Ensayos Revista de Economía–Volumen XXXIII, No.2, noviembre 2014, pp. 59-76

Does educational attainment reduce agricultural day laborer injuries in Mexico?

Seth R. Gitter[*]
Robert J. Gitter[**]

Fecha de recepción: 26 VII 2013 Fecha de aceptación: 23 VII 2014

Abstract

Agricultural work is an inherently dangerous job with the risk of injury considered part of a worker's compensation. We focus on the determinants of an agricultural day laborer (jornalero) having experienced an injury while working. The policy variable of interest is the worker's level of educational attainment as workers with a higher level may be better able to understand how equipment works and safety warnings. Controlling for other factors, we find that at the variable means, a jornalero with an additional year of education has a 7.7 percent lower probability of having experienced an accident.

JEL Classification**:** J430, O130.
Keywords**:** Agricultural employment, injuries, education, day laborers.

Resumen

El trabajo agrícola es una tarea inherentemente peligrosa con riesgo de lesiones que se consideran parte de la remuneración del trabajador. En este artículo nos centramos en los factores que determinan que un jornalero haya experimentado una lesión durante el trabajo. La variable de interés es el nivel educativo de los trabajadores, puesto que los trabajadores con un nivel más alto pueden ser más capaces de entender cómo funciona la maquinaria y las advertencias de seguridad. Controlando por otros factores, que en las medias,

[*] Department of Economics. Address: 101 A Stephens Hall, Towson University, Towson, Maryland 21252 USA. Office Phone: 410-704-2191, Home Phone: 202-834-8116. Email: srgitter@gmail.com.
[**] Department of Economics. Address: 217 Corns Building, Ohio Wesleyan University, Delaware, Ohio 43015 USA. Office Phone: 740-368-3536, Home Phone: 614-446-0632, Fax: 740-368-3551. Email: rjgitter@owu.edu.

The authors thank Mark Purschwitz and Peter J. Olson for their useful comments.

un jornalero con un año adicional de educación tiene una probabilidad 7.7 por ciento menor de haber sufrido un accidente.

***Clasificación JEL*:** J430, O130.
***Palabras Clave*:** Agricultural employment, injuries, education, day laborers.

Introduction

Agricultural work is an inherently dangerous job with injury rates above those in other industries and occupations[1]. The factors that impact injury rates have, however, been given scant attention in the economics literature. The topic is relevant to the discipline as the risk of injury can be considered part of the compensation package. To the extent that a particular job is more prone to injury, then the wage rate should adjust accordingly. In this paper we attempt to illuminate the factors that are associated with the risk of injury for agricultural day laborers in Mexico.

Agricultural work can be performed by the land owners, unpaid family labor, permanent employees or day laborers who are hired on a short-term as-needed basis. We focus our analysis on the last group, jornaleros, the Spanish language term for agricultural day laborers in Mexico. The OECD estimates that in 2006 nearly 2 million people or 5% of Mexican workers in the country were employed in informal agricultural jobs (jornaleros)[2]. This is a rather low-income group with a daily wage of approximately ten dollars a day for the jornaleros in our sample, less than one third of the wage in Mexican manufacturing[3]. These workers are also more vulnerable to economic shocks and usually work on a casual as-needed basis locally. They can, however, migrate elsewhere in Mexico to work.

We postulate that whether or not an agricultural worker has experienced a work related injury depends on the characteristics of the worker as well as the nature of the job itself. If the level of schooling is found to be correlated with the rate of work injuries then increasing the level for jornaleros could be beneficial for the workers and their families as well as reduce the cost of raising crops[4]. It is worth noting that due to the cross sectional nature of our

[1] In the United States agriculture has the highest rate of injuries per worker among all industries in the private sector.
http://www.nsc.org/safety_work/Resources/Documents/IF_pgs52-83.pdf .
[2] http://www.latameconomy.org/fileadmin/uploads/laeo/Documents/E-book_LEo2011-EN_entier.pdf
[3] ftp://ftp.bls.gov/pub/suppl/ichcc.ichccaesuppt2_3.txt.
[4] We assume that there would be some hiring costs associated with replacing an injured worker.

data, our analysis is only able to estimate correlation between education and working injuries. Also due to data limitations we are unable to control for weather variation.

We find that the level of schooling is inversely associated with the probability of a Mexican day laborer having experienced an injury, controlling for demographic characteristics of the jornalero, type of crop and aspects of the job itself. The result is not surprising as a more educated worker can better understand how equipment works and would be more likely to be able to understand safety warnings on machinery, pesticides, herbicides and other agricultural inputs. To the extent that the level of education of jornaleros rises in the future, we can expect a decline in the rate of injuries.

