ABSTRACT

Farming is one of the most hazardous professions. Several studies of farm workers have identified various risk factors associated with injuries and illnesses in several farm worker populations, but few studies have focused on Hispanic migrant farm workers. This study analyzed farm worker employment data and agricultural injury and illness incidence data using Poisson regression to determine if an association exists between the number of Hispanic migrant farm workers and agricultural injury and illness incidence in North Carolina between 1992 and 2001. No significant association was found between the number of these workers and the injury and illness incidence rate. There may be problems with full and accurate reporting of injuries and illnesses in the Hispanic migrant farm worker population. More representative injury and illness data is needed for further analysis.
ACKNOWLEDGEMENTS

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<thead>
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<th>Abbreviation</th>
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<tbody>
<tr>
<td>BLS</td>
<td>Bureau of Labor Statistics</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control</td>
</tr>
<tr>
<td>CI</td>
<td>confidence interval</td>
</tr>
<tr>
<td>DOA</td>
<td>Department of Agriculture</td>
</tr>
<tr>
<td>DOL</td>
<td>Department of Labor</td>
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<tr>
<td>ESC</td>
<td>Employment Security Commission</td>
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<td>IRR</td>
<td>incidence rate ratio</td>
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<tr>
<td>NC</td>
<td>North Carolina</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute for Occupational Safety and Health</td>
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<tr>
<td>OR</td>
<td>odds ratio</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
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<tr>
<td>RR</td>
<td>risk ratio</td>
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<tr>
<td>SE</td>
<td>standard error</td>
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1. Introduction

Agriculture is considered to be one of the most hazardous industries in the United States (NIOSH, 2004; Fenske and Simcox, 2000). Agricultural work, which is physically demanding, puts workers at risk for injuries such as sprains, strains, and dislocations, and illnesses including a wide variety of cancers (McCurdy et al., 2003; Mills and Kwong, 2001). Additionally, workers are exposed to hazards including machinery, electricity, and chemical compounds. Poverty, lack of access to healthcare, and seasonal migration also contribute to increased risk of injuries and illnesses (OSHA, 2004).

Hispanic migrant workers are an important source of labor for the agricultural industry because of their willingness to work in challenging environments for low wages. In North Carolina, their labor is essential for the planting, tending, and harvesting of crops such as tobacco, sweet potatoes, cucumbers, apples, and Christmas trees. Nearly three-quarters of farmworkers in the United States earned less than $10,000 per year (Mehta et al., 2000). In North Carolina, Hispanic migrant workers comprised 35% of the total farm worker population in 2002; a figure that increased from 15% in 1988 (NC ESC, 2003). Including dependents, North Carolina’s farm worker population exceeds 200,000, ranking fifth largest in the United States (Mehta et al., 2000).

Prior studies on agricultural injuries and illnesses have not typically focused on Hispanic migrant workers (McCurdy and Carroll, 2000). This population is difficult to study due to workers’ poor English skills and the fact that agricultural activities are
dispersed over a wide geographic area and change seasonally. Furthermore, agriculture is exempt from many occupational safety and health regulations (McCurdy and Carroll, 2000). Prior research has focused on African-American farm workers and farm owners (McGwin et al., 2000; Lyman et al., 1999) or populations comprised of white family farmers (Lewis et al., 1998). In these studies, various demographic, medical, and personal risk factors associated with farm worker injury were identified.

In a previous study of agricultural injuries in California where only Hispanic migrant workers living in state-operated housing were included, an agricultural injury risk comparable to that seen in other large-scale studies of agricultural workers was observed (McCurdy et al., 2003). However, the authors conceded that it is likely that the true injury risk of Hispanic migrant farm workers is higher, because the study population was not broadly representative of the all Hispanic migrant farm workers.

Risk factors associated with illness have also been studied (Elmore and Arcury, 2001; Mills and Kwong, 2001). Mills and Kwong (2001) found that the risk of certain cancers was elevated in Hispanic farm workers in California relative to the entire Hispanic population in California. Unlike injuries, which result from a single event or exposure, illnesses usually develop over a longer period of time and are multifactorial in nature as a variety of factors can contribute to the development of illness. Therefore, the relationship between exposure and the illness is often less clear. As a result, illnesses are believed to be underreported (BLS, 2003).

