Occupational Injuries Among Agricultural Workers 51 to 61 Years Old: A National Study

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Abstract

Using the Health and Retirement Study (HRS), a nationally representative survey of Americans 51 to 61 yrs old, we examined risk factors for occupational injuries among agricultural workers. Of the 9,756 age-appropriate Americans in the HRS cohort, we studied the 237 farm operators, farm workers, and workers in other agricultural occupations. Using logistic regression analysis, we found that agricultural workers differ from all other occupations in the pattern of risk factors associated with occupational injuries. While heavy lifting and poor sight were risk factors for both agricultural workers and other workers, self-employment was a risk factor for agricultural workers and a protective factor for other workers. Poor hearing and a job requiring good vision were risk factors for other workers, but were protective for agricultural workers. Depression and dissatisfaction with life circumstances were more strongly associated with injuries among agricultural workers than among other workers.

Keywords. Occupational injury, Farmers, Survey, Self-employment, Impaired vision, Impaired hearing, Heavy lifting, Agricultural workers.

In the United States, farming has long been recognized as one of the most dangerous occupations (Merchant, Reynolds and Zwerling, 1995). Estimates of the annual occupational fatality rate range from 17 to 35 deaths/100,000 farmers (NIOSH, 1993; National Safety Council, 1994). Recent studies have also shown high rates of non-fatal injuries among farmers. A prospective study among dairy farmers in New York reported 16.6 injuries/100 farmers per year (Pratt et al., 1992). Among beef and dairy farmers in Ontario, the rate was 7.0/100 farmers per year (Brison and Pickett, 1992). Using a population-based sample, Zhou and Roseman (1994) found an injury rate of 9.9/100 farmers per year in Alabama.

Older farmers may have a higher risk of injury than younger farmers. For fatal injuries among workers in agricultural production and services sectors, those aged 55 to 64 yrs had a relative risk of 1.64 compared to those aged 25 to 44 yrs; those aged 65 and older had a relative risk of 3.30 (Myers and Hard, 1995). However, for non-fatal injuries, the pattern is less clear. In Ontario and New York, older farmers had

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higher rates of non-fatal injuries, but in Alabama, older farmers had lower rates than their younger colleagues (Pratt et al., 1992; Brison and Pickett, 1992; Zhou and Roseman, 1994).

These injury patterns take on increased importance because of the age of our farm population. For the last 35 years, the average American farm operator has been over 50 yrs old; in 1987, the average American farm operator was 52.0 yrs old. In 1990, forty-six percent of U.S. farm operators were aged 55 yrs or older compared with 35% for all U.S. householders (Ahearn et al., 1993). In addition, recent work (Ambe and Murphy, 1995) suggests that injury prevention programming for older farmers may need to be specially designed.

In analyzing a nationally representative sample of older Americans, we examined the associations between occupational injuries and a variety of risk factors stratified by 12 occupations. We found that among agricultural workers the direction of some key associations differed from all other occupations ($p < 0.05$). The associations between occupational injuries and a variety of risk factors among agricultural workers were different from the analogous associations among all other major occupational groups. Here, we present these differences in detail outlining the associations of these risk factors and occupational injuries among the subcohort of agricultural workers in the Health and Retirement Study (HRS). We will discuss risk factors for occupational injury among the non-agricultural workers in the HRS cohort elsewhere.

Methods

Cohort

Our cohort derives from the Health and Retirement Study — a nationally representative sample of Americans 51 to 61 yrs old (Juster, 1994). The HRS cohort was recruited during the 45 wks beginning in April 1992 from a multistage, area probability sample of the continental United States. Households were eligible if they contained one person born between 1931 and 1941. In those households with more than one eligible member, a primary respondent was chosen at random. The primary respondent's spouse was also included, irrespective of age. The HRS oversampled both African-Americans (16.3%) and Hispanics (9.3%). Of the eligible households, 82% agreed to participate, resulting in a total sample of 12,654.

Of the original HRS cohort, we considered only the 9,756 subjects between 51 and 61 yrs of age, excluding spouses outside the age range. Only the 7,089 of these subjects who were employed during the year preceding the interview were at risk for occupational injury. From this group of employed, older workers, we report here on the 237 farm operators, farm workers, gardeners, and other workers in agricultural occupations (codes 473-489; National Center for Health Statistics, 1989).

Variables

In the HRS, the following question defined occupational injury: "During the last 12 mos, that is since (month) of 1991, have you had any injuries at work that required medical attention or treatment or interfered with your work activities?". In addition, the HRS asked about the number of injuries during the last year and the date of the most recent injury. No further inquiry was made concerning the nature, severity, or circumstances of the injuries.