1. Previous Studies of the Causes of Injury of Agricultural Workers

Work on occupational injuries for agricultural workers is most likely to be found in the field of industrial medicine. The literature there gives us a guide to what factors might be used in trying to model the rate of worker injuries in agriculture. Our review consists of material published in English and as a result focuses on workers in the United States. We searched for articles on Mexican agricultural workers, but were unable to find any articles that focused on the industry as a whole. Although Gundacker and Gundacker (2011) discuss cattle ranches in Jalisco, we believe ours is the first article to address accidents of agricultural workers in Mexico. Articles addressing the issue in the United States and other countries are discussed in chronological order.

Gerberich *et al*. (1998) used a multivariate logit mode on the Regional Rural Injury Study to model the causes of agricultural work-related injuries in five Midwestern states in the US. They found that over a third of the injuries involved either adjusting or repairing machinery. Furthermore, those that were engaged in lifting, pushing or pulling were also more likely to have suffered an injury. Also, controlling for the other factors, males had an injury rate 3.6 times that of females.

McCurdy and Carroll (2000) reviewed 16 studies of agricultural injury in the United States and Canada. Some of the studies were limited to one geographical area or part of agriculture, e.g. beef and dairy cattle, while others are of a national nature or included a broader spectrum of agricultural industries. Males were found to be at a higher risk of non-fatal injury. Those engaged in working with cattle also experienced higher rates. The most common causes of injury were falls, machinery and working with animals.

One study noted a higher rate of injury for workers with some post-high school education. Although the studies showed a wide range of injury rates, the typical study found an injury rate of five to ten injuries per 100 years of work by jornaleros.

Hard, Myers and Gerberich (2001) used the Traumatic Injury Surveillance of Farmers to examine non-fatal agricultural work injuries. They found that the main causes of injury were livestock and machinery. Furthermore, injuries rates were found to vary little for workers of different ages.

McCurdy *et al*. (2003) examined agricultural injuries among Hispanic migrant agricultural workers in California. They were able to conduct initial interviews with over 1,200 workers as well as follow-up interviews. They found that men had a higher rate of agricultural injury than women. They also found that injury rates varied by education level but not in a consistent pattern.

Purschwitz (2004) examined health and safety issues in agriculture and how they might be reduced. He noted that tractors were involved in more injuries than any other agent of injury. He also noted that other types of machinery were also involved in a large number of injuries. Furthermore, working with large farm animals was seen as being responsible for a large number of injuries.

Shipp *et al*. (2009) used a logit model to predict the incidence of chronic back pain among agricultural workers in Starr County, Texas. They found that working tree crops was more likely to result in chronic back pain. They also saw that controlling for other factors; people engaged in sorting were less likely to suffer back problems.

Wang, Myers and Layne (2011) looked at hired agricultural workers throughout the United States. They used the National Agricultural Worker Survey. The sample included 13,595 workers in 1999 and 2002-2004. They calculated injury rates for workers but did not estimate a model of the impact of one factor controlling for others. Like others above, they found that males were more likely to have experienced an injury than females. Injury rates varied by educational level but not in a consistent pattern. Those with a 7^{th} and 8^{th} grade education were the most likely to have had an injury, a rate greater than those with less education. Shuttle workers who travelled more than 75 miles to work at a single location had higher injury rates than those who either worked locally or followed the crop, i.e. worked at multiple locations more than 75 miles from their home.

McCurdy *et al*. (2003) used a survey to determine injury rates in a sample of 560 Hispanic agricultural workers in California. They estimated a logit model to determine the odds ratio of suffering an agricultural injury. Being, male, young and married resulted in a jornalero being more likely to experience an injury.

Byler (2013) did not focus exclusively on agricultural workers, and instead examined fatal injury rates for Hispanic/Latino workers in the United States. By a wide margin, the highest rate of fatal injury was found for those working in agriculture, forestry and fishing. Interestingly, foreign born Hispanic/Latino agriculture, forestry and fishing workers had a fatal injury rate approximately one half of that of native-born Hispanics.

Although there are additional studies, a pattern emerges in terms of the correlates and causes of injury. Our study highlights several of the correlate factors with worker injury such as individual characteristics, crop type, job, equipment and conditions. Moreover, the individual characteristics of the worker can be broken down into ones that are not policy variables such as age and gender as well as ones such as the level of formal education where change might reduce the probability of experiencing an injury.