As described above, the literature suggests that an increased number of Hispanic migrant farm workers in the workforce may be associated with a higher injury and illness incidence rate. It is also suggested that although Hispanic migrant workers may be in fact
at greater risk for injuries and illnesses, they are reluctant to seek medical care in the United States (Latino Health Task Force, 2003; Villarejo, 2003). Therefore, the reported injury and illness incidence rate likely would be underestimated. The purpose of this study was to investigate if, in fact, there is a relationship between the number of Hispanic migrant workers and agricultural injury and illness incidence rates in North Carolina between 1992-2001.
II. Background

While considerable information exists about the demographic characteristics of agricultural workers as a whole, less is known about the Hispanic sector in particular. In the 1997-1998 National Agricultural Workers Survey, for which data was collected through a nationwide, random survey of workers in perishable crop agriculture, half of all farm workers were reported to be under 29 years of age (Mehta et al., 2000). The median number of years of schooling among these workers was six, and just 10% of foreign-born farm workers read or spoke English fluently. Nineteen percent of farm workers were employed by farm labor contractors, who serve as intermediaries between the farmer and farm worker, and are responsible for hiring, firing, and supervising the workers. Three-quarters of farm workers were paid by the hour; the rest were paid piece-rate. Employer-provided health insurance covered fewer than five percent of workers.

Villarejo (2003) discussed the difficulties associated with accurately measuring the health status of Mexican-born farm workers, as an unknown yet presumably large share of these workers return to Mexico at the end of each growing season. Many workers may receive health care in their homeland, where their conditions are unlikely to be reported to their employers. Since many injuries and illness are not reported to farm workers’ employers, they are never reported to the Occupational Safety and Health Administration (OSHA). Villarejo pointed out that many hired farm workers who reside in the United States seek medical care only when it is absolutely necessary, visiting
community clinics or hospital emergency rooms. The lack of health insurance, along with cultural and language barriers, discourage many farm workers from seeking medical care in the United States.

Buescher (2003) reviewed available data to assess the health status of the Latino population in North Carolina. Data from the Chief Medical Examiner’s Office from 1996-2000 showed that more than 45% of Latinos age 15 and older, who died from unintentional injuries, such as motor vehicle and workplace injuries, and were tested for alcohol, had a blood alcohol concentration of 0.08 mg/dL or higher. Nearly 31% of Latinos had a very high blood alcohol concentration (more than twice the legal limit of 0.08 mg/dL), compared to 18% of whites and African-Americans. Data from the Centers for Disease Control (CDC) sponsored Behavioral Risk Factor Surveillance System from 1997-2002 indicated that 19% of Spanish-speaking Latinos had consumed five or more drinks in one sitting in the past month, compared with 10% of white and 7.7% of African-Americans. However, this survey was conducted via telephone, thereby excluding the Latino population without telephone service.

The report of the North Carolina Latino Health Task Force (2003) provides an overview on the health of Latinos in North Carolina and explains that fatalism may play a major role in deterring Latinos from getting medical attention. Some Latinos may believe that injuries and illnesses are caused by the evil done to one by another. This report points out that Latinos feel that an individual is often not accountable for matters of health and well being, that there is little that can be done to prevent harm. Additionally, the report discusses how many Latinos are reluctant to seek health care in the United States because they believe health care professionals are insensitive to feelings
of embarrassment associated with being attended by a professional of the opposite gender or undergoing medical tests that compromise personal privacy.

The hazardous nature of agriculture has been examined in numerous studies reviewed by McCurdy and Carroll (2000). These authors point out that most epidemiological studies of agricultural injuries involve family farmers and that few data address the impact of race or ethnicity on injuries and illnesses. McCurdy and Carroll also discuss the need for continued research in the area, including the identification of high-risk groups and injury risk factors.

Lewis et al. (1998) conducted a study that examined risk factors and agricultural injuries in Iowa family farmers. Their research found that a younger age, a work-limiting health problem, exposure to chemicals, and working on someone else’s farm were all significantly associated with injury. In this study, safety training had no significant effect on injury outcome. However, the response rate of the study was only 39.4% and the study was subject to recall bias. Additionally, only white farmers responded to the survey.

