	Drinking water (nitrates > 10 mg/L)	Housekeeping	Other	Total
A	0	0	0	0	0	0
B	2[a]	0	0	0	0	2
C	2[a]	0	0	1	1[c]	4
D	3[b]	3	0	0	2[d]	8
E	2[a]	3	3	2	3[e]	13

0 = no hazard, 1 = minor hazard, 2 = serious hazard, 3 = critical hazard.
[a]Inspection expired.
[b]No fire extinguisher.
[c]Window screens with holes.
[d]No window screens and poor room ventilation.
[e]Two non-working refrigerators with toys inside at the back of the camp.

repaired or repainted for the last 14 years and had no window screens. There were between 10 to 15 occupants in each of the two rooms (∼500 square feet) with one bathroom in each room. In Camp E, poor housekeeping was common, drinking water contained coliforms, and exceeded the State's nitrate limit (10 mg/L). There were farmworker children and pregnant women living at this camp. At the time of the first safety walk-through survey, there were two empty refrigerators not in service with toys inside. No empty pesticide containers were observed at any of the farmworker camps.

The distance from a central location to the field ranged from 1 to 40 miles (mean = 14.8 miles; n = 32). Pesticide and emergency medical information were not updated or posted at central locations, nor at camps for farmworkers (Table II). Ninety three percent wore long pants, 67% wore long sleeve shirts, 94% wore proper footwear, and 68% wore hats (Table IV). Gloves were not often used (11%) and were not provided by agricultural employers. At camps, workers were observed cooking after work wearing their work clothes, whereas a smaller number of them showered and changed clothes before eating.

Overall estimated risk (ER) was determined by multiplying the total hazards found by the number of farmworkers in the field walk-through surveys (Table V). There were no inadequate field sanitation conditions for Employer 2, but several infractions for Employers 3 and 4, this last one included the warehouse site (4W). Many of the farmworkers under Employer 4 were living at migrant Camp E where hazards were also high. Employer 2 provided adequate field sanitation (84% of field survey findings) and had recently built a farmworker camp (Camp A) that was in good condition. Not surprisingly, occupational health risks were higher for farmworkers where no field sanitation was provided and housing was substandard ($P < 0.05$). Lack of drinking water in the field at the time of harvesting was a critical hazard during the summer due to heat stress. Temperatures during the data collection period averaged 77°F, ranging from 60°F in the early morning (5:30 A.M.) to 95°F for early afternoon, with humidity averaging 50%. Those temperatures were higher than the average summer temperatures for that region in Colorado, usually from 57 to 88°F.

Most farmworkers at the warehouse were also seasonal, however, some of the experienced workers often reported returning to the same employer each year. Warehouse bathroom conditions were unhygienic, and there was a lack of available drinking water. Bathrooms did not

TABLE IV. Type of Clothing Worn by Farmworkers During Field Safety Walk-Through

Agricultural employer	Long pants (%)	Long sleeves (%)	Hat (%)	Gloves (%)	Farmworkers (n)
1	100	79	56	14	128
2	93	70	62	10	315
3	91	48	71	> 1	216
4	80	63	79	29	702
4W[a]	100	74	70	< 1	46

[a]Warehouse.

TABLE V. Field Sanitation Conditions and Estimated Risk (ER) From Safety Walk-Through Surveys

Employer	Drinking water	Portable toilet	Decontamination water	Towel	Total	Farmworkers (n)	ER
1	0	1	3	2	6	128	768
2	0	0	0	0	0	315	0
3	3	2	2	2	9	216	1,944
4	3	1	2	2	8	702	5,616
4W[a]	2	2	2	2	8	46	368

0 = no hazard, 1 = minor hazard, 2 = serious hazard, 3 = critical hazard.
[a] Warehouse.

contain soap, towels, or running water. Other hazards included loose clothing worn by farmworkers near moving belts. Machinery was often lacking appropriate safeguards and several ergonomic hazards were present. Estimated Risk for sanitation conditions only was high (ER = 368).

