FACTORS CONTRIBUTING TO ETHNIC INJURY DISPARITIES IN CONSTRUCTION INDUSTRY: A STUDY OF PERCEIVED SAFETY CLIMATE, OCCUPATIONAL INJURIES, AND OCCUPATIONAL FATALITIES IN THE SOUTHEASTERN UNITED STATES

by

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(Under the Direction of Sara W. Robb)

ABSTRACT

**Introduction:** The construction industry has the highest burden of occupational fatalities in the United States of all industries and Hispanic workers are disproportionately affected. **Methods:** Perceived safety climate surveys (n=179) were administered in Athens, Georgia (GA), at local construction sites and home improvement stores and data were abstracted from 3,093 death certificates maintained by the Consulate General of Mexico in Atlanta Georgia. **Results**: Of the 179 individuals who were surveyed, 51 (28%) had a work limiting injury in the previous 3 years and 58 (32%) were Hispanic. The majority of individuals were carpenters or roofers (39%), followed by laborers (22%), painters and dry wall workers (14%), other skilled trades (14%), and supervisors (11%). Hispanic ethnicity ($p<0.0001$), drinking 2 or more alcoholic beverages per day ($p<0.0001$), working for a company that does not provide health insurance (p=0.0022), and working for a company with less than 10 employees (p<0.0001) were significantly associated with lower perceived safety climate scores. The majority of the population worked for companies with less than 10 employees and worked in residential construction. Greater perceived safety climate scores were not significantly associated with injury in either Hispanic or non-Hispanic populations. The proportion of Mexican immigrants who died from occupational injuries is higher among all construction workers (SMR=1.31), roofers (SMR=2.32), and carpenters (SMR=2.25) than other Mexican immigrants workers. The construction industry was protective against suicide (aOR = 0.63) and death from natural causes (aOR=0.70). **Conclusion:** The lower perceived safety climate scores among Hispanic workers indicate that the perception of the importance of safety on the job site is lower among Hispanics construction workers than non-Hispanics construction workers. While this research does not provide evidence that that perceived safety climate is associated with past injury occurrence, this study provides evidence that attention to construction industry injuries is justified across ethnicities, while prioritizing attention to cultural differences. Interventions to reduce occupational injuries and fatalities among Hispanic migrant construction workers should target roofers and carpenters.

**INDEX WORDS:** Safety climate, occupational injury, occupational fatality, Hispanic, migrant health, occupational health, immigrant workers, immigrant health, construction industry, Mexico, standardized mortality ratios

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DEDICATION

Dear Mom - To the moon and back, thank you.

*“Don’t let schooling interfere with your education”*

-Mark Twain

“*El que lee mucho y anda mucho, ve mucho y sabe mucho.”*

– Miguel de Cervantes Saavedra

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# CHAPTER 1
# INTRODUCTION

## Statement of Problem

Occupational injury and fatalities are a notable and unnecessary burden on society. In 2013, occupational injury affected over 3% of the U.S. working population [1], resulting in 4,405 fatalities [2], disproportionately affecting Hispanic workers [3]. Annually, the burden of occupational injuries results in over one million total lost days of work [4]. The impact ranges from the individual and their families to the overall economy, costing Americans close to $200 billion in annual direct and indirect costs [5].

For the years 2009-2013, clear ethnic disparities were present in fatal and non-fatal occupational injuries among all industries. Occupational non-fatal injury rates are approximately 20% higher among Hispanic workers compared to all workers combined (2013: 3.2% vs 3.8%) [4] and fatal occupational injury rates are significantly higher among Hispanic workers compared to non-Hispanic workers (2013: 3.0% vs 3.5%) (Figure 2.1, Appendix A) [2]. The rate of occupational fatalities has also been consistently higher among Hispanics than among all races combined [2] (Appendix B); moreover, the occupational fatality rate disparity among foreign born Hispanic workers is greater than Hispanics born in the U.S. [6, 7]. In recent years (2009-2013), Hispanics have not seen significant improvements in rates of occupational deaths and there has been an approximate 12% increase in the number occupational deaths while non-Hispanics have seen reduced rates and counts [2]. Occupational fatality rates and counts for all workers, Hispanic workers, and non-Hispanic workers are presented in **Appendix A.**

The construction industry comprises the largest share of occupational deaths (19% in 2013) among U.S. industries [2], is made up of over 1.1 million workers [8], and is composed of approximately 25% Hispanic workers [9]. In 2013, there were more fatalities (n=856) in the construction industry than any other U.S. industry [2]. The total number of occupation fatalities by leading industry are presented in **Figure 2.2**. In the last five years, the trends in construction fatalities have paralleled overall occupational fatality trends. The number of deaths for the construction work force combined has decreased 5%, while deaths among Hispanics in construction have increased 13%. The rate of fatal work related injuries among the Hispanic construction workforce is significantly higher than their non-Hispanic counterparts (10.7 vs 8.8 / 100,000 workers) (Appendix B) [2]. Ethnic disparities in occupational injuries have been persistent throughout the last three decades [2], exist in many industries in the United States [10], and mostly affect Hispanics of Mexican origin [11]. Among Hispanics, construction workers reported supervisor pressure, competition for jobs, and intimidation against raising safety concerns as barriers to workplace safety [12]. Additionally, Hispanics in the construction industry have relatively low health literacy [13], limited use of personal protective equipment (PPE) when they felt it limited productivity or was uncomfortable [14], and are more likely to have machinery and fall-related hospitalizations [15]. Among low wage immigrant workers in a variety of industries, construction workers reported more frequent hazards at work, more frequent injuries, less knowledge of workers' compensation laws, less work training, and less health care access (access to a doctor and health insurance) [16].

Workplace safety climate has emerged from the understanding that workplace safety and injury prevention should be examined from a holistic approach, considering both proximal and distal influencing factors [17]. This includes, but is not limited to, the immediate workplace environment as well as the perception of the important safe behaviors. A positive safety climate is understood to influence workers attitudes and behaviors towards greater workplace safety [18], and is currently recognized by U.S. policy makers [19] and internationally as a key component of workplace safety [20].