In contrast, detailed information was obtained on the demographics, health, working conditions, financial, and family status of the respondents. In this

exploratory study, we use as independent variables the HRS variables which have been identified in the occupational or farm literature as risk factors for occupational injuries as well as those we believe may be risk factors even though they have not yet been reported as such. Since this is a cross-sectional survey, we divided the independent variables into two groups.

First, we considered those independent variables that were likely to have preceded the occupational injuries and, thus, could be considered as potential predictors of injury. These include age, 55 to 61 yrs compared to 51 to 54 yrs; sex, male compared to female; Black compared to non-Black; Hispanic compared to non-Hispanic; education, 12 or fewer years compared to more than 12; rural, non-standard metropolitan area counties compared to standard, metropolitan area counties; obese, Quetelet score greater than 30 compared to less than or equal to 30; alcoholic, three or four positive answers on the CAGE screen (Cutting back, Annoyed, Guilt, Eye-opener; Bush et al., 1987) compared to others; disabled prior to occupational injury compared to others; sight, poor or fair with glasses compared to others; hearing, poor or fair with hearing aid compared to others; job requiring physical effort all or most of the time compared to others; job requiring stooping or kneeling all or most of the time compared to others; job requiring heavy lifting all or most of the time compared to others; job requiring concentration all or most of the time compared to others; job requiring good vision all or most of the time compared to others; experience, three or more years on same job compared to others; self-employed compared to others. All information on job requirements was reported by the subjects in response to the question "thinking about your job, please tell us how often these statements are true. My job requires . . . ".

Second, we considered those independent variables, such as depression, which might have predated the injury and predicted it, but also might have been a consequence of the injury. These include income, greater than $44,000/yr compared to less; depression, the 30% with the most CES-D (Center for Epidemiologic Studies – Depression Scale; Radloff, 1977) symptoms compared to the rest; those with some difficulty getting up after sitting compared to those with no difficulty; those with some difficulty stooping compared to those with no difficulty; those with some difficulty pushing large objects compared to those with no difficulty; those with some difficulty lifting 10 lb compared to those with no difficulty; those with some difficulty walking a block compared with those with no difficulty; those with some difficulty walking several blocks compared to those with no difficulty; those whose health was worse than one year ago compared to those whose health was the same or better; those whose emotional health was fair or poor compared to those whose emotional health was better; those who were somewhat or very dissatisfied with their house, neighborhood, health, finances, friendships, marriage, job, family life, the way they handle problems, or life overall compared to those who were more satisfied.

Analysis

To calculate injury rates, assuming an average of one year of exposure per subject, the number of injured agricultural workers was the numerator and the number of workers with a primary agricultural occupation at the time of the interview was the denominator. The database does not specify if each work-related injury occurred at a primary job or at a second, off-farm job. For these calculations, we used SUDAAN (Survey Data Analysis software; Shah et al., 1992) which takes into account the complex design of the HRS including the stratification, weighting, and intraclass correlation among the sample observations. As we previously reported (Zwerling et

al., 1995), we believe that the one-year recall timeframe used in the HRS causes the crude injury rates to underestimate the rates that would have been obtained had we used a two- or four-week recall timeframe. Others (Harel et al., 1995; Landon and Hendricks, 1995) have shown that recent injuries are more likely to be reported than injuries which occurred many months ago. As outlined in our previous work (Zwerling et al., 1995), we adjusted our injury rates to what they would have been using a four-week recall period, using a regression model derived from the larger HRS data set. Our cohort of agricultural workers was not large enough to allow validation of this model on the agricultural workers alone.

We then compared the risk factors for injury among agricultural workers with the risk factors for injury among other older workers. First, we calculated the odds ratios of the univariate associations of the potential risk factors with occupational injuries among agricultural workers and compared them with the analogous odds ratios among the other workers in the HRS cohort. Second, we calculated a logistic regression model for occupational injuries among agricultural workers, forcing in the risk factors which we had found associated with occupational injuries among other workers: a job that requires heavy lifting, a job that requires good vision, self-employment, poor hearing, and poor sight. Third, we calculated a logistic regression model assessing the association of occupational injury with those risk factors which clearly preceded the occupational injury. Following the modeling strategy of Hosmer and Lemeshow (1989), we chose variables which had a p-value < 0.2 in the univariate analyses. We then entered the variables in a logistic regression model using backwards elimination, thus eliminating any variable that did not contribute at the level of $p < 0.1$. Fourth, we looked at the univariate associations between occupational injuries and the independent variables that may have preceded or followed the injury.