2. Conceptual Framework

The probability of having experienced a work-related injury is expected to depend on characteristics of the worker such as their age, education, gender and migration status and experience. The job related characteristics include the crops worked on, job performed, and equipment used and working conditions. Ideally we would like to have had a question that referred to injuries occurring in a specific time frame, e.g. did you experience an injury in the last three months. To our knowledge, however, no such data set exists for Mexico. The closest we could find was the Encuesta Nacional de Jornaleros Agrícolas 2008-2009 (National Survey of Agricultural Day Laborers) which had a question asking if the worker had ever experienced an injury at work. Some jornaleros who had experienced an injury in an earlier year might have sought work in another field and would not be in the sample. This limitation is noted as well as the fact that the respondent has experienced an injury with no time frame specified.

Increased education has the potential to reduce worker accidents as educated workers are better able to store and use safety information to avoid injury

(Gyekye and Salminen, 2009; Arcury, Estrada and Quandt, 2010)[5]. On the other hand some researchers have found a positive relationship between education and worker injury (Hansen, 1989; Iverson and Erwin, 1997), these studies conclude that higher accident rates may be the result of more educated workers performing jobs that require more information because they are risky. Evidence from China and the US shows that not having a high school diploma is associated with increases in worker injury (Yu *et al*. 2010; Orrenius and Zavodny, 2009). In the Chinese study the biggest reduction in accidents was for completing high school, while earlier years of schooling had little impact. This result suggests that higher level function learned in high school may be more important than basic literacy skills learned in elementary school.

The level of education is the key policy variable and we wish to ascertain if those with higher levels are less likely to have had an injury[6]. A large share of the Mexican population is indigenous. Almost one in five people in our sample speak an indigenous language and are classified as indigenous in our study. These workers are thought to potentially have been more likely to have experienced an injury as their schools may not have been of the same quality as others and hence merely examining the years of schooling may not account for the reduced levels of learning experienced by indigenous people. Moreover, if discrimination exists, then the indigenous workers may be assigned more dangerous tasks. Also, if they have difficulty with Spanish, then they may experience difficulty in understanding any safety instructions. Since the dependent variable of interest is having ever experienced an injury, we use age as a factor in the model. Although the probability of having an injury in the last year might vary by age group, as our dependent variable is having ever experienced an injury older workers are hypothesized to have more years working in agriculture and a higher cumulative probability of having experienced an injury.

Several of the studies discussed above note that males are at a higher risk for having had a work-related injury. As we do correct for the job performed and work conditions, to the extent that males engage in more higher risk behavior

[5] It is well established that education can also influence health (Schultz, 1999). Health is an endogenous variable as it influences agricultural production (Strauss 1986, Schultz, 2005) and the possibility of injury. In that sense our measure of education may reflect the worker's overall human capital including their health and education.

[6] It is interesting to note that Wang *et al*. (2011) found that among farm workers in the United States those with a 7th and 8th grade education had higher injury rates than those with lower levels of education and McCurdy *et al.* (2003) found that education had no effect on injuries for California farm workers. These results are hypothesized not to be the case for Mexican workers and hence we include it in our model with additional years of schooling hypothesized to reduce the probability of an injury.

within these jobs they would be more likely to have experienced an injury, ceterus paribus.

Past and current migration may also impact the chances of having had an injury. Jornaleros who have worked in another nation, usually the United States, may have been exposed to alternative, safer methods of performing tasks and may be able to use these methods back in Mexico. Some of the day laborers are working very close to home, being hired by a nearby employer to help during a particularly busy period in the growing cycle. Other jornaleros have traveled to a different state to work. As noted, Wang *et al*. found that working more than 75 miles from home could affect the chances of an agricultural worker experiencing an injury. Their results, however, varied depending on whether the agricultural worker was working at a single location or followed the crop to different location. We will examine if working in a different state from the jornaleros home state affects the probability of having experienced an injury.

In examining the job related characteristics, it is possible that the crop itself may affect having experienced an injury. Although we do control for the job performed, equipment and working conditions, it is conceivable that our controls do not pick up all aspects of the risk associated with working on some crops. With that in mind, it is also possible that some jobs may be more likely to be associated with having an injury. For example, workers who are foremen or cooks may have lower rates of injuries than those who are pickers or loaders. As stated above, McCurdy *et al*. found that working with livestock was associated with a higher incidence of injuries and we have a variable for cuidadores in our model, the caretakers of animals. Other jobs might have different levels of risk. Shipp *et al*. found that sorters had lower rates of back pain and Geberich *et al*. saw that almost a third of agricultural injuries were suffered while doing lifting, pushing and pulling. We do include other job variables to capture these affects.

The equipment employed by the jornalero can also be thought to influence the chances of having suffered an injury. Some equipment can be inherently dangerous to work with such as sharp tools. Gerberich *et al*. as well as Hard, Myers and Gerberich (2001) found that working with machinery was associated with higher injury rates. Purschwitz also noted that working with tractors and machinery was associated with higher injury rates. We include variables to examine the effects of working with such types of equipment as tractors, packing machines and other types of equipment. Our last set of factors focuses on working conditions. We examine such conditions as working two or more meters off the ground, a possible contributing factor in light of McCurdy and Carroll's (2000) finding that falls were one of the most common causes of injury.