Lyman et al. (1999) conducted a study to determine what factors are associated with increased risk of agricultural injury for white owner/operators, African-American owner/operators, and African-American workers in Alabama and Mississippi. This prospective study also provided information about the racial distribution and prevalence of prior agricultural injuries in the study population. Data were collected using questionnaires sent to 1,310 farmers in rural counties with a large African-American population. Farmers and farm workers were identified by a database maintained by the
Alabama and Mississippi Agricultural Statistics Services, and other owner/operators and workers were recruited through county agricultural agents and farm associations.

The Lyman et al. (1999) study found several factors, such as tractor use, highly mechanized farming operations, and alcohol consumption were associated with prior injury in white owner/operators. For African-American owner/operators, being fatigued while farming was associated with prior injury. For African-American workers, carefulness about safety and alcohol consumption were associated with prior injury, although the association between alcohol consumption and prior injury did not follow a linear trend. Also, African-American workers were more likely to report injuries requiring medical attention or hospitalization. However, since the study period was the farmers' and farm workers' entire career, not just a more recent period, a recall bias may be present in this study.

McGwin et al. (2000) re-analyzed the data collected in the Lyman et al. (1999) study to examine risk factors for African-American farm workers more closely. They observed that injury rates were 2.9 times (95% confidence interval (CI)= 2.0-4.3) higher for African-American farm workers compared to African-American owners and Caucasian owners. African-American farm workers were less well educated, significantly younger, and less likely to have a chronic medical condition than African-American or Caucasian owners. Additionally, African-American workers had a significantly higher alcohol consumption rate than both African-American and Caucasian owners. Results of this study supported the finding of the study by Lewis et al. (1998) that those who work on farms owned by others are at increased risk for injury. However, the African-American farm workers who participated in this study were not selected in a manner
similar to farm owners and may not be representative of African-American farm workers in Alabama and Mississippi.

McCurdy et al. (2003) studied agricultural injury in Hispanic migrant farm workers, who were residing at state-administered Migrant Housing Centers in California. An initial questionnaire and subsequent follow-up survey collected data on occupational history, health habits and status, and demographic characteristics. The injury risk for workers in the study population was comparable to the risk for workers in other large-scale studies of farm workers. For females, being paid piece-rate was associated with increased injury risk.

The findings in the McCurdy et al. (2000) study should be considered in light of the fact that the study population consisted solely of workers residing at Migrant Housing Centers, where residents are limited to farm workers and their families. These families are usually able to find employment and housing in advance and remain in these Centers for an extended period of time. Therefore, single workers and workers with more itinerant habits, who may have different injury risks, were excluded from the study population.

In addition to these large-scale studies on farm workers described above, other studies have examined specific risk factors in the farm worker population. Stallones and Xiang (2003) assessed the role of alcohol consumption on the occurrence of agricultural injuries. The study population consisted of a random sample of farmers who have a farm truck registered in the state and who earn more than half of his or her income from farming. Telephone interviews were administered to gather information about
demographic characteristics, health status, and risk factors, including alcohol consumption. Data for this study were collected over a period of three years.

Stallones and Xiang (2003) concluded that both frequency and amount of alcohol consumed per sitting were significantly associated with increased risk of agricultural injury. Farm residents who drank three or more drinks per day had a farm work injury rate of 3.62 per 10,000 person-days (95% CI= 2.38-4.85), compared to an injury rate of 3.02 per 10,000 person-days for residents who drank one to two drinks per day (95% CI= 2.44-3.60). Non-drinkers had an injury rate of 1.94 per 10,000 person-days (95% CI= 1.51-2.37). Injury rates were highest for farm residents who worked 50 to 149 days annually off of the farm, 3.96 per 10,000 person-days (95% CI= 2.61-5.31). Also, younger farm residents, 39 years of age and fewer, had higher injury rates, 3.70 per 10,000 person-days (95% CI= 2.86-4.53). However, most of the study population was white and only included subjects identified as farm operators and not farm workers. Since there may be differences in patterns of alcohol consumption between farm operators and farm workers, the findings of this study may not necessarily be applicable to farm workers.