Several recent investigations have used safety climate measures to effectively evaluate contractor safety assessment programs [21], differences in employment and personal characteristics among Hispanic workers [22], correlations with personal protective equipment provision, risk of injury [23, 24], and risky construction industry occupations [25]. Other investigations have used safety climate measures to examine person- and situation-based antecedents of workplace accidents and injury [17, 26], group safety climate [17], and safety climate across construction trades [27].

Research regarding safety climate has proven effective in directing injury reducing interventions [28] by combining organizational factors and individual characteristics. Attention to safety climate is essential to improve workplace safety outcomes [29], has been used effectively in minority populations and

Spanish speaking populations [22, 25, 30], and will help shape and appropriately target future interventions [27]. However, to our knowledge, there has never been an investigation that evaluates differences in safety climate among different ethnicities in the construction industry.

## Purpose and Objectives

The overarching goal of this research is to investigate factors contributing to ethnic disparities of occupational injury among construction workers in the southeastern United States.

The rationale for this investigation is that construction-related occupational injury and fatality in the southeastern United States (SEUS) is influenced by safety climate and occupation.

Specifically, we hypothesize:

(1) Hispanic construction workers in Athens, Georgia have a lower perceived safety climate score than non-Hispanic workers.

(2) Associations between perceived safety climate and injury differ between ethnicities.

(3) Among a group of first generation Mexican immigrants, the construction industry will have a higher proportion of deaths than other industries and laborer and low skilled occupations are at greater risk for work site fatalities.

**Approach 1 (Aims 1 and 2)**

The specific aims and objectives of Approach 1 are detailed in **Figure 1.1**. Aims 1 and 2 were based on a surveyed population of construction workers in Athens, Georgia. They were asked about their workplace perceived safety climate, ethnicity, and injury history. The surveyed population was gathered from local home improvement stores and construction sites in Athens, GA. A sample size of 179 was collected and was adequate for detecting differences in perceived safety climate score between populations of those who have had workplace injuries and those who have not in the previous 3 years. A measurement instrument was created that included:

1) Demographic profile (age, race/ethnicity, gender, occupation, country of birth, language spoken at home, and length of time in the United States)

2) Workplace characteristics (size of construction company, type of construction, specific occupation, employment status, health insurance, and hours worked/week)

3) Workplace injury history (description of most recent incident in previous 3 years, type of injury, whether the injury was reported to job site supervisor, number of days were missed from work, whether workers' compensation was filed, whether the injury was reported to a supervisor, and whether treatment was sought at a hospital/clinic/doctor's office).

4) Safety climate perception (validated 10 question composite score reflecting norms, assumptions, beliefs, and attitudes toward workplace safety adapted from previous surveys. [21, 31]).

| Figure 1.1 Specific Aims, Objectives, and Hypotheses of Aims 1 and 2 | |
|---|---|
| **Aim 1** | **Aim 2** |
| To investigate associations between ethnicity and safety climate perceptions in the construction Industry in Athens, Georgia.<br><br>**1a.** Present univariate characteristics of surveyed construction industry workers.<br><br>**1b.** Explore univariate associations between demographic characteristics and perceived safety climate scores.<br><br>**1c.** Use multivariate linear regression models to explore associations between ethnicity, occupation and perceived safety climate score, while adjusting for demographic and workplace characteristics. | Investigate associations between Hispanic ethnicity, injury incidents, injury characteristics, and safety climate among construction workers in Athens, Georgia.<br><br>**2a.** Present univariate characteristics of surveyed construction industry workers and injuries.<br><br>**2b.** Use logistic regression to investigate the association between injury occurrence and injury report, and perceived safety climate scores. |
| **Hypothesis**: (H1) We expect perceived safety climate scores to be lower among Hispanic construction workers compared with non-Hispanic construction workers. (H2) We expect perceived safety climate scores to be lower among non-skilled occupations, such as laborers, assistants and apprentices. | **Hypothesis:** (H1) We expected lower perceived safety climate scores to be associated with a greater odds of having been injured on the job. (H2) We expect perceived safety climate scores to be associated with greater odds of reporting injury to supervisor. |

**Approach 2: Investigate Construction industry mortality among 1st generation Mexican migrants in SEUS**

The specific aims and objectives of Approach 2 are detailed in **Figure 1.2**. *Aim 3* is based on data abstracted from death certificates maintained by the Consulate General of Mexico, in Atlanta, Georgia. The consulate maintains records for all deaths of Mexican nationals who are repatriated to Mexico. Death certificates were available for the years 2003-2013.

| **Figure 1.2. Specific Aims, Objectives, and Hypotheses of Aim 3** |
|---|
| **Aim 3) Investigate the association between construction industry occupations and occupational fatalities and work in construction industry and other causes of death that occur away from the job site.**<br><br>**3a. Presents characteristics of occupational deaths among SEUS Mexican population from 2003-2013**.<br><br>**3b. Calculate the age adjusted standardized mortality ratio for occupational fatality among individual construction occupations versus expected occupational fatalities for overall construction occupational fatalities.**<br><br>**3d. Use logistic regression to determine whether working in the construction industry is associated with other manners of death other than occupational fatalities (natural, accidental, homicide, and suicide).** |
| Hypothesis: (H1) We expect laborer and low skilled occupations to be associated with higher odds of occupational fatalities. (H2) We expect suicide and homicide fatalities to be lower and accidental fatalities to be higher than other occupations. |

## Significance of Research

This research addressed a significant problem in an underserved and understudied population at high risk for occupational injury. Our investigation was targeted at Hispanic construction workers in SEUS.

The Hispanic population in the SEUS has grown at a faster rate than any other region in the U.S. and the majority are of Mexican origin. In 2000-2010, the SEUS experienced growth of the Hispanic population 2-3.5 times faster than the U.S. as a whole [32]. Occupational injury and fatalities were a significant burden [7, 33], and there are ethnic injury disparities among prominent industries in the region [34].