3. Data and Econometric Model

The source of data for this study is the Encuesta Nacional de Jornaleros Agrícolas 2008-2009 (National Survey of Agricultural Day Laborers 2008-2009). The survey was conducted of a sample of 2,824 Mexican day laborers by the Ministry of Social Development and the Autonomous University of Chapingo. The sample was selected to be a nationally representative sample of the number of day laborers used in various crops, adjusted for the time employed in each crop. The enumerators filled out the questionnaires, rather than the respondents, as almost a fifth of the sample self-reported as illiterate.

The outcome variable examined is self-reported injuries on the job. The survey instrument asks if the respondent has ever suffered an injury. Of the sample 9% had reported that they had experienced an on-the-job injury. One potential problem with this measure is that selection bias may occur as someone killed on the job or injured so severely that they are no longer able to work as an agricultural day laborer would not be in the sample. In that sense our measure is of injuries that are not completely debilitating and our measure represents a lower bound. Even if injuries that remove people from the work force are correlated with those that merely injure the worker, then our results will shed light on other types of injuries. Even if the two are not correlated given that almost 1 in 10 workers had experienced an injury, policies can be created to help target this population.

Table 1
Descriptive Statistics

		Mean	SD			Mean	SD
Dependent	Reported Having Had Injury	9%	29%	**Job**	Fumigator	40%	49%
Individual	Age	36.49	12.36		Picker	89%	32%
	Years of Education	5.16	3.53		Foreman	9%	29%
	Indigenous	18%	39%		Packer	17%	38%
	Male	81%	39%		Driver	7%	26%
	Migrant in Mexico	14%	34%		Cook	2%	13%
	Migrant Other Country	20%	40%		Animal Caretaker	8%	27%
Crop	Sugar Cane	10%	30%		Loader	26%	44%
	Red Tomato	26%	44%		Other	26%	44%
	Coffee	11%	31%	**Equipment**	Sharp Tools	80%	40%
	Orange	8%	28%		Fumigator Backpack	44%	50%
	Mango	10%	30%		Pump	18%	39%
	Apple	8%	27%		Tractor	16%	36%
	Squash	13%	33%		Packing Machine	9%	28%
	Green Tomato	12%	32%		Ladders	29%	45%
	Chile	27%	44%		None	9%	29%
	Melon	12%	32%		Other	6%	23%
	Grapes	10%	30%	**Conditions**	Lift Heavy Items	69%	46%
	Peach	7%	25%		Time Bending Over	82%	39%
	Pineapple	1%	12%		Work where Chemicals Applied	55%	50%
	Banana	7%	25%		Exposure Cold or Heat	83%	37%
	Tobacco	1%	11%		Noise and Dust Exposure	43%	49%
	Other	51%	50%		Work 2 Meters in Air	32%	47%
					Fire Management	9%	29%
					None of the Above	2%	14%

Source: Encuesta Nacional de Jornaleros Agrícolas 2008-2009.

The main variable of interest is the worker's educational attainment. Clearly other factors that we are unable to control for in the analysis (parent's wealth, health, and innate intelligence) could influence both schooling and the likelihood of injury. Therefore, it is worth noting that our estimates are of correlation between schooling and injury. Future studies could use exogenous variation in educational attainment to test for causality. Our contribution is to examine if the hypothesis that schooling reduces injuries is supported by correlation between schooling and injury.

We include several predictor variables in our estimation of the influences on reported injuries. Equation 1 below shows each of the included independent variables. These variables can be broken down in to two types. The first includes individual characteristics such as age, education (years of schooling), and binary dummies for respondents who are indigenous or male. In addition, this group includes variables that control for internal and external migration. These are binary variables that equal one if true, i.e. the respondent is currently working in a state other than where they were live or has ever migrated to the United States.

(1)
$$
\begin{aligned}
Probility\ (injury) &= \beta_0 + \beta_1 Age + \beta_2 YearsEducation \\
&+ \beta_3 Indigenous + \beta_4 Male \\
&+ \beta_5 InternalMigrant + \beta_6 ExternalMigrant \\
&+ \alpha_i \sum_{i=1}^{16} Crop_i \\
&+ \alpha_{i+16} \sum_{i=1}^{9} Job_i + \alpha_{i+25} \sum_{i=1}^{8} Equipment_i \\
&+ \alpha_{i+33} \sum_{i=1}^{8} Conditions_i + \epsilon
\end{aligned}
$$

The second set of independent variables controls for the environment the respondent works in. Each respondent reported up to three crops they worked in with 15 potential choices and one category for other crops. We create 16 binary variables to control for each of those crops; since each respondent could report more than one crop we can include all of the binary variables. Next we control for nine potential types of jobs given that some jobs may be more dangerous than others as discussed in the previous section. The jornaleros could report working in more than one job. Additionally particular

types of equipment may be prone to injuries, e.g. ladders or cutting tools[7]; hence we included each of eight binary responses to types of equipment used. Finally we control for responses to eight questions on working conditions which include exposure to noise, heat and cold, and chemicals that could potential lead to an injury.