The cost of health care appears to deter many in the Hispanic population from seeking medical attention, even something as fundamental as routine health screenings. Skaer et al. (1996) conducted a randomized intervention trial in Washington State to determine how the cost of mammograms influences Hispanic women’s obtaining one. Women in the control group received information on the benefits of having a mammogram. Women in the intervention group received the same education but also were given a voucher for a free mammogram. Over 17% of controls received a
mammogram, compared to 87% of women in the intervention group. Women receiving vouchers were 47 times more likely to obtain a mammogram than the control group. Therefore, financial obstacles appear to be a determinant of health screening among Hispanic women.

Although North Carolina has a substantial migrant population, there is a paucity of research on migrant farm worker injuries in the state. Ciesielski et al. (1991) conducted a cross-sectional study of 287 workers in randomly selected migrant camps in North Carolina. Data on the cause, type, and treatment for injuries suffered during the past three years and demographics were collected. Among injured workers who thought medical treatment was necessary, 41% did not receive treatment within 24 hours, and 24% never received medical care. Lack of transportation or employer refusal prevented 24% from receiving care within 24 hours. The employer paid for medical expenses in 38% of cases. The study concluded that workers' belief that they cannot be absent from work is an important reason in their not seeking medical attention.

There is small, but growing, literature on illnesses caused by farm work. Elmore and Arcury (2001) interviewed twenty male Hispanic seasonal farm workers in the North Carolina Christmas tree industry to assess the knowledge of these workers as it pertained to pesticide exposure. Most workers believed that pesticides were harmful, although their responses varied as to how harmful pesticides could be. Several respondents reported feeling ill as a result of pesticide exposure but none ever sought medical attention, since they seriously doubted that their employers would provide assistance in securing treatment.
Mills and Kwong (2001) examined cancer incidence in workers belonging to a largely Hispanic farm worker labor union in California for the years 1987-1997. A roster of union members was electronically linked to the California Cancer Registry, which identified members diagnosed with cancer. California Hispanics diagnosed with cancer served as the reference population. Odds ratios were significantly elevated for leukemia (OR= 1.59, 95% CI= 1.07-2.37), stomach cancer (OR= 1.69, 95% CI= 1.24-2.27), and cervical cancer (OR= 1.63, 95% CI= 1.11-2.44). The odds ratio for brain cancer was also elevated but was not significant (OR= 1.57, 95% CI= 0.96-2.53). Additionally, the stage of cancer was more advanced at the time of diagnosis in union members than in the California Hispanic population as a whole. Therefore, there are likely a large number of cancer cases present in the population that have not yet been diagnosed. These findings suggest that the agricultural injury and illness incidence reported by the BLS is likely less than the true rate.

In summary, previous research on farm worker injuries and illnesses suggest that Hispanic migrant farm workers are at increased risk for experiencing agricultural injuries and illnesses. Risk factors, such as high alcohol consumption, low levels of education, and working on others’ farms, among others, imply higher injury and illness incidence. However, other studies indicate that while these workers may be at higher risk for injuries and illnesses, they are reluctant to seek out medical care in the United States because of their belief that they have to work, the cost of medical care, lack of transportation, and cultural differences in the medical community. Consequently, many ailments that befall Hispanic migrant workers may go undiagnosed and unreported to the proper authorities. In reality, the reported injury and illness incidence rate may be less
than the true rate. This study examined employment and injury data to determine what association exists between the number of Hispanic migrant farm workers and the injury and illness incidence rate in the agricultural production sector.
III. Materials and Methods

A. Study Population

Farm worker employment data was obtained from the North Carolina Employment Security Commission (ESC). Labor economists provided estimates on changes in farm worker employment by examining current county level trends in the farm worker labor market relative to the previous year’s. Farm workers were assigned to one of four categories: seasonal, Hispanic migrant, non-Hispanic migrant, and year round. Estimates for each of these categories from the previous year are then adjusted accordingly. The agency compiles these estimates for every county in North Carolina on an annual basis.

