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A Cohort Study of Injuries in Migrant Farm Worker Families in South Texas

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PURPOSE: This cohort study estimated the frequency of and risk factors for work injuries among migrant farmworker families over a two-year period.
METHODS: The cohort consisted of 267 families. Bilingual interviewers asked mothers to respond for their family soliciting demographic, psychosocial, employment, and work-related injury information. Cox regression was used to examine risk factors for first injury events.
RESULTS: Of the 267 families, nearly 60% migrated and 96% of these completed the follow-up interviews. These families represented about 310 individuals each year who had participated in farmwork on average 6 days a week, 10 hours a day, for 2.7 months in the past year. Twenty-five work-related injuries were reported with an overall rate of 12.5/100 FTE (95% C.I., 8.6–19.0). Working for a contractor increased the hazard ratio, and use of car seat belts and working for more than one employer during the season decreased it.
CONCLUSIONS: If person-time at risk for injuries is taken into account the reported injuries are substantial. Because the injuries were quite diverse, specific interventions may have to focus on improved working conditions (physical and economic), ergonomic modifications, and enhanced enforcement of existing regulations.
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KEY WORDS: Farm work, Youth, Texas, Hispanics, Injury, Migrant Workers, Family, Surveillance.

BACKGROUND

Very little is known about occupational injuries, either fatal or nonfatal, in agriculture in general and in agriculture involving migrant farmworkers in particular. The reasons for the paucity of data include incomplete surveillance, inconsistencies in the definition of work, the absence of legal injury-reporting requirements for small farms (< 11 employees), self-employed farmers and unpaid family workers, and difficulties in defining injuries in this population (1–8). It is estimated that 85% of migrant and seasonal farmworkers work on farms with fewer than 11 employees (9).

However, sufficient data exist to document agriculture as a hazardous work environment for children and adults in the United States and in Texas (2, 3, 10–17). Agriculture is the second most hazardous industry in the United States in terms of death rates (18), and it is tied for third highest among eight major industry classifications for nonfatal injuries (19). Further, many of the studies relate to farm owner and operators and their families and not farm workers (7, 20–24), and the majority of these data relate to adults.

Injury prevention efforts have been hindered by a lack of data on specific work patterns and risk factors for injuries in farm worker families. The objective of this cohort study was to use a school-based tracking system for migrant farmworker students as a sampling frame to identify migrant farmworker families in order to estimate the incidence of and risk factors for occupational injuries over a 2-year period. Only one cohort study of injuries among farmworker

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Selected Abbreviations and Acronyms

BLS = Bureau of Labor Statistics
FTE = full-time equivalent
MEP = Migrant Education Program
NGS = New Generation System
OSHA = Occupational Safety and Health Administration
RGCCISD = Rio Grande City Consolidated Independent School District

families has been published. This study by McCurdy and colleagues (15) was an important contribution to laying the groundwork for cohort analysis of injuries in migrant farmworkers. This study defined the cohort as seasonal residents of migrant housing centers in northern California at the beginning of the 1997 harvest season. The team's innovative use of cohort analyses included Poisson regression and Cox proportional hazards regression to estimate incidence and to identify potential risk factors of farmworker injury. A potential limitation of the McCurdy and colleagues study was the combination of retrospectively and prospectively collected data in the cohort analyses. Although the inception of the cohort was clearly defined as 1997, the cohort analyses for injury incidence appear to have backdated cohort members' time at risk of injury to the beginning of the 1996 harvest season. A possible problem with such backdating is akin to the problem in using surviving prevalence cases in a case-control study. In such a study, one may not be able to distinguish determinants of injury from determinants of injury survival and recovery, which in the McCurdy and colleagues study would be defined as establishing 1997 residency in one of the study migrant housing centers. Analyses separating the historically from the prospectively ascertained cohort data could resolve this. In the current study, the sampling frame made it easy to define the inception of the cohort as Spring 2000 and to include in the analyses only injuries and work experience after the inception of the cohort. To further address the gaps in the literature of injuries in migrant farmworker families, our study was conducted in a population-based home-state setting in which participants were interviewed at their permanent residences.