In a second model we break the years of education data into three dichotomous dummy variables (Primaria, Secondaria, High School), which equal one when the worker highest level of schooling is primaria (primary,1-6 years of school, 53% of the sample), secondaria (secondary,7-9 years, 23%), high school 10 or more years [8%]. The omitted category is no school [16%].

(2)
$$\begin{aligned} Probility\ (injury) &= \beta_0 + \beta_1 Age + \beta_2 Primaria + \beta_3 Secondaria \\ &+ \beta_4 HighSchool + \beta_5 Indigenous + \beta_6 Male \\ &+ \beta_7 InternalMigrant + \beta_8 ExternalMigrant \\ &+ \alpha_i \sum_{i=1}^{16} Crop_i \\ &+ \alpha_{i+16} \sum_{i=1}^{9} Job_i + \alpha_{i+25} \sum_{i=1}^{8} Equipment_i \\ &+ \alpha_{i+33} \sum_{i=1}^{8} Conditions_i + \epsilon \end{aligned}$$

4. Results

Our model estimates the effect of several types of independent variables; individual and the characteristics of the job such as crop, job, equipment used and working conditions. The main result we find is that additional education is associated with a reduction in the likelihood a respondent reports having experienced a work-related injury. We also identify crops, jobs and working conditions that are significantly correlated with the likelihood of a respondent reporting having experienced an injury. In particular working with tree crops more than two meters above the ground is associated with higher reports of injuries.

[7] It is possible that the condition of equipment can affect the likelihood of an injury, e.g. machinery in disrepair might lead to an accident. We do not, however, have data on this.

We begin by examining individual characteristics. It is important to keep in mind that around 9% of respondents reported having suffered a work-related injury. We find that in the first model shown in Table 3 an additional year of schooling at the mean number of years of schooling (5.2) is associated with a reduction in injuries of 0.4 percentage points[8]. In a second model we create binary variables for highest level of schooling attended, we find those who had attended high school experienced 4.6% fewer accidents, essentially half of the average. Those with middle or primary schooling saw a non-statistically significant decrease in accidents.

The worker's age was positively associated with reports of injuries, but not statistically significant (p-value =0.16) at the mean value. We attempted an additional model with age and age squared but it did not alter the results[9]. Turning to the several binary indicators of individual characteristics, the reported marginal coefficients are for a discrete change from X = 0 to X =1, i.e. comparing not having that characteristic to having it, calculated at the mean of the variable. For example the coefficient on indigenous respondents was 0.026 (P-value 0.07) which indicates that for two respondents who were equal in all other categories that the indigenous respondent would be 2.6 percentage points more likely to report having suffered an injury. This represents a nearly 30% increase in the reported injury rate of 9%. Those who migrated within Mexico reduced injuries by 5.2 percentage points and therefore had fewer than half the injuries of those who did not migrate. In the model we did not find being male had a statistically significant effect. If we drop crop, job and working conditions the marginal effect on being male is 5.4 percentage points and statistically significant at the 1% level suggesting males are 60% more likely than females to have injuries. The difference in results suggests males are more likely to choose dangerous jobs, crops or working conditions but once this is controlled for males and females have equal rates of injury.

We examine 15 potential crops and control for a category of other crops. Of the 15 crops 3 are found to be associated positively with injuries and 2 negatively with injuries. Sugar cane, coffee and oranges are associated with increases in potential injuries of 3.7, 4.9 and 8.5 percentage points respectively with sugar cane statistically significant at the 10% level and coffee and oranges at the 5% level. Mangos and green tomatoes were associated with a reduction of 3.9 and 2.9 percentage points in injuries, respectively. We reran the model using only individual and crop

[8] We also added a variable for literacy but controlling for other factors, it did not have a statistically significant effect.

[9] We also ran the model with state fixed effects for the workers state of residence and do not find that the results change substantially. These results are available upon request.

characteristics and obtained essentially the same results in terms of magnitude and sign.