Participation in the group interview was voluntary and not randomly assigned. Table VI presents percentages of field conditions responses by group of farmworker versus walk-through survey findings. Percentages in survey findings were calculated per number of total field safety walk-through surveys by employer. Farmworkers from Employer 1 responses to items pertaining to specific sanitary provisions ranged from 18% for drinking water to 29% for soap, single-use towels, and decontamination water. In terms of actual behavior, farmworker responses to the interviews showed that 51% of the farmworkers washed their hands before using the toilet when they worked in the fields. Fifteen percent of the workers who smoked responded that they washed their hands before smoking while working in the fields. However, during survey periods, farmworkers were observed not washing hands before eating (n = 33), not washing hands before smoking (n = 5), not washing hands before drinking (n = 13), and not washing hands before using the portable toilet (n = 12). Based on field observations, the percentage of farmworkers washing their hands after using the portable toilet was higher (85%) than washing hands before eating or using the portable toilet.

TABLE VI. Comparison of Observed Conditions (Field Safety Walk-Through Surveys) and Farmworkers Responses Regarding Field Sanitation

	Farmworkers responses (%)	Field survey findings (%)
Employer 1		
Drinking water	18	100
Decontamination water	29	0
Soap	29	0
Towels	29	0
Employer 2		
Drinking water	81	100
Decontamination water	19	100
Soap	37	34
Towels	44	100
Employer 3		
Drinking water	46	10
Decontamination water	7	0
Soap	0	0
Towels	0	0
Employer 4		
Drinking water	52	10
Decontamination water	5	0
Soap	11	0
Towels	9	0
Employer 4—Warehouse		
Drinking water	25	0
Decontamination water	42	0
Soap	8	0
Towels	0	0

DISCUSSION

Farmworkers have been excluded from preventive medicine and occupational health efforts and are indeed described as suffering the highest work related injury, morbidity, and mortality rate in the nation [Schenker, 1996]. Work and field conditions risks for farmworkers combined with their health access, education, and access to information leave this population at a substantially greater risk than the general population for occupational injuries and diseases [Wilk and Holden, 1998; Ward et al., 2001]. The results of our investigation support the recommendations of other researchers in that farmworker living and working environments require considerable improvements [Austin et al., 2001].

The estimated risk of occupational hazards in this study was high for farmworkers living and working in inadequate conditions. Adequate Camps (A and B) had a manager,

living near by or on site, who supervised housekeeping and general conditions, whereas camps with no responsible manager available tended to have a higher prevalence of safety and sanitary risks. The absence of fire extinguishers at Camp D was considered a critical hazard. Furthermore, no training or information on the use of a fire extinguisher was provided, although this was not required by law, such safety information would be critical to control the spread of highly hazardous smoke and toxic fumes in the event of a fire. At Camp E, the manager improved conditions reported during this study by promptly removing the empty refrigerators found. However, drinking water was still provided from the back of a pickup truck stored in a tank covered with plastic.

Farmworkers had little control over their occupational exposure or their access to sanitary facilities in the field or at labor camps. Since it was likely that workers lacking proper field sanitation conditions would be living in substandard housing, exposures in the field to pesticides are likely exacerbated by the fact that workers may have prolonged skin contact because of the inability to access facilities for decontamination. The safety walk-through surveys showed that field sanitation conditions were constantly observed by at least by one of the participating employers, Employer 2, who provided adequate living conditions at Camp A.

The WPS does not specify the maximum distance from the central location to the field. The finding of a mean distance of 14.8 miles from the work groups to the applicable central locations indicates that workers in reality do not have ready access to the information that the central location is supposed to provide. In most cases, farmworkers did not have transportation in case of an emergency and they rarely had access to communication with others outside their work group. None of the central locations displayed pesticide or emergency medical information recommended by the standard. Our findings highlight the importance of providing pesticide and emergency information that is truly available to the farmworkers in the fields and posted at camps [EPA, 1993].