This study focused on issues that were established by national organizations as leading health priorities in the U.S. Healthy People 2020 aims to reduce fatal and non-fatal work related injuries, specifically fatal injuries in construction (OSH 1.3) [35]. Also, the National Construction Agenda for occupation and safety and health research practices strategic goals 8.0 (Construction Culture) and 12.0 (disparities) are addressed in this proposal [36].

To our knowledge, no epidemiologic assessment has been conducted that evaluates differences in perceived safety climate by ethnicity in construction or any other U.S. industry. Additionally, there is limited literature regarding non-occupational fatalities associated with occupation, especially among first generation Hispanic migrants.

## Study outline

Chapter 2 of this dissertation details the literature that is relevant to a full understanding of the issues surrounding construction safety, health disparities of Hispanic workers, an overview of safety climate research in the construction industry, and gaps in the literature. Chapter 3 describes the methods that were used in conducting this investigation, including data collection, data sources, and statistical analysis. Chapters 4, 5, and 6 are presented in manuscript format, including background, methods, results, conclusions, references, and detail the Aims 1, 2, and 3 individually. Chapter 7 provides a summary of all findings, describes strengths and limitations, and makes recommendations for future research.

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# CHAPTER 2

# LITERATURE REVIEW

## Introduction

The Occupational Safety and Health Act was enacted in 1970 and grants U.S. workers the right to a safe work environment [1].

Occupational injuries and fatalities remain a significant and unnecessary burden on society.  In 2013, occupational injury affected over 3% of the U.S. working population[2], resulting in 4,405 fatalities [3] and disproportionately affected Hispanic workers [4].  The burden of occupational injuries permeates our society, with total days of work lost due to injury exceeding 1.1 million [2]. The impact ranges from the individual and their families, to the overall economy, costing Americans close to $200 billion in direct and indirect costs annually [5].

The following sections present an overview of the scientific literature regarding construction industry fatal and non-fatal injuries with a specific focus on ethnic disparities and safety climate. The first section will review the epidemiology of occupational injuries and fatalities in the United States overall and in the construction industry in recent years.  This is followed by a description of the organizational and individual-level characteristics of construction accidents that lead to work site injury, and a section describing the disparate outcomes in the Hispanic working populations.  Lastly, gaps in knowledge and the direction of future research will be presented.

## Epidemiology of Construction Injuries

National data regarding occupational illness and injury are recorded in several ways: 1) occupational illness and injury is mandated notifiable by physicians [6], 2) U.S. standard death certificates include entries for industry and occupation of decedent, and fatalities that happen at work [7], 3) Annual Survey of Occupational Illness and Injury [2], and 4) Annual Census of Fatal Occupational Injury [3].

National occupational injury and fatality data are collected annually by the United States Bureau of Labor Statistics' Illness and Injury and Fatalities Program through the U.S. Department of Labor's Census of Fatal Occupational Injury (CFOI) [3] and Survey of Occupation Occupational Illness and Injury (SOII) [2]. Reported illness and injury rates are calculated using population characteristics from the Current Population Survey's Labor Force Statistics [2]. The Occupational Safety and Health Act of 1970 (the OSH Act) requires employers selected by the Bureau of Labor Statistics to maintain occupational injury and illness data. The U.S. Department of Labor's Occupational Safety and Health Administration's (OSHA) definition of recordable events that requires companies to report death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness. Partial exemptions allow companies with ten or less employees to abstain from recording events unless specifically requested by OSHA or the event results in a fatality or hospitalization of 3 or more individuals [8]. SOII provides estimated injury and illness counts and incidence rates based on a sample of approximately 230,000 establishments from 44 participating U.S. states and territories. CFOI attempts to identify all deaths that are determined to be occupationally related and compiles data from death certificates, and insurance investigation. All deaths included in the count are independently verified by CFOI staff[3].

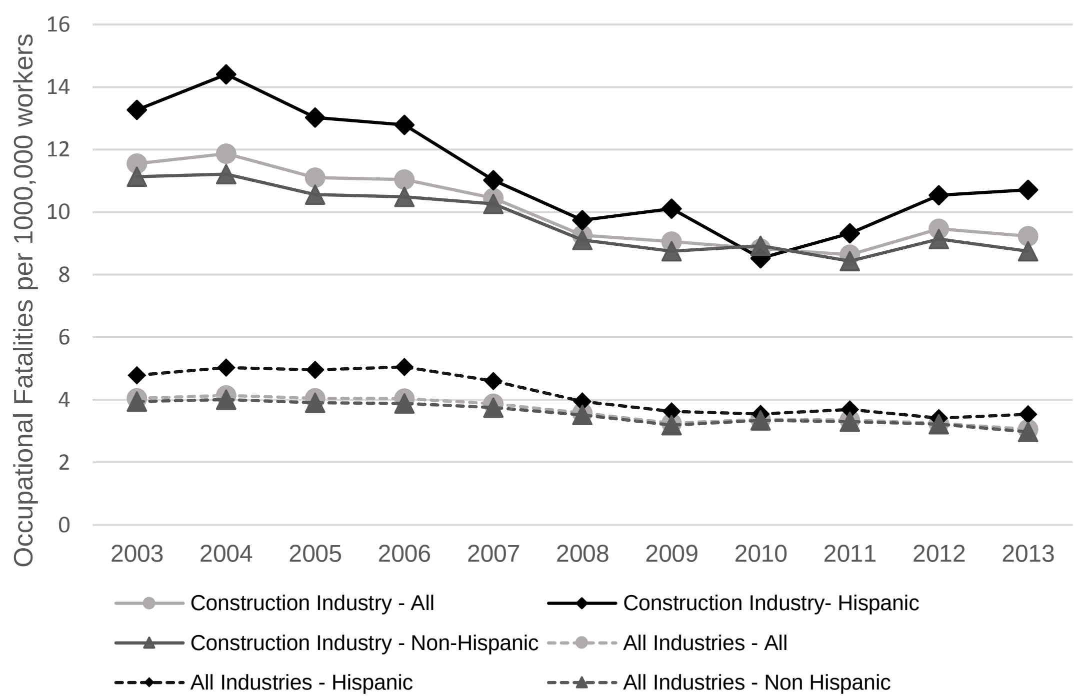
**Occupational Injury and Fatalities in U.S.**

In all industries and occupations, the rates of non-fatal occupational illness and injury were lower in 2013 than in 2012 and the number of occupational fatalities also decreased approximately 5% (4,628 vs 4,405) [3]. The leading causes of injury in both men and women are sprains, strains, tears, soreness, and pain. Rates of injury resulting in days of work lost are approximately 20% higher in men than women (119.2 vs 97.0 per 10,000 full time workers) [9]. Among all industries, Caucasian individuals made up 40% of cases, followed by Hispanics (12%) and African Americans (8%), and in 40% of cases race was not reported. Workers ages 45-54 years had the most days of work missed [3, 9].