Figures for H-2A workers were also collected. An H-2A farm worker is a foreign worker who has received an H-2A visa, allowing the worker to perform farm work in the United States for a fixed period of a year, renewable for up to three years. No estimation is required in enumerating these workers because they are registered with the United States government. The vast majority of H-2A workers are from Mexico, and their employment conditions are significantly different from other Hispanic farm workers because their employers are required to furnish Workers’ Compensation insurance, transportation to and from the worker’s temporary home, and housing that is periodically inspected by the government. Because of these major differences, H-2A workers were not included in the same category as with other Hispanic workers in the data analysis.
The ESC defines a seasonal farm worker to be one who, during the preceding twelve months, met all of the following guidelines: (1) worked at least twenty-five days during which some farm work was performed, (2) earned at least half of his or her income from farm work, (3) was not employed year round by the same employer doing farm work, (4) and was not a full-time student. A Hispanic migrant farm worker is one of Hispanic descent, who meets the first three guidelines listed above and whose farm work required travel such that he or she was unable to return to his or her permanent residence in the same day. A migrant farm worker of a race other than Hispanic was considered a non-Hispanic migrant worker. Full-time students traveling in groups other than their families were excluded. A person who worked at least 1750 hours per year was considered a year round farm worker (NC ESC, 2003).

B. Injury and Illness Data

The North Carolina Department of Labor (DOL), in conjunction with the United States Bureau of Labor Statistics (BLS), supplied injury and illness incidence rate data for the agricultural production sector. The agricultural production sector encompasses only those crop-producing farms with ten or more full or part-time employees at any one time during the previous calendar year. Such farms are mandated to submit information, including the type of work that the farm engages in, the number of farm workers, the number of hours worked by these farm workers, and the number of recordable injuries and illnesses, to OSHA on an annual basis.

OSHA regulations define a recordable injury as a loss of consciousness, restriction of work or motion, transfer to another job, or any medical treatment beyond first aid. An injury results from a single instantaneous exposure or single work-related
event. OSHA regulations define a recordable illness as a disorder resulting from factors associated with employment. An occupational illness includes both acute and chronic illnesses that may be caused by absorption, ingestion, inhalation, or direct contact (OSHA, 2004).

BLS analyzes the reported injury and illness data and publishes injury and illness incidence rates for the entire agricultural production sector, expressed as the number of total cases per 100 full-time workers. The figures are published annually, except in years which there are a limited number of responses or the reliability of the data is in question. For this study, injury and illness incidence data for the years 1994 and 1999 were missing. Figures for all other years between 1992 and 2001 were available.

C. Statistical Analysis

Statistical analyses of the data were conducted using SPSS software (SPSS Incorporated, Chicago, IL). The injury and illness incidence data were assumed to have a Poisson distribution. Consequently, Poisson regression analysis was employed because this type of analysis is often used to model counts of particular events in a given period of time (Frome, 1983; Kleinbaum et al., 1998). Coefficients were estimated for Equation 1:

\[
\ln \text{(incidence)} = \beta_0 + \beta_1 \text{(Hispanic migrant)} + \beta_2 \text{(seasonal)} + \beta_3 \text{(other)} + \beta_4 \text{(year)}
\]

where \( \ln \) is the natural logarithm, the terms \( \text{Hispanic migrant} \) and \( \text{seasonal} \) refer to the number of thousands of workers in that population, as classified by the ESC. The \( \text{other} \) group includes all non-Hispanic migrant, all non-seasonal, and all H-2A farm workers combined. The \( \text{year} \) term refers to the year between 1992 and 2001.
The term \( \beta_0 \) refers to the natural logarithm of the injury and illness incidence rate when the values of the various farm worker populations are at their reference levels, which is the number of workers employed in each sector in 1992. The coefficients \( \beta_1, \beta_2, \) and \( \beta_3 \) refer to the change in the natural logarithm of the incidence per change in the number of thousand workers in the corresponding sector. The coefficient \( \beta_4 \) refers to the change in the natural logarithm of incidence per change in year.