When using complex sample designs such as the HRS, one should use analytic procedures and software that are consistent with the sample design. On the other hand, when the data are sparse, the accuracy of the asymptotic assumptions of large sample theory is in doubt. Thus, we would prefer to carry out exact calculations. Since we knew of no software which allowed for exact calculations in the context of complex sample designs, we used SUDAAN to calculate the overall injury rates using an asymptotic approach. For the stratified analyses and logistic regression analyses where the number of injuries become sparser, we chose to make exact calculations, ignoring the sample design. To this end, we used StatXact-Turbo (Cytel Software, 1992) and LogXact-Turbo (Cytel Software, 1993).

Results

Table 1 describes the association of industry and occupation in the HRS agricultural worker cohort. Of the 237 for whom data were available, 38% were farmer operators, 23% were farm workers, and 23% were gardeners and groundskeepers. By industry, 38% worked in crop production, 24% in livestock production, and 22% in agricultural services. More than a quarter of the gardeners worked in agricultural production industries. Since occupational injury was not statistically significantly associated with the subcategories of industry or occupation (data not presented), subsequent analyses will not distinguish between farmer operators, farm workers, gardeners, and other agricultural occupations.

Among agricultural workers, there were 15 injuries. The adjusted injury rate was 13.9/100 farmers per year compared with an adjusted rate of 8.0/100 workers per year for other workers. Table 2 compares the associations between various risk

Table 1. Number of subjects in the HRS agricultural worker cohort by occupation and industry codes

Industry Code	Farm Operators (473)*	Occupation Code Farm Workers (479)*	Gardeners (486)*	Other	Total
Agricultural production, crop (10)†	39	31	0	17	87
Agricultural production, livestock (11)†	38	11	0	4	53
Agricultural services (20-21)†	6	8	28	11	53
Other	3	5	22	4	34
Total	86	55	50	36	227‡

* U.S. Census Occupation Code Number.
† U.S. Census Industry Code Number.
‡ Total is less than cohort because of missing data.

factors and occupational injuries among agricultural workers with those associations among other workers. For some risk factors, such as age, rural residence, disability, impaired sight, jobs requiring heavy lifting, and jobs requiring concentration, the associations were similar in both groups. For others, the agricultural workers group was too small to allow precise estimation. However, for several key risk factors, the associations between the risk factor and occupational injuries were in the opposite direction among agricultural workers than among all other workers. For example, among agricultural workers, the odds of occupational injury was 0.28 times as high for males than for females; the corresponding odds ratio among other workers was 1.38. Agricultural workers with impaired hearing had an odds ratio of 0.30 for

Table 2. A comparison of univariate associations between risk factors and occupational injuries for agricultural workers and other workers

Risk Factor	Number with Risk Factor (%)*	Agricultural Workers with Injuries	Agricultural Workers' Odds Ratio†	Older Workers' Odds Ratio†
Age (55-61 vs. younger)	129 (58)	8	0.84 (0.29-2.52)	0.82 (0.66-1.01)
Male	194 (87)	10	0.28 (0.09-0.99)	1.38 (1.06-1.79)
Black	36 (16)	1	0.35 (0.02-2.11)	1.23 (0.93-1.63)
Hispanic	40 (18)	1	0.31 (0.01-1.86)	1.21 (0.74-1.98)
Education (≤ 12 yrs)	187 (84)	11	0.52 (0.16-1.98)	1.78 (1.38-2.29)
Rural	124 (55)	9	1.24 (0.42-3.86)	1.16 (0.92-1.48)
Quetelet > 30	64 (30)	4	0.87 (0.23-2.76)	1.29 (1.01-1.65)
Alcoholic	22 (9)	3	2.50 (0.53-9.19)	1.95 (1.27-2.99)
Disabled	39 (17)	4	1.81 (0.48-5.87)	1.54 (1.02-2.33)
Sight (poor & fair vs. better)	34 (16)	4	2.17 (0.57-7.10)	2.01 (1.49-2.72)
Hearing (poor & fair vs. better)	41 (19)	1	0.30 (0.01-1.80)	2.08 (1.59-2.71)
Job Requirements				
Physical effort	158 (74)	7	0.47 (0.14-1.67)	2.45 (1.89-3.18)
Stooping or kneeling	110 (39)	5	0.65 (0.18-2.19)	2.23 (1.76-2.83)
Heavy Lifting	176 (82)	12	--- (1.03-∞)	3.40 (2.55-4.53)
Good vision	80 (38)	1	0.14 (0.01-0.85)	1.28 (0.94-1.73)
Concentration	74 (32)	4	0.93 (0.24-3.18)	1.09 (0.84-1.42)
Good people skills	134 (64)	8	1.19 (0.35-4.67)	1.24 (0.97-1.59)
Three years experience	32 (15)	0	0.00 (0.00-1.06)	0.75 (0.53-1.05)
Self-employment	119 (55)	10	2.10 (0.65-7.97)	0.44 (0.30-0.66)

* The denominators used to calculate these percentages vary because of missing data.
† 95% confidence interval.