For the years 2009-2013, for all industries, ethnic disparities exist in fatal and non-fatal occupational injuries. Occupational non-fatal injury rates are approximately 20% higher among Hispanic workers compared to all workers combined (2013: 3.2% vs 3.8%) [2]. The rate of occupational fatalities have also been consistently higher among Hispanics than all races combined [3]. In recent years (2009-2013), occupational fatalities have been on a slight decline for all workers combined and for each individual race/ethnicity, but for Hispanics the trend is reversed and there has been approximately a 12% increase in the number of occupational deaths [3]. Rates and counts of occupational injury, by ethnicity, for all industries in the United States are presented in Figure 2.1 (Appendix A).

The disparities in workplace injuries between Hispanic and non-Hispanic workers appear to be widening when compared with reported injury rates 20 years ago [3]. The rate of occupational fatalities have also been consistently higher among Hispanics than all races combined [3]. Moreover, the occupational fatality rate disparity among foreign born Hispanic workers is greater than U.S. born Hispanic workers [10, 11]. In recent years (2010-2013), while occupational fatalities have been on a slight decline for all workers combined and for each individual race/ethnicity, there has been approximately a 13% increase in the number of occupational deaths among Hispanics (Figure 2.1, Appendix A) [3].

Figure 2.1. Occupational Fatality Rates for Construction Industry and All Industry, in the United States, by Ethnicity, 2003-2013



### Occupational Injury and Fatalities in Construction Industry

The construction industry makes up the largest share of occupational deaths (18% in 2013) [3]among U.S. industries, is made up of over 1.1 million workers [12] and is composed of approximately 25% Hispanic workers [13]. In 2013, the construction industry had the most occupational fatalities in the U.S. (856), 17% more than the second leading industry (Transportation and Warehousing: 733 fatalities) [3]. In the last 5 years, the trends in construction fatalities among all workers have paralleled overall occupational trends, where the number of deaths for the construction work force combined has decreased 5%, while deaths among Hispanics in construction have increased 13%[3]. The rate of fatal work related injuries among the Hispanic construction workforce is significantly higher than their non-Hispanic counterparts (10.7 vs 8.8 / 100,000 workers) (Appendix B) [3]. The total number of occupation fatalities by leading industry are presented in **Figure 2.2**.

**Figure 2.2 U.S. occupational fatalities, by leading industry, 2013**

| | Number of Fatalities | Percent of total |
|---|---|---|
| **Construction** | 856 | 19% |
| **Transportation and warehousing** | 733 | 17% |
| **Agriculture/forestry/fishing/hunting** | 500 | 11% |
| **Professional and Business Services** | 430 | 10% |
| **Manufacturing** | 312 | 7% |

Source: U.S. Department of Labor Bureau of Labor Statistics (USBLS), *Census of Fatal Occupational Injuries.* 2013

## National Data Limitations

In 2013, reported rates of non-fatal occupational injury in the construction industry were comparable to all industries combined (3.8 vs 3.5 per 100 full time workers), though interpretation is limited. It is a general consensus and several recent studies have corroborated that occupational injuries are drastically underreported [14-16]. Additionally, in 2013, ethnicity data was missing from 40% of cases reported to the U.S. Bureau of Labor Statistics[9]. The concerns about reporting completeness have begun to be addressed by the Bureau of Labor Statistics and they have conducted research that addresses the limitations [17-19]. A meeting was convened in 2013 by the Council of State and Territorial Epidemiologists to address underreporting on occupational illness and injury surveillance. The participants concluded that improved reporting could be achieved if multi-source surveillance systems for traumatic injuries were implemented in multiple states, the system expanded state based surveillance to include more states, worker populations and hazards under surveillance were expanded, and there was increased collection of occupational information in national health surveys [20]. Studies in 2010 and 2012, in Washington DC, Wisconsin, and Kentucky, by the Bureau of Labor Statistics found some limited advantages of integrating SOII surveillance with workers compensation databases [21-23].

In 2011 a study found that small construction companies were the most likely to underreport and estimated that only 25% of severely injured Hispanic workers and 53-66% of non-Hispanic workers were being captured by the Bureau of

Labor Statistics' SOII [16]. Among a small sample of Hispanic residential roofers in North Carolina, Arcury et al. found that 40% had been injured in the last year (an over 10-fold difference from officially reported rates) [24]. Lastly, a cohort study prospectively followed 107 Hispanic residential construction workers and concluded that official reports represent a three to four fold underestimation of injury [15].

## Causes of Construction Injuries

Though the causes of occupational accidents, injuries, and fatalities are multifactorial and have been related to organizational/management, group, and individual characteristics [25]. Investigations and national statistics of construction injuries have revealed many common themes with regards to the workplace environment, risky occupations, and individual characteristics.

Four types of construction industry accidents account for approximately 60% of its fatalities. In 2013, 37% of construction fatalities were caused by falls, 10% caused by being struck by objects, 9% from electrocutions, and 3% from being caught in-between equipment [26]. Approximately 86% of non-fatal construction injuries happen between 8:00 am and 4:00 pm, 98% of construction injuries occur in men, close to 75% occur in individuals between the ages of 25-54, and 35% occur within the first year of working with an employer [13].