The coefficients resulting from regression analysis were then exponentiated according to the expression \( e^{(\beta n)} \), where \( n \) refers to the coefficient for the population of either *Hispanic migrant, seasonal, or other* sector or *year*. This term represents the incidence rate ratio (IRR). The IRR for the worker population terms is the change in injury and illness incidence per change in the number of thousand workers in the corresponding worker population, adjusted for the other worker populations. Similarly, the IRR for time represents the change in injury and illness incidence per change in year. Confidence intervals of the incidence rate ratio at the 95% levels were calculated according to Equation 2:

\[
CI = e^{(\beta n + z*se(\beta n))}
\]

where \( z \) represents the appropriate \( z \)-value of the 95% level of confidence and \( se(\beta n) \) represents the standard error of the estimate of \( \beta n \).
IV. Results

Farm worker employment data is summarized in Figure 1. Although this study focused on years 1992-2001, employment data for the years 1988-2002 are shown to illustrate long-term trends in farm worker employment.

![NC Farm Worker Population, 1988-2002](image_url)

**Figure 1. NC Farm Worker Population, 1988-2002**

The overall farm worker population declined by approximately one-third between 1988 and 2002. The number of Hispanic migrant workers increased from about 23,000 in 1988 to nearly 39,000 in 2002, a 35% increase, and the number of seasonal farm workers fell by 60%, from nearly 100,000 to 40,000, over this time period. Yet the number of other workers, which consists of the total number of non-Hispanic migrant farm workers,
year-round farm workers, and H-2A farm workers, remained fairly constant, at about 30,000 each year.

Injury and illness incidence rate data is summarized in Figure 2. Although figures for 1994 and 1999 were not available, the incidence rate fell from 18.3 cases per 100 full-time workers in 1992 to 3.8 cases per 100 full-time workers in 2001.

![Injury and Illness Incidence Rate, Agricultural Production Sector, 1992-2001](image)

Figure 2. Injury and Illness Incidence Rate, Agricultural Production Sector, 1992-2001.

Poisson regression analysis of the model is summarized in Table 1.

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>( \beta )</th>
<th>se(( \beta ))</th>
<th>IRR (( e^{(\beta)} ))</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.998</td>
<td>4.816</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Hispanic Migrant</td>
<td>-0.005</td>
<td>0.181</td>
<td>0.995</td>
<td>(0.700, 1.414)</td>
</tr>
<tr>
<td>Seasonal</td>
<td>0.022</td>
<td>0.050</td>
<td>1.022</td>
<td>(0.928, 1.127)</td>
</tr>
<tr>
<td>Other</td>
<td>0.082</td>
<td>0.091</td>
<td>1.085</td>
<td>(0.910, 1.295)</td>
</tr>
<tr>
<td>Time</td>
<td>-0.107</td>
<td>0.351</td>
<td>0.899</td>
<td>(0.454, 1.777)</td>
</tr>
</tbody>
</table>
The IRR for *Hispanic migrant* indicates that for every thousand worker increase in the number of these workers, injury and illness incidence declined by 0.5%. For *seasonal* workers, injury and illness incidence increased by 2.2% for every thousand worker increase in the population. For *other* workers, which include H-2A workers, year round workers, and non-Hispanic migrants, injury and illness incidence increased 8.5% for every thousand worker increase in this population. The IRR for the *year* term indicates that injury and illness declined approximately 10% per year. None of the coefficients for the worker populations is significant. The IRR and corresponding confidence interval for the intercept were not calculated because their interpretations are not meaningful.

Poisson regression analysis was conducted on a model that added an interaction term between *year* and *Hispanic migrant* to Equation 1. The signs of a couple of coefficients estimated using this new model were not in agreement with those coefficients described in the above table. The coefficient for the time term indicated that injury and illness incidence increased by nearly 10% per year, a figure that is not supported by the data as shown in Figure 2. Additionally, the coefficient for the Hispanic migrant term was positive. None of the coefficients estimated for this model was significant.
V. Discussion

This study fails to support that an association exists between the number of Hispanic migrant farm workers is associated with the reported injury and illness incidence rate in the agricultural production sector. The 95% CI of the IRR of the Hispanic migrant term contains 1, meaning that there is no significant association between the number of these workers and the injury and illness incidence rate. An IRR greater than 1 means that there is a significant positive association between these quantities. Inversely, an IRR less than 1 means that there is a significant negative association between the number of workers in a particular sector and the incidence rate. The CIs of all coefficients contain 1, indicating that they are not significantly different from each other.