METHODS

Study Population

Starr County, Texas, with a population of 53,597 (25), is located on the Texas-Mexico border. Rio Grande City Consolidated Independent School District (RGCCISD) is the largest of three school districts in Starr County and includes nearly 60% of the students. More than 90% of its students are classified as economically disadvantaged (26). The Migrant Education Program in RGCCISD maintains files on migrant students through the New Generation System (NGS), a system to identify migrant students and to transfer enrollment, demographic, academic, and health data across the United States. Estimating sample size with standard parameters (alpha = .05; beta = .20; 2-sided test), a probability of injury of 10%, a probability of risk factor exposure of 50%, and a sample size of 400, we would have sufficient power to detect a relative risk of 2.1. We randomly sampled 372 families from 1520 families listed in NGS. We initially interviewed 371 mothers in spring 2000 to screen for the family's intention to migrate. Among those interviewed, 267 mothers indicated the family's intention to migrate, and these families were enrolled in our cohort. After the migration season (in fall 2000), we recontacted all 267 mothers, and if their families had migrated, we asked them to participate in an interview in their permanent residences in Starr County. Written informed consent was obtained. Experienced interviewers were overseen by an expert field supervisor with over 20 years of experience in Starr County. For the year 1 interview, each mother who had migrated in 2000 was asked to respond for herself and on behalf of her husband, her oldest child, and the youngest of her children who had also worked as migrant farm laborers in year 1. For the year 2 interview, because there were so few "youngest" children doing farm work in Year 1, only data on mothers' "oldest" farm worker children were included for the year 2 (2001–2002) interviews. Thus, there was a total of three possible interviews that took place in spring 2000 (baseline), fall/winter 2000–2001 (year 1 follow-up), and fall/winter 2001–2002 (year 2 follow-up). The bilingual survey included questions on demographics, work history, injuries, health symptoms, work hazards, pesticide exposure, smoking, alcohol consumption, and sleep. Interview items were adapted from previous surveys of farmworkers (15, 27, 28). The final draft was reviewed by a panel of academic investigators and government researchers. The instrument was pilot tested in a focus group that included Spanish speaking interviewers, migrant farm worker mothers, and a primary care physician trained in occupational epidemiology. Each mother was offered a $15 gift card to a local grocery/discount store for her participation in each follow-up survey. The duration of each interview was approximately a half hour to 1 hour. All study procedures and forms were approved by The University of Texas Health Science Center Committee for the Protection of Human Subjects.

Definitions of Migrant Farm Work and Work-Related Injury

A farm work job was one that was involved in an aspect of food production. Farm workers were considered *migrants* if they had to spend the night away from their permanent residences in Starr County to do their farm jobs. Participants were asked to report the average number of hours worked per week for each job during the migration season. *Work-related injury* was defined as a nonfatal acute injury that occurred while doing farm work or traveling to or from work during the migration season. Interviewers used a standardized set of prompts to anchor the scope of injury types (e.g., sun and heat-related problems, car crashes getting to or from work, cuts from tools, strained backs after heavy lifting, electrical burns, getting pesticides in eyes resulting in infections, injuries involving animals, or serious insect bites/stings while working). Only the first occurrence of any nonfatal acute farm-related injury over the 2-year period was included. Cumulative trauma (e.g., chronic back pain and hand/wrist pain) is excluded from this definition.

Statistical Analysis

Descriptive statistics and a descriptive analysis were completed using the SAS system for Microsoft Windows (29), STATA (30), and SPSS (31) statistical packages. Using STATA, a more in-depth examination of the time to first injury event was conducted using Cox regression. Models were clustered by person, as individuals who participated in both years of follow-up were allowed multiple records. First, univariate analysis of factors considered primary determinants of interest or strong potential confounders were run based on our review of the literature and importance in the context of migrant farmworker injury prevention (e.g., factors listed in Table 1). Of the statistically significant ($p < 0.05$) variables, the variable with the greatest univariate point estimate and most precise confidence interval was identified as the strongest variable. Each additional potential determinant, confounder or effect modifier was next examined in a model that also included the strongest variable. Using a criterion of less than or equal to a 0.05 significance level for the new "main effect" term or a 15% or greater change in the rate ratio for the strongest variable with the inclusion of the new main effect term (32), other potential determinants, confounders, or effect modifiers were individually evaluated. A model was next fit that included the full set of potential determinants, confounders, or effect modifiers and variables previously eliminated, one at a time. The next model included the subset of variables from the intermediate model and all first-order interaction terms. The final, most parsimonious model included the subset of variables that were either significant as a main effect term or a confounder (15% change in the rate ratio for employer type) or effect modifier (interaction term significant at the 0.05 level).