Individual and construction company characteristics have been associated with workplace safety. Larger companies with more than ten employees are considered safer than small ones [27, 28]. Workers with less skill, such as workers employed in apprentice positions, with less experience are less familiar with safety policies than those with experience [27, 29]. Accordingly, research has shown that the highest burden of occupational injury and fatalities among construction workers is among unskilled laborers [15, 30]. Falls that result in fatalities in the construction industry happen more often among self-employed workers, individuals age 55 and older, Hispanic workers, small (1-10) establishments, and at residential construction sites [31, 32]. Fatal falls have also been associated with working as a roofer, iron worker, laborer, and carpenter [33]. Additionally, investigations have observed insufficient use of fall arrest devices and monitoring unguarded floor openings on construction sites [27].

Construction occupations are not limited to excessive risk for workplace injuries. Construction laborers have higher mortality rates from cirrhosis, cerebrovascular disease, chronic obstructive pulmonary disease, ischemic heart disease, and leukemia than other construction occupations[34], and asthma and bronchitis have been associated with painting occupations [19]. Also, construction employment has been associated with gaps in health literacy regarding cardiovascular health risks [35] and seatbelt usage [36]. One study in Colorado found that construction occupations have the fourth highest age-adjusted incidence rate in men and the highest rate in females of all occupations for suicide [37]. A recent meta-analysis including 34 studies (retrospective population-level studies and case-control studies), including 93 occupations, also found that low skill level occupations are at higher risk for suicide [38].

## Ethnic Disparities

The disparities in occupational health outcomes between Hispanic and non-Hispanic workers contradicts some health outcome dynamics often observed in Hispanic populations in the U.S. Though not universally accepted in the literature [39-41], Hispanic and migrant populations have some health advantages despite lower education and income, as shown by U.S. population statistics. This anomaly has been has been addressed as *the healthy migrant paradox* [42-45]. This has been explained by a *healthy worker bias*, in which it is presumed that the healthiest individuals migrate for work , and a *salmon bias* in which unhealthy individuals or those who become sick return to their home country [40]. National data reveals that both foreign born and native U.S. Hispanics live longer than non-Hispanic White populations [46-48]. This dynamic is not universal to all health outcomes. In addition to occupational fatalities, Hispanics have higher fatality rates for diabetes, stomach cancer, liver cancer, cervical cancer, HIV/AIDS, liver disease than non-Hispanics [49]. In addition, Hispanic male youth have higher mortality rates of homicide and automobile accidents [50], and Mexican migration is associated with poorer mental health [51].

There is evidence of persistent disparities among Hispanic workers and occupational outcomes throughout the last 3 decades [52] in many industries in the United States [53], mostly affecting Hispanics of Mexican origin [54, 55]. Hispanic construction workers identified supervisor pressure, competition for jobs, and intimidation against raising safety concerns as barriers to workplace safety [56]. Additionally, there was relatively low health literacy [29] and limited use of PPE when they felt it limited productivity or was uncomfortable [28]. Hispanics were more likely to have machinery and fall related hospitalizations than other ethnicities [57] and are at elevated risks for most other occupational injury outcomes [53]. Among low wage immigrant workers in a variety of industries, construction workers reported more frequent hazards at work, more frequent injuries, less knowledge of workers compensation laws, less job- related training, and less health care access (access to a doctor and health insurance) [58].

The relationship of migrant workers with regulatory and governmental authority is complicated and is a somewhat delicate balance between respect and distrust. An example of its tenuous nature was illustrated in an incident in 2005 in Goldsboro, North Carolina. A large group of migrant workers responded to a flyer that was advertised as a mandatory safety meeting, sponsored by the U.S. Occupational Safety and Health Administration (OSHA). In reality, the meeting was a part of a sting operation by the U.S. Federal Bureau of Immigration and Customs Enforcement in which 48 immigrant workers (Mexican, Honduran, El Salvadorian, and Ukrainian) were arrested. Representatives from OSHA commented that they were not aware of the sting, did not condone the tactics, and were sorry to see hard earned community rapport disappear [59].

Cultural factors/attributes may play a role in ethnic disparities. It has been shown that Hispanic workers may weigh job security and production more heavily than workplace safety [28, 60] and there is a lack of culturally and linguistically appropriate trainings [61]. The literature is mixed regarding the role of language in construction safety. In some studies, language is reported as a barrier to workplace safety [56] and for some it is not [4, 29]. Lastly, conventional trainings targeting assertiveness have been less effective among Hispanic workers than non-Hispanic workers [60], and may not adapt to the needs of the diverse Hispanic population. The Hispanic population is often regarded and studied as a homogenous group when it is composed of individuals from 20 separate nations in South and Central America with unique cultural distinctions that may contribute differentially to health outcomes [42]. It is important to recognize the heterogeneity may play a role in construction industry safety [62].

Occupational injury has been shown to decrease with supervisorial supported safety at work sites, use of personal protection equipment, perceived importance of safety to employers (work safety climate) [24], and consistent implementation of other recognized hazard prevention strategies [27]. The role of institutional involvement is unclear in workplace safety and injury prevention. While some regulation and legislation enforcement activities have been shown to be effective in improving workers' safety [63], there remains debate about the effectiveness of issuing violations and there is limited literature that supports it [64]. Additionally, training interventions, inspections or the introduction of occupational health services have had limited success in the reductions of non-fatal injuries[65]. Similarly, adherence to Occupational Safety and Health Administration (OSHA) guidelines have limitations [66] but have also shown some effectiveness in reducing occupational injury [27].

In addition to injury rates, Hispanic and Black construction workers have been shown to have lower monetary settlements from worker compensation claims than injured white workers. This disparity exists despite the fact that for specific injuries the mean temporary total disability and permanent partial disability in whites were equivalent to or lower than those in Hispanic and black construction workers [67]. This may be due to lack of understanding of workers' compensation procedures or that workers in underrepresented minorities feel intimidated by authority [29].

## Safety Climate

Safety climate has emerged as an important component in workplace safety research and can be applied to virtually all industries and work settings. Workplace safety climate has emerged from the understanding that workplace safety and injury prevention should be looked at from a holistic approach, considering both proximal and distal influencing factors. Safety climate is influenced by safety policies and programs, organizational climate, and environmental conditions [68]. Workplace safety climate is currently recognized by U.S. policy makers [69] and internationally as a key component of workplace safety [32].