The observed decline in the overall injury and illness incidence rate is at odds with a recent study that examined fatal agricultural injuries in North Carolina from 1977 to 1991. Richardson et al. (1997) reviewed all fatal agricultural injuries during this period, using death certificates and medical examiner reports to collect data on the decedents' race, age, means of injury, and occupation, among others. They observed that the rate of fatal injury among African-American farmers increased 14.7% per year, while it rose 1.8% per year among Caucasian farmers. There were no cases involving Hispanic workers to include in this study.
The fatal injuries described by Richardson et al. (1997) should be considered both in deriving estimates for fatality rates but also as sentinel events, indicating hazardous work conditions that may play an important role in non-fatal injuries. Unlike data provided by farming operations that only employ ten or more full-time workers used to generate agricultural injury and illness incidence rates by the BLS, the data from medical examiner reports and death certificates used to generate fatal agricultural injury rates are based upon all farming operations, regardless of size. The findings of the Richardson et al. (1997) suggest that if a broader spectrum of farming operations were utilized to derive estimates of injury and illness incidence rates, these estimates would likely be higher.

Studies by Lyman et al. (1999) and by McGwin et al. (2000) indicate that African-American farm workers employed by farms larger than 200 acres are at higher risk for agricultural injury (RR= 1.37 and 3.2, respectively for each study). African-American farm workers residing in the study area and Hispanic migrant farm workers likely experience similar socioeconomic marginalization because African-Americans in Alabama and Mississippi and Hispanic migrant workers in North Carolina fill similar low-end, low wage agricultural jobs. As a result, the injury risk ratios of these groups may be comparable.

Since the trend of farm consolidation described by Richardson et al. (1997) has continued (NC DOA, 2003), and the number of migrant farm workers has increased during this period, it would be expected that the reported injury and illness incidence rate would increase, but this is not the case. It is difficult to determine the proportion of farms larger than 200 acres that employ more than ten full-time workers at any time during the year, but it is likely that most such farms of this size employ more than ten full-time
workers. The fact that an increase in the injury and illness incidence rate was not observed suggests that injuries may not be fully reported.

In many occupations, Workers' Compensation plays an important role in paying the costs associated with a work-related injury. Employers who utilize Workers' Compensation for their employees have an incentive to keep their operations as safe as possible, since premiums are based on the size and type of operations, and the claims filed. In North Carolina, only employers who regularly employ ten or more full-time workers are required to provide coverage. Since the number of farms in North Carolina employing ten or more full-time workers has likely increased during recent years, the growing presence of Workers' Compensation may partly explain the decline in injury and illness incidence rates during this same period. With the bottom line affected by the cost of their Workers' Compensation premium, farm operators are more likely to implement measures to make their farms safer, thereby reducing the number of claims filed and the cost of their premium.

The data used in this analysis have several major shortcomings. As was mentioned earlier, OSHA requires only farms that employ ten or more full-time employees to report injuries and illnesses. Although it is impossible to determine exactly how many North Carolina farms employ less than ten full-time workers, the NC DOL estimates that most North Carolina farms are small operations. Etherton et al. (1991) estimated that 89% of farms in the United States employ fewer than ten full-time workers. Consequently, estimates for injury and illness incidence rate are based on just a small percentage of farms. Also, since BLS only publishes state wide figures for injury and illness incidence, county-level analysis of the association between farm worker
populations and incidence was not possible. The fact that injury and illness incidence data are not published by ethnicity poses other problems, preventing the focused analysis of incidence in specific populations.

The underreporting of illnesses and injuries, particularly illnesses, by the Hispanic population is problematic. As discussed earlier, many in the Hispanic community are reluctant to seek medical attention in the United States. Data on injury and illness claims made by H-2A workers were obtained from the North Carolina Growers Association, a large farm labor broker. Of the 92 reported injury and illness claims from January 2003 to December 2003, 87 claims were for injuries and just 5 were for illnesses (NCGA, 2003). These data indicates that injuries are reported far more frequently than illnesses.