TABLE 1. Description of migrant farm work including crops worked, job tasks performed, and location in year 1 and year 2

	Year 1		Year 2	
Variable/Category	Frequency	%	Frequency	%
Location				
Texas Only	107	34.0	74	27.9
Both	7	2.2	0	0.0
Out of Texas Only[†]	201	63.8	191	72.1
Crops Worked[‡]				
Cotton	123	39.0	69	26.0
Corn	54	17.1	54	20.4
Asparagus	42	13.3	28	10.6
Potatoes	37	11.7	29	10.9
Beets	37	11.7	26	9.8
Trees	24	7.6	16	6.0
Grapes	13	4.1	17	6.4
Peanuts	12	3.8	15	5.7
Job Tasks Performed[‡]				
Hoed	117	37.1	98	37.0
Sorted	66	21.0	47	17.7
Weeded	59	18.7	23	8.7
Harvested from the ground	58	18.4	33	12.5
Harvested from trees	16	5.1	14	5.3
Operated farm machinery	7	2.2	15	5.7
Detassled	10	3.2	19	7.2
Cut crops	–*	–	23	8.7
Worked cleaning crops	–*	–	43	16.2

*Not collected in first year.
[†]AR, CA, CO, FL, GA, ID, IL, IN, KS, LA, MI, MN, MS, NC, ND, NE, NM, OH, OK, OR, TN, UT, WA, WI.
[‡]Participants could report multiple crops and job tasks.

RESULTS

Descriptive Statistics

Of the 267 mothers in the cohort, 154 (57.7%) mothers migrated during year 1 and 143 (59.8%) during year 2 (including 32 mothers who did not migrate in year 1). Each year, approximately 96% of the mothers who migrated completed the follow-up survey. Of the 267 families, 100% were Hispanic and mothers had lived in Starr County for an average of 17 years. The average family size was 4.70 members (range 1–10). In year 1, 13 mothers (2 could not be located, 9 moved, and 2 died) were lost to follow up (4.9%), while 14 mothers (3 could not be located, 8 moved, and 3 were still migrating at time of survey) were lost to follow up in year 2 (5.5%).

Description of Employment and Work Intensity

Of the 154 migrating families in year 1, 119 mothers, 104 fathers, 71 oldest children, and 21 youngest children

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participated in farm work. The average ages of these family members were 40 (mothers), 44 (fathers), 18 (oldest child), and 14 years (youngest child). Of the 143 migrating families in year 2, 105 mothers, 95 fathers, and 65 oldest children participated in farm work. On average, participants worked 6.2 days/week, 10.1 hours/day and held 1.7 farm jobs in follow-up year 1 and worked 6.0 days/week, 9.7 hours/day and held 1.6 farm jobs in follow-up year 2. Because the family unit usually worked together and the age of the farmworker children was skewed toward high school age, the distribution of these factors did not vary across mothers, fathers, and children. Regarding type of employer, 75.2% (237) of family members were employed by growers/owners only, 11.1% (35) worked for contractors and growers/owners, and 13.7% (43) were employed by contractors only in follow-up year 1. In year 2, 58.5% (155) of family members were employed by growers/owners only, 9.1 % (24) were employed by both contractors and growers/owners, and a higher proportion 32.5%, (86), worked for only contractors.

In follow-up years 1 and 2, approximately 34.0% and 27.9% of participants, respectively, worked only in Texas. As presented in Table 1, the remaining participants worked in 24 other states, the top five of which included Washington, Michigan, Illinois, California, and North Dakota. Table 1 displays the most frequently worked crops and performed job tasks. Cotton was the most commonly worked crop in both follow-up years (39%, 26%). The most commonly performed job task in both follow-up years was hoeing (37.1%, 37.0%) followed by sorting (21.0%, 17.7%), harvesting from the ground (18.4%, 12.5%), and weeding (18.7%, 8.7%).

Prevalence of Workplace Hazards, and Health Behaviors

The most prevalent workplace hazards included working with or around the following (percentages for follow-up year 1 and 2 respectively): knives/cutting tools (57.9%; 59.8%), tractors (52.2%; 54.4%), repetitive hand work (44.7%; 50.4%), bending/stooping repetitively (43.8%; 46.2%), chemicals (41.5%; 43.8%), all terrain vehicles (37.7%; 46.0%), irrigation ditches (30.9%; 41.8%), hitched equipment (24.4%; 34.6%), lifting objects repetitively (23.3%; 26.1%), and moving heavy objects (20.5%; 24.6%).