In order to present a review of safety climate, it is necessary to separate it from safety culture. While both safety climate and safety culture are both terms to describe the distal factors comprising a work environment that either promotes or challenges safe behaviors, they are not equivalent [70]. The term 'safety culture' was first used in in summary reports following Chernobyl Power Plant Accident [71] and is understood to be an overall sense of shared beliefs, values and traditions around workplace safety. Safety culture has been defined as 'the product of individual and group values, attitudes, perceptions and patterns of behavior that determines a team or organization's commitment to safety management' [72]. Safety culture reflects personal, psychological, and environmental factors that determine an organization's ongoing commitment to safety [73].

Like other cultures, safety culture evolves slowly and is resistant to change, while safety climate is more flexible, adaptable and is a closer antecedent to safe behaviors [70]. Safety climate has been considered a snapshot of safety culture [74-76] and also a product of safety culture [73]. Safety climate refers to the relative priority of safety, rather than the content of individual procedures, largely prioritizing safety over production [77], and can exist at various tiers of organizational structures [77]. Safety climate is pervasive in contemporary occupational safety research having been investigated in, but not limited to, agriculture [78, 79], industrial plants [80], geriatric care [81], oil and gas industry [82], automobile industry [83], and health care [84].

A safety climate measure was first published in 1980, from industrial workers in Israel, and was developed from previous work exploring factors relating to organizational climates, such as motivational and creativity climates [85]. Dov Zohar's inaugural safety climate measured organizational dimensions through a 49 question survey and performed step-wise discriminant analysis to achieve the smallest number of safety climate dimensions to be tested. The preliminary analysis included 8 dimensions: 1) Perceived importance of safety training programs, 2) Perceived management attitude toward safety, 3) perceived effects of safe conduct on promotion, 4) perceived level of risk at work place, 5) perceived effects of required work pace on safety, 6) perceived status of safety officer, 7) perceived effects of safe conduct on social status, and 8) perceived status of safety committee. The eight dimensions were tested on 20 large (500-1000 workers) factories and found to be an effective tool to measure occupational behavior related to safety.

In 1986, investigators Brown and Holmes tested Zohar's 8 factor model on accident outcomes in the United States among Illinois and Wisconsin manufacturing and produce companies using confirmatory factor analysis. They found that Zohar's model was not supported (GFI=0.525, root mean square residual=0.21), but instead found a 3-factor model to be appropriate (GFI=0.930, RMSR=0.0.064). The 3 factors identified were 1) employee perception of how concerned management was with their wellbeing, 2) employee perception of how active management was in responding to this concern, and 3) employee physical risk perception [86]. Another more recent evaluation of Zohar's model, performed in 2007 by Johnson on manufacturing employees, also found that the full questionnaire was an effective predictor of safety climate related outcomes (behavior and accident experience), but excessive and could be shortened to 3 factors [87].

The first safety climate model to be used specifically on construction workers descends from Brown & Holmes' refinement of Zohar's model. The model was conducted on 9 non-residential construction sites in Baltimore, MD [88]. The investigators, Dedobbeleer and Béland, validated that the 3-factor model was an appropriate model for construction workers, but found that their weighted least square statistical method revealed a 2 factor, 9 question model, was an equally good fit ($X^2$=4.74, *df*=2, p=0.093). The 2 dimensions that were found to be most fitting for construction workers and have persisted into contemporary research are perceptions regarding 1) management's commitment to safety and 2) workers' involvement in safety [88].

In 2002, Gillen et al., adapted the Dedobbeleer and Béland 2-factor, 9 question safety to divide one question. Their 2-factor 10 question model was used to evaluate safety climate among union and nonunion construction workers and was found to have a significant positive correlation with injury severity (r=0.183, p=0.003). The complete questionnaire is detailed in **figure 2.3** [89].

| Figure 2.3. Gillen et al., 2-Factor, 10 Question Safety Climate Survey |
|---|
| **Factor 1. Management concerns and safety activities?** |
| Workers Safety practices are very important to management? |
| Workers are regularly made aware of dangerous work practices or conditions?[1] |
| Are workers are regularly praised for safe conduct?[1] |
| How much do supervisors seem to care about your safety? |
| Did you receive instructions on safety when hired? |
| Are there regular job safety meetings? |
| Is proper equipment always available? |
| **Factor 2. Employee risk perceptions** |
| Do you have almost total control over personal safety? |
| Is taking risks part of the job? |
| What is the possibility of getting injured in the next 12 months? |
| [1] Questions that were previously one question in Dedobbeleer and Bélend's 9 question survey ("How much emphasis does the foreman place on safety practices on the job?")[88] |

In 2013, a study used Dedobbeleer and Béland's model to evaluate differences in associations between management and employee safety climate and contractor safety assessment programs (CSAP) among 68 companies in Massachusetts. The investigation revealed little correlation between the companies' assessed safety assessment programs and safety climate scores, calling in to question the validity of the CSAP. Additionally, they found similar safety climate scores among workers and management in the companies [90].

Two studies investigated safety climate among Hispanic construction workers using Gillen's 2002, 2-factor; ten question model. In 2012, they surveyed 119 Hispanic construction workers in North Carolina in order to investigate differences in employment and personal characteristics. They found that roofers had the lowest safety climate scores (p<0.01) and that attending regular safety meetings (p<0.07), not using damaged equipment (p<0.01), and not seeing coworkers create unsafe situations (p<0.06) were positively associated with perceived safety climate scores [14]. In another investigation using the same model, Arcury et al. collected prospective data on 89 Hispanic roofers in North Carolina and found moderately significant associations between perceived safety climate and risk of injury (p=0.073) [24].

An additional safety climate model includes Griffin and Neal's work with Australian manufacturing workers. They developed a 4 dimensional model: management commitment to safety, safety practices, supervisor support for safety, and work pressure. This was implemented in a 19 question survey instrument [91], which has been effective in in examining person and situation-based antecedents of workplace accidents and injury. This survey tool was used in 2013 to examine safety climate among different construction trades and found significant differences in safety climate between construction trades ($F_{36,9835}$ = 8.53, p<0.001) [92].