Table 2
Marginal Effects of Probit on Injuries for Workers Age 18-65

Category	Independent Variable	Coefficient	Coefficient	Mean
Individual	Age	0.001	0.001	36.49
		(1.41)	(2.01)*	
	Years of Education	-0.004		5.16
		(2.34)*		
	High School		-0.046	0.09
			(3.37)**	
	Secondaria		-0.008	0.23
			(0.49)	
	Primaria		-0.013	0.53
			(0.94)	
	Indigenous	0.026	0.027	0.18
		(1.68)	(1.75)	
	Male	0.015	0.015	0.81
		(1.06)	(1.06)	
	Migrant in Mexico	-0.052	-0.050	0.14
		(5.27)**	(5.02)**	
	Migrant in Other Country	0.006	0.005	0.20
		(0.50)	(0.37)	
Crop	Sugar Cane	0.037	0.038	0.10
		(1.54)	(1.59)	
	Red Tomato	0.015	0.015	0.26
		(1.03)	(1.02)	
	Coffee	0.049	0.050	0.11
		(2.05)*	(2.08)*	
	Orange	0.085	0.079	0.08
		(2.66)**	(2.55)*	
	Mango	-0.039	-0.040	0.10
		(3.02)**	(3.15)**	
	Apple	-0.001	-0.002	0.08
		(0.07)	(0.11)	
	Squash	0.024	0.024	0.13
		(1.22)	(1.20)	
	Green Tomato	-0.029	-0.030	0.12
		(2.11)*	(2.16)*	
	Chile	-0.000	0.000	0.27
		(0.01)	(0.01)	
	Melon	0.004	0.004	0.12
		(0.25)	(0.23)	
	Grapes	0.029	0.027	0.10
		(1.31)	(1.26)	
	Peach	-0.005	-0.006	0.07
		(0.24)	(0.28)	
	Pineapple	0.029	0.033	0.01
		(0.60)	(0.65)	
	Banana	0.027	0.028	0.07
		(1.09)	(1.11)	
	Tobacco	0.080	0.081	0.01
		(1.21)	(1.22)	
	Other	0.009	0.008	0.51

Note: continues on next page.

Continued from previous page… Table 2
Marginal Effects of Probit on Injuries for Workers Age 18-65

Category	Independent Variable	Coefficient	Coefficient	Mean
Job	Fumigator	0.015	0.015	0.40
		(1.03)	(0.99)	
	Picker	-0.008	-0.007	0.89
		(0.44)	(0.36)	
	Foreman	-0.013	-0.014	0.09
		(0.86)	(0.91)	
	Packer	-0.025	-0.025	0.17
		(1.96)	(1.98)*	
	Driver	-0.008	-0.009	0.07
		(0.46)	(0.48)	
	Cook	0.035	0.039	0.02
		(0.76)	(0.83)	
	Animal Caretaker	0.030	0.031	0.08
		(1.41)	(1.46)	
	Loader	0.046	0.045	0.26
		(3.13)**	(3.07)**	
	Other	0.007	0.008	0.26
		(0.61)	(0.65)	
Equipment	Sharp Tools	0.009	0.010	0.80
		(0.56)	(0.58)	
	Fumigator Backpack	-0.022	-0.023	0.44
		(1.54)	(1.62)	
	Pump	0.003	0.003	0.18
		(0.19)	(0.19)	
	Tractor	0.012	0.011	0.16
		(0.76)	(0.71)	
	Packing Machine	-0.014	-0.014	0.09
		(0.78)	(0.79)	
	Ladders	0.015	0.013	0.29
		(1.01)	(0.92)	
	None	0.001	0.001	0.09
		(0.05)	(0.04)	
	Other	-0.023	-0.024	0.06
		(1.48)	(1.56)	
Conditions	Lift Heavy Items	-0.017	-0.016	0.69
		(1.34)	(1.30)	
	Time Bending Over	0.005	0.006	0.82
		(0.38)	(0.43)	
	Work where Chemicals Applied	0.008	0.009	0.55
		(0.74)	(0.82)	
	Exposure Cold or Heat	0.027	0.027	0.83
		(2.04)*	(2.02)*	
	Noise and Dust Exposure	0.030	0.030	0.43
		(2.58)**	(2.67)**	
	Work 2 Meters in Air	0.041	0.042	0.32
		(2.83)**	(2.93)**	
	Fire Management	0.066	0.067	0.09
		(2.90)**	(2.93)**	
	None of the Above	0.019	0.020	0.02
		(0.31)	(0.33)	
	N	2,548	2,548	

Note: t-statistics in parentheses below the coefficient. * $p<0.05$; ** $p<0.01$.

In terms of jobs only loaders were significantly and positively associated with increased injuries with a nearly 50% higher injury rate (marginal effect 4.6 percentage points). Consistent with the literature we found those who worked with animals were more likely to have reported injuries although the p-value is only 0.11. Packing agricultural goods was found to be the job negatively associated with injury rates, suggesting a relatively safe job.