On average, participants slept 6.8 hours (year 1) and 6.9 hours (year 2) while migrating and 8.2 hours (year 1) and 8.3 hours (year 2) with better quality sleep while at home in Starr County. Alcohol use while migrating was reported for over 20% of fathers compared to less than 2% of mothers (years 1 and 2). For both years, ever having smoked was reported for less than 10% of mothers reported compared to more than 40% of fathers. Dental care during the past year was asked of participants during the second year of follow-up. Only 17% of participants reported ever visiting a dentist.

Analysis of Time to First Injury Event

Over the 2 years of follow-up, 25 work-related first injury events were reported. Ten injuries were reported in year 1 and 15 injuries in year 2. In total, 12 injuries occurred in mothers, 9 injuries in fathers, and 4 injuries in children. Table 2 lists injury type, medical care, lost work time, and reasons for not seeking medical care. All injuries occurred on-the-farm job or in transport to a farmwork job. Among the 25 injuries, nine resulted in lost work time (with eight exceeding the traditional four or more hour work loss time). Beyond this, five additional injuries not resulting in lost work time were treated in hospitals or clinics. An additional six injured participants indicated they did not seek medical care because they could not stop work, did not have access to medical facilities, or lacked money.

In total, 390 individuals contributed 399,462 person-hours of time. The overall injury rate was 12.5 per 100 FTE (based on 2,000 work hours/year). Among adults, the rate per 100 FTEs was 16.7 (95% C.I., 9.6–31.3) for mothers and 11.0 (95% C.I., 5.9–23.1) for fathers and among children the rate was 8.7 (95% C.I., 3.2–30.6).

Table 3 presents the most parsimonious model for acute injury using Cox regression. The final model included type of employer (hazard ratio = 6.86), general use of automotive seat belts (hazard ratio = 0.02), number of farm jobs/employers during the season (hazard ratio = 0.40), and access to employer-provided toilet paper while working in the fields (hazard ratio = 2.26, but not significant). The "employer-provided toilet paper" variable remained in the model because it caused a greater than 15% deflection in the hazard ratio for employer type and thus is an important confounder as noted in the methods section. The fit of the final model was examined using various graphical methods including Cox-Snell residual analysis and influence/leverage analysis (33). All graphical depictions supported a reasonably well-fit model. A global test based on Schoenfeld residuals was used to assess potential violation of the proportional hazards assumption (34). The p-value (0.33) based on a chi-square distribution with 8 degrees of freedom suggests no violation of the proportional hazards assumption across time.

Person-type (mother, father, child) was considered as a covariate in the Cox models and was not an independent risk factor, confounder or effect modifier. In addition, we adjusted for family effects by conducting Mantel-Haenszel chi square analyses stratified by family ID number. The Breslow-Day test for heterogeneity across strata was not significant, and the summary rate ratio estimates did not

TABLE 2. Description of injuries in year 1 and year 2 among mother, fathers, and children (n=25)