Evidence is accumulating that safety climate is effective in shaping interventions by combining organizational factors and individual characteristic to improve workplace safety outcomes [93, 94]. Other recent investigations have supported the importance of safety climate in construction industry occupational safety research [95], finding psychological factors to be more influential to worker safety than the physical condition of the work site [96]. Investigations have found safety climate scores to be reliable predictors of safety related outcomes, such as reduced injury frequency and severity, safe behaviors [87], company accident rates [97], and self-report injury [94]. Scores can differ between groups in the same company, and can be measured at various tiers of industry, such as work groups and sub-units of workers [98].

The research proposed in this investigation will focus on Gillen's adaption of Zohar's safety climate model. It has been suggested that safety climate measures may have different validity across industries [99], and that lengthy questionnaires may lead to respondent fatigue [100]. Gillen's 10 question survey is brief, has been used effectively in the construction industry. While this model has not been formally validated, it is the has been used effectively and has shown significant associations with safe behaviors on construction sites by Hispanic workers [14, 24]

## Gaps in Literature

While research has been conducted and has effectively identified factors associated with workplace injury, there is a considerable gap in knowledge. Specifically, more research needs to be dedicated to addressing factors contributing to ethnic disparities and safety climate in the construction industry.

A focus on the safety of Hispanic workers is not novel [62], as it is clear that Hispanics are and have been disproportionately affected for decades. While there is substantial literature that investigates this disparity, the full picture is not completely understood. While the literature indicates that some characteristics that are unique to the Hispanic population, such as language and fear of authority, may contribute to the disparity, many questions remain unanswered. Understanding the dynamic between ethnicity and occupational injury is further complicated by the cultural and migration characteristics of the Hispanic pollution in the United States.

Additionally, further research is necessary to understand Hispanic workers' occupational, social, economic, and cultural background in order to begin to reduce their excess of occupational fatalities [4]. This is especially true for temporary employment positions on small crews that generally are not covered by OSHA mandates [8], and in low skill level workers, such as laborers and apprentices [15].

An additional limitation of the current research regarding Hispanic and migrant health is the homogeneous classification of these groups [101, 102]. The Hispanic population in the United States is comprised of individuals from approximately 20 separate nations in South and Central America with unique cultural distinctions that may contribute differentially to health outcomes [42]. While in some cases it is difficult to reach beyond a homogeneous classification of Hispanic populations, specific attention should be devoted to identifying and investigating unique population clusters.

Research from this proposed investigation will provide guidance to direct future research and intervention strategies. There has been very little research done linking intervention strategy and occupation [34], and using academic research to inform the process is essential [103]. Though there has been some success using community-based participatory research strategies among Hispanic construction workers [104], there should be better integration of safety climate into intervention design, implementation, and evaluation [60].

Specific focus should be paid to the southeastern United States (SEUS), where the Hispanic population is growing at a faster rate than any other region in the U.S. and the majority is of Mexican origin. The SEUS region experienced growth of the Hispanic population 2-3.5 times faster than the U.S. as a whole [105], and the Hispanic population makes up a large percent of the occupational fatalities [106]. Some research has shown that the southern region of the U.S. is disproportionately burdened with fatal falls [11].

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# CHAPTER 3
# METHODS

## Part 1: Safety Climate, Construction Injuries, and Ethnicity (Aims 1 & 2)

### Data Collection

We administered a single survey targeting construction workers in Athens, GA in order to accomplish ***aims 1 and 2***.

Content of the survey is presented in **Figure 3.1** and the survey instrument is presented in the Appendices (Appendix C). Each survey collected a brief demographic profile of the individual, recorded workplace characteristics, asked about most recent injury (in last 3 years), and included a 10 question perceived safety climate measure. This research utilized Gillen's ten-item scale [1] that was used in Arcury's studies among Hispanic construction workers [2, 3] , which is a slight adaption of a 9-question previously validated measure [4]. This safety climate measure was chosen for its simplicity/brevity, and previous effective use in construction industry research among Hispanic populations [1, 3-6]. The survey was created in English and translated to Spanish. The survey was back-translated from Spanish to English, to ensure accuracy, by native Spanish speakers.

Each participant was administered a survey and assigned a unique identifying number (UIN). Participant age was verified (above 18 years) for each respondent but no other personal identifying information was collected from participants. Participants were read a script that described the purpose and importance of the investigation. The surveys were administered in person and took less than 10 minutes each. Participants were assured that their participation was voluntary and their answers would remain anonymous. Surveys were conducted in person and on paper, and all survey results were entered into a password protected electronic database. Survey participation rates for all individuals approached were sampled over 3 days. All individuals conducting surveys were trained and followed a strict protocol. All study activities were conducted by students and staff at the University of Georgia's College of Public Health, and were approved by the University of Georgia's Institutional Review Board.