We examined the working conditions and equipment used. Four types of conditions were associated with a greater likelihood of injury Exposure Cold or Heat, Noise and Dust Exposure, Work Two Meters in Air, Fire Management with increases of 2.7, 3.0, 4.1 and 6.6 percentage points, respectively. We obtain similar results in estimation with only individual and working conditions as independent variables. We did not find any statistically significant relationships with equipment. When we ran a regression with only individual and equipment we find that only the use of ladders increases the likelihood of experiencing an injury, which is consistent with the findings on oranges, a tree crop that requires ladders for picking, and our finding in terms of conditions.

There were two crops that had statistically significantly higher levels of accidents (Coffee and Oranges), one job (Loader) and three working conditions (Noise and Dust Exposure, Working Two Meters in the Air and Fire Management.) The model was re-estimated separately for only those with these characteristics and the results are presented in Table 3. Only the individual characteristics were used as independent variables in these regressions. Education did not have an effect for jornaleros working in coffee or oranges nor those who were loaders. When we examine the characteristics of the job, however, education does appear to reduce the probability of experiencing an accident for jornaleros who were exposed to noise and dust as well as those working two meters or more in the air, although not for those in fire management. This could mean that additional schooling enables workers to engage in safer practices when noise and dust exposure is present and for those working off the ground. This might be due being able to better understand safety instructions.

Table 3
Marginal Effects of Probit for Selected Groups

Variable	Coffee	Oranges	Loader	Noise	Height	Fire
Age	-0.001	0	0.002	0.000	-0.001	0.004
	(0.64)	(0.06)	(1.45)	(0.29)	(0.48)	(1.69)
Years of education	-0.003	-0.005	-0.004	-0.008	-0.009	-0.007
	(0.47)	(0.47)	(0.80)	(2.39)*	(2.35)*	(0.69)
Indigenous	0.046	-0.052	0.036	0.002	0.003	0.023
	(1.08)	(0.76)	(0.88)	(0.08)	(0.08)	(0.29)
Male	0.111	-0.238	-0.09	0.065	0.015	0.029
	(3.04)**	(1.52)	(1.07)	(3.07)**	(0.39)	(0.27)
Migrant in Mexico	-0.103	0.051	-0.109	-0.095	-0.093	0.003
	(2.49)*	(0.38)	(3.39)**	(4.88)**	(3.19)**	(0.03)
Migrant Other Country	0.034	0.022	-0.01	0.018	0.054	-0.02
	(0.50)	(0.30)	(0.28)	(0.71)	(1.62)	(0.33)
N	278	213	669	1,092	812	232

Note: t-statistics in parentheses below the coefficient. * $p<0.05$; ** $p<0.01$.

Conclusion

Agricultural work carries a substantially higher than average risk of on-the-job injuries. We examined whether higher levels of education among Mexican day laborers were associated with lower levels of injuries controlling for other characteristics of the workers and the jobs. We found that education reduced the probability of having had an injury. The sample was not a relatively well educated one with a mean level of education of only 5.2 years of schooling completed. Each additional year of schooling reduced the probability of having suffered an injury by 0.4 percentage points calculated at the mean for all variables. This translated into reducing the probability of having suffered an injury by 7.7 percent. As the education level of the population continues to increase, this should bode well for a reduction in the rate of injury rates. Education of respondents reflects the national trend of increasing education[10].

[10] In the sample respondents in their 20s have on average one year more of schooling than those in their 30s (6.4 vs. 5.4.) A similar difference is seen between those in their 40s, 50s and 60s with average number of years of school completed 4.5, 3.2, and 1.9 years respectively.

Males have higher injury rates than females but the effect is not statistically significant when we control for the crop, job, and equipment used and working conditions. This shows that the higher rates are due more to the aspects of the jobs males choose rather than their behavior within specific jobs. Those who are indigenous, as measured by speaking an indigenous language, have higher rates controlling for other factors. We cannot say if this is due to their schooling being of lower quality or perhaps being assigned worse jobs within each category or not being able to understand safety instruction but their injury rate is higher. Jornaleros working in a different state experienced lower injury rates by a rather substantial amount. This may be due to better workers migrating to make more money as a jornalero but the data does not allow us to state this with certainty.

We also found that some crops were associated with more work-related injuries including sugar cane, coffee and oranges. The only job that had a statistically significantly different level of injuries was the higher rate for loaders. None of the equipment variables had a statistically significant effect. Jornaleros who worked around noise and dust, worked two meters or more off the ground and were engaged in fire management were more likely to have experienced injuries with the effect being statistically significant at the 0.05 level and exposure to cold and heat at the 0.10 level. This indicates that certain conditions are associated with higher injury rates and would also lead to the possibility of engaging in efforts to reduce the injury rates for those experiencing these working conditions.