	Nature	Body Part	External Cause	Location	Person Type	Lost Time from Work	Treatment or Medical Care
1	Contusion	Forehead	Iron pole	Fields	Father	No	Employer-treated; refused treatment by medical professional
2	Abrasion	Knee	Fall from bench to ground level	Grain storage / silo	Father	No	Went to hospital / clinic
3	Strain	Waist	Overexertion / strenuous movement	Vegetable factory	Oldest Child	No	Self-treated; employer prohibited taking sick leave
4	Strain / inflammation	Forearm / fingers	Overexertion / strenuous movement	Meat processing company	Mother	No	Employer-treated
5	Strain / inflammation	Forearm / fingers	Overexertion / strenuous movement	Barn	Father	No	Employer-treated
6	Strain	Neck	Overexertion / strenuous movement	Fields	Mother	10 days	Self-treated; no transportation
7	Loss of consciousness / contusion	Waist	Fall to the ground level from standing	Vegetable fields	Mother	1 day	Went to hospital / clinic
8	Cut	Finger	Knife	Fields	Mother	No	Employer-treated; could not stop work
9	Cut	Finger	Scissors	Vegetable fields	Father	No	Employer-treated
10	Contusion	Hand & hip	Fall	Vegetable cannery	Mother	No	Hospital / clinic
11	Abrasion	Eye	Tree branch	Carrot fields	Mother	No	Hospital / clinic
12	Contusion	Leg	Fall from a tractor top ground level	Tomato fields	Mother	1 day	Hospital / clinic
13	Hemorrhage	Head	Vehicle crash	Roadway to work	Father	105 days	Hospital / clinic
14	Skin rash	Hands	Possible contact with allergen or chemical	Field / orchard / nursery	Father	No	Self-treated; could not stop work
15	Abrasion	Upper back	Fall from a box to ground level	Vegetable factory	Father	2 days	No treatment; worker felt it was useless to go to employer-provided physician
16	Infection, rash	Eye & arms	Object dislodged while detasseling corn	Corn fields	Mother	No	Self-treated; could not stop work, no medical facilities, no money for medical care
17	Infection, blisters, rash	Eye & arms	White powder from corn plants	Corn fields	Father	No	Self-treated; could not stop work, no medical facilities, no money for medical care
18	Contusion	Foot	Box of squash	Squash fields	Father	No	Hospital / clinic
19	Painful rash	Inner thigh	Possible contact with allergen or chemical	Grain fields	Mother	2 days	Self-treated; could not stop work; no transportation; no money for medical care
20	Blisters, loss of toenail	Toes	Contact with chemicals	Grain fields	Oldest child	1 day	Self-treated; could not stop work; no transportation; no money for medical care
21	Cut	Leg	Knife	Sorghum fields	Oldest child	No	Self-treated
22	Heat stroke	Whole body	Heat	Asparagus fields	Mother	2 days	Self-treated; no medical facilities
23	Cut, abrasion	Knee	Vehicle	Berry fields	Oldest child	No	Self-treated
24	Blisters	Legs	Contact with pesticide in recently treated field	Barley fields	Mother	2 hours	Employer-treated, no money for medical care; could not stop work
25	Fracture	Foot	Fall to ground level from standing	Vegetable factory	Mother	No	Hospital / clinic

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TABLE 3. Final Cox model examining time to first injury event

Variable	Hazard Ratio	95% C.I.	p-value
Employer-Type			
Owner/Grower Only	Referent		
Contractor/Combined Employer Types	6.86	2.54–18.50	0.000
General Seat-belt Use			
No	Referent		
Yes	0.02	0.01–0.09	0.000
Number of Farm Jobs (continuous variable)	0.40	0.23–0.69	0.001
Employer-Provided Toilet Paper			
No	Referent		
Yes	2.26	0.74–6.91	0.153

Note. 9 records with missing values.

differ from the hazard ratio estimates generated by our Cox models (data not shown).

DISCUSSION

This study involved several methodologic strengths and advanced our knowledge about injuries and injury reporting. A major contribution of this study was the ability to calculate acute nonfatal injury rates based on person-time at risk over 2 years and to examine risk factors utilizing Cox regression also requiring person-time at risk. The nature of farm work being sporadic and intense in work hours, as documented in this study, can be best accounted for with a person-time analysis. Our method of ascertaining this cohort also comprised some major strengths. The New Generation System through the Migrant Education Program made it possible to not only locate a cohort of migrant farmworker families in their home state, but to draw a random sample from a well-defined sampling frame. This method minimizes the potential for selection bias and increases the generalizability of our results. This sampling method also helped alleviate ascertainment problems associated with nontraditional housing. Interviewing participants in their home state and in their permanent homes (away from their employer) increased their ability to be more forthcoming with information about work hazards and injury occurrence. Reporting of injuries by the mother on behalf of her family continues to be used in other farmworker studies of children (12,15), but may not be the optimum method. This issue will be addressed in-depth in a reliability paper, and there is evidence that children of school age can report accurately their own health information (35). It may be useful for other investigators, who may be planning studies with migrant farmworker populations from home states, to note that in each of our 2 years of follow up, nearly 40% of the cohort did not migrate, despite their stated original intention.

Similar to the McCurdy and colleagues study in California (15), our population was sampled by families, and the adults were older and less male than the National Agricultural Workers Survey sample (29). A major limitation of the overall study is the self-reported format, in which injuries could not be validated. Also, medical assessment of injury severity was not possible. However, this population often does not have resources (money, time, availability) to access standard sources of medical care (17). Further, the definition of work-related injury as utilized by other investigators often requires 4 or more hours of work-loss time or medical treatment (15, 36). In the migrant farmworker population, our experience has shown that this definition would exclude most minor as well as many serious injuries, as qualitative data from this study and our previous work with this population indicate that they often work through the pain of an injury because they cannot afford to lose pay or possibly their job. Further, there is not a single word or phrase in Spanish that encompasses the meaning of the English phrase "work-related injury". We found the need to provide examples of categories we wanted to include. If we restricted the analyses to include only "traditional" injuries, we would further underestimate the rate and limit our understanding of occupational nonfatal injuries in this population.