There is also considerable difficulty in accurately counting the number of farm workers. The ESC lacks the resources to conduct primary research directly with farm workers, so instead they must utilize secondary sources to provide estimates for the number of workers in these populations. The population estimates for a particular year are based in part on the estimates from the previous year, so there is potential for bias in these estimates.

Despite the fact that the ESC employs secondary data to derive its farm worker population estimates, their results are in agreement with a study that utilized more sources to determine the number of farm workers in these populations. Larson (2000) conducted an enumeration study of migrant and seasonal farm worker populations for the Migrant Health Program of the United States Department of Health and Human Services. To derive its estimates, this study produced estimates for the number of farm workers by using a broader spectrum of organizations and agencies that have contact with these
workers than the ESC. Such organizations and agencies included migrant head start programs, grower associations, primary care associations, and the state Departments of Agriculture, Labor, and Health and Human Services. Even though data for this study were drawn from a greater number of sources, its estimates are in agreement with those from the ESC. This agreement suggests that although the data from the ESC is not perfect, it is reasonably accurate.

Factors other than the number of type of farm worker also have an impact on the injury and illness incidence rate. Such factors may include: farm worker unemployment rate, prevailing weather conditions, and OSHA enforcement of regulations. A low farm worker unemployment rate may be associated with an increased injury and illness incidence rate because certain necessary farm worker jobs may go unfilled, resulting in overexertion by other farm workers. An unseasonably hot growing season is likely to coincide with an increased injury and illness incidence rate because of heat stress. Stricter enforcement of regulations from year to year is likely correlated with a decreased incidence rate. However, it is difficult to account for these factors in the model tested by this study. Since so few years of data were available, stratifying based on these factors is not possible.
VI. Conclusions

While the data show no significant association between the number of Hispanic migrant workers and the observed injury and illness incidence rate, the lack of injury and illness data for workers on small farms limits the conclusions that can be drawn from this study. Previous research suggests that an increase in the number of Hispanic migrant farm workers should be significantly associated with an increase in the injury and illness incidence rate. Clearly, there is a need for better, more representative injury and illness incidence data for the population of farm workers.

One way to gather such data is for the North Carolina General Assembly to mandate Workers' Compensation for all farm workers, or at least for farms employing three or more workers, as in general industry. Aside from the obvious benefits of helping to protect the health and finances of these workers, such a program would provide better data on the injuries and illnesses that befall all farm workers, not just those who work on farms that employ ten or more full-time workers. In 2003, Senate Bill 632, which mandated Workers’ Compensation for farms that employed three or more full-time workers, was introduced but not passed.

Additionally, OSHA regulation of farms that employ less than ten full-time workers would likely result in decreased injury and illness incidence rates, while simultaneously providing more data on injuries and illnesses of farm workers who are employed by smaller farms. Gray and Scholz (1993) conducted a study involving
manufacturing plants that found a significant decline in workplace injuries associated with OSHA inspections. For inspections that result in a penalty being imposed, the effects continued for up to three years after the inspection. Similar effects are likely to be experienced if OSHA were to begin regulating farms that employ three or more workers.

County level analysis of the association between injury and illness incidence and employment would permit a greater understanding of local trends. Currently, the injury and illness incidence rates reported by BLS are available only at the state level, although farm worker employment by county is available. Certain counties in North Carolina employ upwards of 3300 Hispanic migrant farm workers annually, while many others employ fewer than 100 of these workers. Analyzing local trends would allow researchers and government officials to determine what problems and successes there are in specific counties within the state and make appropriate policy changes.

Similarly, injury and illness incidence data for specific farm worker populations would be useful. The injury and illness data used in this study is for the aggregate of all farm workers. OSHA should consider requiring farms to submit information on the race of their employees and their county of operation in their annual reports to OSHA. Such requirements would allow increased surveillance of injuries within specific farm worker populations.
VII. References


North Carolina Department of Labor, Safety and Health Survey Section. 2000 Occupational Injuries and Illnesses in North Carolina.