Table 3. A comparison of the multivariate model developed on other workers with same model applied to agricultural workers

Risk Factor	Agricultural Workers' Odds Ratio*	Older Workers' Odds Ratio*
Heavy lifting	2.86 (0.43-∞)	2.75 (2.00-3.78)
Self-employment	2.83 (0.58-19.97)	0.47 (0.32-0.69)
Poor hearing	0.29 (0.01-2.22)	1.60 (1.11-2.30)
Poor sight	3.08 (0.41-19.19)	1.53 (1.11-2.09)
Job requires good vision	0.16 (0.00-1.23)	1.43 (1.04-1.98)

* 95% confidence interval.

injury compared with unimpaired agricultural workers; among other workers the odds ratio was 2.08. Agricultural workers who reported their jobs required physical effort or stooping and kneeling had less risk of injury than agricultural workers who reported their jobs required little effort or stooping and kneeling (odds ratios 0.47 and 0.65). Among other workers, these odds ratios were 2.45 and 2.23, respectively. Finally, self-employed agricultural workers had an odds ratio of 2.10 for occupational injury compared with agricultural workers who worked for others. For other workers, self-employment was protective (odds ratio 0.44).

Multivariate modeling yielded similar results. Table 3 shows the odds ratios calculated when the logistic regression model developed on other workers was applied to agricultural workers. For agricultural workers, poor sight and jobs requiring heavy lifting were associated with occupational injuries, just as they were for other workers. However, self-employment, which had been protective for other workers, was a risk factor for injury among agricultural workers. Poor hearing and jobs that require good vision, which had been risk factors for injury among other workers, were protective from injury among agricultural workers. However, probably because of the relatively small size of our agricultural worker sample, all of the 95% confidence intervals for the farmer model included "one". Applying the Hosmer and Lemeshow (1989) modeling strategy to the agricultural workers, we found four variables to consider as potential risk factors for occupational injuries: 1) sex, 2) a job that requires heavy lifting, 3) a job that requires good vision, and 4) a history of alcohol abuse. Both backward and forward regression led to a univariate model including only a job requiring good vision as a risk factor.

Finally, we looked at the association between occupational injuries and the second group of potential risk factors which may have caused the injury, but could also have been consequences of it. Table 4 shows that the pattern of these associations is similar to that among other workers. However, some of these associations have higher odds ratios among agricultural workers than among other workers: depressive symptoms (odds ratio 3.05); dissatisfaction with marriage (2.61), job (2.95), family life (5.48), the way problems are handled (5.20), and life overall (4.35). These findings suggest possible risk factors for injuries among older agricultural workers which could be evaluated in a cohort study.

Discussion

Using a nationally representative sample of older Americans, we found that agricultural workers differ from all other occupations in the pattern of risk factors associated with occupational injury. Although heavy lifting and poor sight were risk factors for agricultural workers and other workers alike, self-employment, poor hearing, and a job requiring good vision behaved differently among the two groups of workers. Among agricultural workers, self-employment tended to be a risk factor

Table 4. A comparison of the univariate associations between risk factors and occupational injuries for agricultural workers with the same associations for other workers adjusted for the non-farmer logistic regression model