There is a long history of human capital studies that show the level of earnings as depending on the level of education. Our work shows that the level of education also impacts another aspect of compensation, the probability of experiencing a work-related injury for Mexican agricultural day laborers. Although we find that the crops (oranges, coffee and sugar care), jobs (loading) and conditions (noise and dust, working on ladders and fire management) that are most associate with injuries the main finding is that controlling for the characteristics of the worker and the job, increased levels of schooling can lead to lower injury rates. This suggests that Mexico's efforts through the conditional cash transfer program Oportunidades and other efforts to increase school enrollment may have the indirect benefit of lowering worker accidents. This would pose an interesting future research question to compare formal general public education increases to targeted education on preventing jornalero injuries.

References

Arcury, T. A., Estrada, J. M., and Quandt, S. A. (2010). "Overcoming language and literacy barriers in safety and health training of agricultural workers". *Journal of agromedicine*, *15*(3), 236-248.

Byler, C. (2013). "Hispanic/Latino Fatal Occupational Injury Rates". *Monthly Labor Review*, February 2013, 14-23.

Gerberich, S. G., Gibson, R. W., French L. R., Lee, T., Carr, W. P., Kochevar, L., Reinier, C. M. and Shutske, J. (1998) "Machinery-Related Injuries: Regional Rural Injury Study I (RRIS-I)". *Accident Analysis and Prevention*, 38(6), 793-804.

Gyekye, S. A., and Salminen, S. (2009). "Educational status and organizational safety climate: Does educational attainment influence workers' perceptions of workplace safety?". *Safety Science*, *47*(1), 20-28.

Gundacker, C., and Gundacker, N. (2011). "An exploratory pilot study of childhood injuries on cattle farms in Jalisco, Mexico". *Journal of agromedicine*, *16*(3), 226-232.

Hansen, C. P. (1989). "A causal model of the relationship among accidents, biodata, personality and cognitive factors". *Journal of Applied Psychology*, 74, 81–90.

Hard, D. L, Myers, J. R. and Gerberich, S. G. (2001) "Traumatic Injuries in Agriculture" National Agricultural Safety Database http://nasdonline.org/document/1837/d001773/traumatic-injuries-in-agriculture.html.

Iverson, R.D., Erwin, P.J. (1997). Predicting occupational injury: the role of affectivity. *Journal of Occupational and Organizational Psychology*, 70, 113–128.

McCurdy, S. A. and Carroll, D. J. (2000). "Agricultural Injury". *American Journal of Industrial Medicine*, 38(4), 463-480.

McCurdy, S. A., Samuels, S. J., Carroll, D. J. Beaumont, J. J. and Morrin, L. A. (2003). "Agricultural Injury in California Migrant Hispanic Farm Workers". *American Journal of Industrial Medicine*, 44(3), 225-235.

Orrenius, P. M., and Zavodny, M. (2009). "Do immigrants work in riskier jobs?". *Demography*, *46*(3), 535-551.

Purschwitz, M.A. (2004). Health and Safety of Personnel in Agriculture. In McNulty, P and Grace, P. (Eds.), *Agricultural Mechanization and Automation*, Volume II. In Encyclopedia of Life Support Systems.

Schultz, T. P. (2005). Productive benefits of health: Evidence from low-income countries. In López-Casasnovas, G., Rivera, B. and Currais, B. (Eds), *Health and Economic Growth: Findings and Policy Implications* (257-286). Cambridge MA: MIT Press.

Schultz, T. P. (1999). "Health and schooling investments in Africa". *The Journal of Economic Perspectives*, 67-88.

Shipp, E. M., Cooper, S. P., del Junco, D.J., Delcos, G. L., Burau, K. D., Tortolero, S. and Whitworth, R. E. (2009). "Chronic Back Pain and Associated Work and Non-Work Variables from Starr County, Texas". *Journal of* Agromedicine, 14(1), 22-32.

Strauss, J. (1986). "Does better nutrition raise farm productivity?". *The Journal of Political Economy*, 94(2), 297-320.

Wang, S., Myers, J. R. and Layne, L. A. (2011). "Injuries to Hired Crop Workers in the United States – A Descriptive Analysis of a National Probability Survey". *American Journal of Industrial Medicine*, 54(10), 734-747.

Yu, W., Yu, I. T., Li, Z., Wang, X., Sun, T., Lin, H., Wan, S., Qiu, H., and Xie, S. (2012)."Work-related injuries and musculoskeletal disorders among factory workers in a major city of China". *Accident Analysis & Prevention*, *48*, 457-463.