Using an unrestrictive definition, 25 work-related injuries were reported during the 2 years of follow-up for an injury rate of 12.5/100 FTE (95% CI = 8.6–19.0). These rates varied by person-type, being highest for mothers (16.7/100 FTE). This higher rate among mothers may reflect more complete reporting for herself as compared to other family members. Nine of the injuries resulted in lost work or recreation time, and eight were treated at a hospital or clinic. Because of differing injury definitions, inclusion of multiple injuries per worker, and the inclusion of retrospectively ascertained data, the rates reported by McCurdy and colleagues are not directly comparable to ours (15). In addition, McCurdy and colleagues did not provide family member-specific rate estimates. However, even with our more inclusive injury definition, the 95% confidence interval for our overall rate of 12.5/100 FTE (8.6–19.0) overlaps the 95% confidence intervals of the rate reported by McCurdy and colleagues (15) (9.3/100 FTE; (7.5–11.5).

Further our study would be affected by underascertainment of injuries due to recall. The literature suggests length of time since injury is a critical factor (37, 38). However, we have no a priori reason to suspect recall bias on the basis of differential reporting of injury among exposed versus unexposed migrant farmworkers. Furthermore, statistical tests revealed no violation of the proportional hazards assumption across time in any of our Cox models, suggesting the lack of serious bias in estimating the effects of potential

risk factors despite differing durations of injury recall. Given the lower rate of injury for father and children compared to mothers, there is also potential underreporting of injury by mothers for fathers and children. However, person-type was considered as a covariate in the Cox model and was not significant.

Results of the Cox regression suggest at least three determinants of acute injury. First, farmworkers employed by contractors or combined employer types (contractors and owner/growers) have 6.9 times the risk of acute injury compared to farmworkers employed exclusively by owners/growers. The implications of this risk factor are not clear and are inconsistent with results reported by McCurdy and colleagues (15) for indirect employment. However, if contract work is related to piece-rate work, then these results would be supported by McCurdy and colleagues (15) results for piece-rate work in women (RR 4.9, 1.8–12.8). It would be important to seek to understand the factors associated with contractor employment. In a California study of farm labor contractors and their increasing impact in that state, many contractors reported that the lack of enforcement of regulations by the government places honest contractors at a relative economic disadvantage (39). Second, farmworkers who usually wore their automotive seat belts were much less likely (RR = 0.02) to sustain an acute injury, perhaps indicative of safety behavior. Third, farmworkers who held a greater number of jobs during a migration season were less likely (RR = 0.40) to experience an acute injury, and the risk decreased as the number of jobs increased. The protective effect of having more jobs is not fully understood, unless it relates to greater experience or variety needed to keep workers from inattention (40). Finally, having been provided toilet paper, a marker of access to basic field sanitation, was not statistically significant in the model. The variable decreased the point estimate for employer type by greater than 15% and was included in the final model.

CONCLUSIONS

Collectively, this study adds to our previous work (41–43) with farmworkers and continues to demonstrate our ability to access, follow, and collect meaningful information from this previously understudied population. Our data support the need for primary data collection from young farmworkers, ascertainment of work histories to calculate person-time at risk, increased access to health and dental care, and development and implementation of school-based and/or community interventions. Because the number of injuries was small and quite diverse, specific interventions may have to focus on improved working conditions (physical and economic), ergonomic modifications, and enhanced enforcement of existing regulations. This recommendation is supported both by our findings and by those of McCurdy and colleagues (15) regarding employer characteristics. Although not the focus of this article, it is important to consider the broader array of injury outcomes including chronic conditions (such as back pain and hand/wrist pain, which will be the focus of a separate article) and dental care. It would take much larger studies to examine detailed causal mechanisms for specific injuries. However, interventions based on more distal organizational- or systems-level determinants (rather than proximal factors such as a worker's knowledge, attitudes, or behavior) may be as effective or have an even greater impact. Haddon's matrix (44) provides a useful framework including agent, host, and environment for studying determinants and formulating intervention options. Further, more research, similar to the work of Faucett and colleagues (45), is sorely needed on the validity and psychometric properties of survey instruments for use in migrant farmworker populations. Despite the overall decline in the number of family farms in the United States, the need for intensive manual labor performed by farmworkers and their children is expected to increase (46), suggesting a continuation of health risks to this population.

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