Risk Factor	Agricultural Workers' Odds Ratio*	Older Workers' Odds Ratio*
Income	0.65 (0.21-2.22)	0.97 (0.71-1.33)
High depression	3.05 (1.03-9.55)	1.47 (1.17-1.85)
Some difficulty with		
Getting up	1.30 (0.42-3.85)	1.54 (1.22-1.94)
Stooping	0.78 (0.23-2.35)	1.93 (1.45-2.57)
Pushing	2.13 (0.45-7.73)	1.50 (1.04-2.17)
Lifting 10 lb	0.58 (0.03-3.54)	1.73 (1.28-2.35)
Walking a block	3.19 (0.66-12.05)	1.44 (0.86-2.42)
Walk several blocks	1.74 (0.46-5.64)	1.37 (1.04-1.80)
Health worse	0.64 (0.03-3.94)	1.31 (0.91-1.88)
Emotional health poor	1.93 (0.51-6.28)	1.45 (1.08-1.96)
Dissatisfaction with		
House	1.71 (0.36-6.25)	1.03 (0.68-1.56)
Neighborhood	1.96 (0.41-7.14)	0.94 (0.64-1.40)
Health	1.16 (0.25-4.10)	1.77 (1.31-2.38)
Finances	1.63 (0.54-4.82)	1.37 (1.07-1.77)
Friendships	0.95 (0.04-6.10)	1.46 (0.95-2.25)
Marriage	2.61 (0.10-21.09)	1.33 (0.71-2.52)
Job	2.95 (0.59-11.91)	1.44 (1.02-2.05)
Family life	5.48 (0.68-30.80)	1.00 (0.67-1.48)
Way problems are handled	5.20 (1.27-18.66)	1.21 (0.87-1.69)
Life overall	4.35 (0.86-17.46)	1.53 (1.05-2.24)

* 95% confidence interval.

for occupational injuries: among other workers, it was protective. Among agricultural workers, poor hearing and a job requiring good vision tended to be associated with not having an occupational injury; among other workers, they were risk factors for occupational injury. Finally, a cluster of variables — depressive symptoms and dissatisfaction with marriage, job, family life, the way problems are handled, and life overall — tend to be more strongly associated with occupational injuries among agricultural workers than among other workers.

In a survey like the HRS, it is difficult to tell whether depression and dissatisfaction are the consequences of occupational injuries or the causes of them. The strength of the associations of occupational injuries with depressive symptoms and dissatisfaction with life and family may reflect the increased role of work in agricultural workers' lives. For many, farming is not just a job, but a way of life. Often agricultural workers live at their worksite. Thus, it is not surprising that an injury at work can have broad implications for their satisfaction with life. Alternatively, agricultural workers who are depressed or dissatisfied may be at increased risk for occupational injury because of inattention, cognitive changes or side effects of medications. The first follow-up of the HRS cohort may help resolve this question.

Similarly, self-employment may have different implications for agricultural workers than for other workers. For other workers, self-employment may be associated with greater control over the way work is structured and paced. For agricultural workers, the conditions and pace of work may be more dictated by the weather and the condition of the field — things that the agricultural worker cannot control. Self-employed agricultural workers may well be at a disadvantage in dealing

with these natural conditions because they often work alone and don't have the option of sharing the most dangerous work. Among agricultural workers, poor hearing is often associated with use of farm machinery. It may be that the extra experience with the machinery that leads to hearing loss also translates into safer work practices. The interpretation of the protective effect of a job requiring good vision is less clear.

A major strength of this study is the nationally representative sample of the HRS. By looking at the agricultural worker subsample from this survey, we are more likely to get a balanced picture of the risks for older agricultural workers throughout the country.

However, the study has substantial limitations as well. First, because agricultural workers made up only 2% of the national sample, we had only a small number of them to analyze. This is reflected in the width of the confidence intervals and the fact that, even for some strong associations, the confidence intervals for the odds ratio include one. This may explain the unexpected direction of some odds ratios.

Second, the small size of our subsample necessitates the use of exact statistical calculations rather than asymptotic approximations. But we are not aware of any commercial software that does exact calculations while taking into account the complex sampling structure of the HRS. Thus, we have ignored the complex sampling structure of the HRS in calculating our models. However, for the overall rates, we did evaluate the impact of the sample design. Using SUDAAN, we estimated a design effect of 0.80 which implies that our confidence intervals are conservative, perhaps 10% too wide.

Third, because the data on risk factors and occupational injuries were collected in the same survey, there is the possibility of recall bias. The occurrence of injuries could make subjects more likely to remember risk factors. However, since the HRS was not cast as an injury study, most of the risk factor questions are posed in different parts of the questionnaire, far removed from the injury questions, thus reducing the amount of recall bias.

Fourth, since all injuries were self-reported, it is possible that agricultural workers are less likely to report injuries than other workers, resulting in a more severe mix of injuries among the agricultural workers. In any case, this article only considers nonfatal injuries; the risk factors for fatal injuries could be different.

Fifth, it is possible that our older agricultural workers may differ importantly from their younger colleagues in their risk factors for injury.

Given these limitations, our study cannot demonstrate conclusive associations between the risk factors studied and occupational injuries among older agricultural workers. However, we believe that our data suggest that the risks for occupational injuries among agricultural workers differ from those among other occupational groups. The results of this exploratory study may provide hypotheses for future research.

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