Farmworkers often work in agricultural warehouses where products are sorted prior to shipping. The warehouse selected for the study was surveyed using an additional checklist that contained items similar to those used in the walk-through survey of typical industrial operations (i.e., machine guards). Survey findings at the warehouse uncovered poor sanitary conditions, lack of potable drinking water, unguarded machinery hazards, and loose clothing worn around moving machinery parts. These findings would likely indicate noncompliance with OSHA regulations and present risks to workers that should be eliminated. While most of the workers in the warehouse were former field workers, some of them had become seasonal workers no longer migrating for other jobs but working during the winter at ski resorts, restaurants, etc. When asked about the differences in field vs. warehouse, workers expressed their interest in working in a covered environment and a more predictable schedule.

There were some important differences, when farmworkers' responses were compared to the findings obtained from safety walk-through surveys (Table VI). In response to the question ''Does your employer provide drinking water in the field?'', 18% of the workers at Employer 1 responded ''Yes''. In contrast, the safety walk-through surveys indicated drinking water was always available in the field. Asking farmworkers questions about sanitary conditions may give a response that is more related to experience over a longer term. For example, if only 18% of workers reported ''Yes'' to having drinking water in the field, this may indicate that drinking water is not always available even though it was there during periods of the walk-through survey.

Overall, remarkable discrepancies occurred in all farmworker responses vs. survey findings, although at the warehouse, when the employer was present at the group interview, the percentages of positive responses were higher than survey findings. Farmworkers' responses pertaining to field sanitary conditions for Employer 4 (which is the same employer as in the warehouse) also were higher than survey findings. At the warehouse, a soda machine was available for workers to purchase drinks, but there was no water, soap, or single-use towels available in the bathrooms to wash hands, and no drinking water. The absence of a foreman during the group interview could explain the responses compared to findings at Employer 3. However, greater differences from survey findings were found in responses at Employer 1. At this employer's site, some of the farmworkers were coming back every year for more than 15 years; these farmworkers may have wanted to be loyal to their employer by providing a ''desirable'' answer.

Indeed, fear of jeopardizing employment has been described among reasons for farmworkers not reporting work anomalies [McCurdy and Carroll, 2000]. In fact, for twelve groupings (Table VI), the percentage of farmworkers reporting yes to the presence of facilities were higher than observed in field surveys. Aside from the availability of drinking water in the fields, critical evaluation must be made of farmworker responses trying to please the investigator with a desirable answer. Information can be provided to farmworkers so they understand the implications of their answers for investigators. Differences in responses between farmworkers and walk-through surveys for Employer 2 and 3 could be explained by the observation period of this investigation. Circumstances could have changed when the walk-through surveys were not being conducted. Responses from farmworkers are widely used in research, and further research is needed to assess the probability of a precise response, given the survey methodology used.

The attempt to record farmworker behaviors more critically, other than taking farmworker responses at face value, needs further development. Limitations of this study were that the safety walk-through surveys were not linked to individual responses of the farm workers. Modifying the method of observation to identify the farmworkers who respond to the interviews would provide more accurate data for observed behaviors during the field safety walk-through surveys. The period of time for observation varied throughout the day, establishing different types of circumstances and farmworker behaviors. Variability from one period of observation to the next for this study represented a challenge in assessing the conditions for this highly mobile workforce.

Research of farmworkers and agriculture represents a challenge for investigators using conventional study designs [Zahm and Blair, 2001]. In this study, conducting surveys at different times was useful to better estimate farmworkers' environmental conditions (i.e., temperature), and to document the variability in farmworkers' tasks and work schedules. However, for recording purposes, that lack of structure in place and time had consequences for the data collected. For example, not all farmworkers took a scheduled lunch break, and the number of farmworkers washing their hands before eating or after eating was determined by how many of them choose to eat at the time of the survey. On the other hand, the method of observation was unobtrusive and the working atmosphere remained open with employers, foreman and farmworkers, since there was no work interruption caused by investigators.

In summary, field safety walk-through surveys provided valuable information on occupational risks to farmworkers both during their work in the fields and while living in farmworker housing. Employer 2 provided many good work practices and it was noted that having a manager living in the camp or close by who had responsibilities for housekeeping and general conditions was associated with better living conditions for farmworkers. Should these work practices prove to be effective in reducing risks to farmworkers, they could be modeled by other employers across the state to improve the occupational health and safety of farmworkers.

These findings suggest that to reduce the occupational exposures of farmworkers employers must comply with federal regulations in providing a safe working environment. Additionally, interventions for risk awareness among all parties needs to incorporate the adoption of safe behaviors among farmworkers. While additional regulation by itself may not a useful foundation [Arcury et al., 2001], compliance with regulations decreased farmworkers occupational risks in this study. Different avenues ought to be evaluated to improve farmworker living and working conditions with new approaches beyond enforcement, including new partnerships between investigators, agricultural employers, and farmworkers.

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REFERENCES

Arcury TA, Quandt SA, Cravey AJ, Elmore RC, Russell GB. 2001. Farmworker reports of pesticide safety and sanitation in the work environment. Am J Ind Med 39:487–498.

Austin C, Arcury TA, Quandt SA, Preisser JS, Saavedra RM, Cabrera LF. 2001. Training farmworkers about pesticide safety: issues of control. J Health Care Poor Underserved 12(2):236–249.

Australian Agricultural Health Unit. 1977. Agricultural health and safety guidance notes. Moree, NSW.

Colorado Department of Public Health and Environment. 1995. Final report: summer migrant education health program. 4300 Cherry Creek Drive South, Denver, Colorado 80246-1530.

Environmental Protection Agency (EPA). 1993. The worker protection standard for agricultural pesticides. US EPA 735-B-93-001. Prevention, Pesticides, and Toxic Substances (H6506C). SSOP, Washington, DC 20402-9328.

McCurdy SA, Carroll DJ. 2000. Agricultural injury. Am J Ind Med 38:463–480.

National Agricultural Statistics Service (NASS), Agricultural and Statistics Board, U.S. Department of Agriculture. 2000. Sp Sy 8 (5-00), Farm Labor National Agricultural Statistics Service USDA Washington, D.C.

Schenker MB. 1996. Preventive medicine and health promotion are overdue in the agricultural workplace. J Public Health Policy 17(3):275–305. Review.

U.S. Department of Labor. 1987. Occupational Safety and Health Administration: 29 CFR Part 1928. Field Sanitation; Final Rule. Directive Number: STP 2-1.138. Fed. Reg. 52:16095, Washington, D.C. (May 1, 1987).

U.S. Department of Labor. 1999. Occupational Safety and Health Administration: 29 CFR Part 1910. 142; 1911: Temporary Labor Camps Standard. Fed. Reg. 64:42150-42151, Washington, D.C. (July 27, 1999).

U.S. Department of Labor. 2000. Findings from the national agricultural workers survey: 1997–1998. A demographic and employment profile of United States farmworkers. Research report No. 8. Website: http://www.dol.gov/asp/programs/agworker/report_8.pdf

USDA National Agricultural Statistics Service. 2000. Agricultural Fact Book. Website: http://www.usda.gov/news/pubs/fbook00/contents.htm

Villarejo D, Runsten D. 1993. California's agricultural dilemma: higher production and lower wages. Davis, CA: California Institute for Rural Studies, p 1–48.

Ward MH, Prince JR, Stewart PA, Zahm SH. 2001. Determining the probability of pesticide exposures among migrant farmworkers: results from a feasibility study. Am J Ind Med 40(5):538–553.

Wilk V, Holden R. 1998. New directions in the surveillance of hired farm worker health and occupational safety. National Institute for Occupational Safety and Health (NIOSH) May 5, 1995 to identify priorities for hired farmworker occupational health surveillance and research. Publications Dissemination, EID; NIOSH, Cincinnati, OH 45226.

Zahm SH, Blair A. 2001. Assessing the feasibility of epidemiologic research on migrant and seasonal farmworkers: an overview. Am J Ind Med 40(5):487–489.