| Figure 3.1 Components of Construction Worker Survey[a] | | |
|---|---|---|
| ***Demographic Profile*** | ***Age*** | ***Years (continuous)*** |
| | ***Race/ethnicity*** | ***Hispanic, Non-Hispanic-White, Non-Hispanic-Black, Other*** |
| | ***Occupation*** | ***Carpenter, roofer, electrician, laborer, supervisor, other*** |
| | ***Country of Birth*** | ***United States, Mexico, other*** |
| | ***Length of Time in U.S.*** | ***Years (continuous)*** |
| | ***Language spoken at home*** | ***3 tier scale English/Spanish and other*** |
| | ***Number of years in construction*** | ***Years (continuous)*** |
| ***Workplace Characteristic*** | ***Type of construction*** | ***Residential, Commercial, or Both*** |
| | ***Number of workers on job site*** | ***1-10, 11-50, 50-100, 100+*** |
| | ***Employment status*** | ***Permanent or Temporary(Self Employed)*** |
| | ***Health insurance provided*** | ***Yes or No*** |
| ***Workplace 3 year Injury History*** | ***Have you been injured at work in the last 3 years?*** | ***Yes or No*** |
| | ***Type of injury*** | ***8 Categories*** |
| | ***Missed work due to injury*** | ***Yes or No*** |
| | ***Treatment received*** | |
| | ***Report to supervisor*** | |
| | ***File for workers compensation*** | |
| ***Safety Climate Measure[a]*** | ***Workers' safety practices are very important to the management*** | ***Strongly disagree (1)<br>Disagree (2)<br>Agree (3)<br>Strongly agree (4)*** |
| | ***Workers are regularly made aware of dangerous work practices or conditions*** | |
| | ***Workers are regularly praised for safe conduct*** | |
| | ***Workers receive instructions on safety when hired*** | |
| | ***Workers attend regular safety meetings*** | |
| | ***Proper safety equipment is always available*** | |
| | ***Workers have almost total control over personal safety*** | |
| | ***Taking risks is not part of my job*** | |
| | ***The possibility of being injured at work in the next 12 months is very likely*** | |
| | ***Supervisors do as much as possible to make my job safe*** | ***Supervisors are only interested in doing the job fast and cheap (1)<br>Supervisors could do more to make my job safe (2)<br>Supervisors do as much as possible to make my job safe (3)*** |

*[a]Gillen et al. adaption of Dedobbeleer and Zohar safety climate models [1, 4, 7]*

**Population**

Surveys were conducted in Athens, GA. Athens-Clarke County Metropolitan Statistical Area (MSA) is composed of Madison, Clarke, Oglethorpe and Oconee Counties, and in 2010 had 120,000 residents. The formal construction industry employs approximately 2,200 individuals and is the 3rd leading occupation for males in Athens MSA. In 2014, the Athens metropolitan formal construction industry had approximately 400 establishments[8, 9]. All construction workers were targeted and no specific group or ethnicity was intentionally oversampled. We identified a convenience sample of men (18 years and older) who work in construction in the Athens MSA. We contacted local construction companies and builders identified through the Athens Area Home Builders Association (http://aahba.com/). Additionally, we identified construction sites, asked permission from the foreman/supervisor, and surveyed the willing workers. Lastly, individuals were approached at home improvement/hardware stores. Recruitment was accomplished in 2 steps: (1) recruitment of company permission, and (2) conducting surveys in the field.

1) Construction company recruitment took place throughout the Athens area. The search will began with the Athens Area Home Builders Association, internet and phone book, and through key informants in the community supporting our project. In order to recruit company participation, a letter in English was written that explains the purpose and importance of the investigation on UGA letterhead and signed by Dr. Robb (Appendix D). Initial contact with companies was be done by email. An in-person meeting was requested to discuss the purpose of

the investigation and administration of the survey. Companies and agencies were assured of their company and their employees' anonymity.

2) In the field, individuals were approached at construction sites and home improvement/hardware stores. Individuals were read a participant recruitment script that informed them of the purpose of the study (Appendix E). On construction sites, a manager or supervisor was identified and asked for permission to l to request the participation of workers at the jobsite. At home improvement stores, all individuals exiting the stores were approached.

A contingency plan was in place in the event that the target sample size (Tables 3.2 and 3.3) was not obtained in and around the Athens Metropolitan area. In that case, the recruitment radius was to be expanded to include additional surrounding cities until the target sample size was reached. If it were necessary, the recruitment would have been expanded to include Atlanta, Georgia, where the formal construction industry employs approximately 100,000 individuals [10]. The expanded recruitment radius was not necessary.

**Exclusion Criteria**

Men and women aged 18 years and older were included in this investigation. Individuals were excluded from the investigation if they did not speak or understand English or Spanish, or if for any other reason they could not comprehend the purpose of the study or any components of the survey. Individuals were excluded if for any reason they were unable to provide informed consent.

**Human Subjects Research**

All study procedures and survey instruments were reviewed and approved by the University of Georgia's Institutional Review Board for Human Subjects Research (STUDY00002177).

**Sample Size**

Sample size estimates for each aim (1 & 2) are presented below in **Figure 3.2**. All sample size estimates for this survey were calculated for $\alpha = 0.05$ and $\beta = 0.80$. The safety climate score is a summative score for the 10 questions and is scored from 10-39, with a higher score indicating a higher or more positive safety climate. Based on previous literature among construction workers, we estimated the mean of the population to be $\mu_1 = 23$ **(S.D. = 5.3)** [2].

***Figure 3.2. Sample Size Estimates for Construction Worker Survey***

| Difference to Detect | $\mu_1 - \mu_2$ | $n_0 + K * n_0$ | | |
|---|---|---|---|---|
| | | (Aim 1) $K_1$=1/3 | (Aim 2) $K_2$=1/4 | ***α = 0.05*** |
| 10% | 1.30 | 694 | 812 | ***β =0.80*** |
| 15% | 1.95 | 314 | 368 | $\mu_1$=13 |
| 20% | 2.60 | 176 | 203 | ***σ =5.3*** |
| 25% | 3.25 | 112 | 131 | $K_1$= 1/3 |
| 30% | 3.90 | 68 | 91 | $K_2$= 1/4 |

*α = Significance level*
*β = Power*
*μ = expected mean*
*σ = Standard deviation of expected mean*
*K = Ratio of expected unequal populations*

$$n = \frac{2(Z_{1-\alpha/2} + Z_\beta)^2}{\left(\frac{\mu_1-\mu_2}{\sigma}\right)^2}$$ (Single sample size for equal population sizes)

$$K = \frac{n}{2n_0 - n}$$ (Adjustment for unequal sample sizes)

**Total Sample Size =** $n_0 + K * n_0$

**$K_1$=1/3** *(Expect approximately 1 Hispanic worker for every 3 non-Hispanic workers)*

**$K_2$=1/4** *(Expect Approximately 1 injury for every 4 non-injury)*

**Aim 1 –** The principle objective of the first aim was compare differences in mean health safety score among Hispanics and non-Hispanics. Based on census data, we expected 25% of the construction industry population to be Hispanic and 75% non-Hispanic **(K=1/3)**[11].

**Aim 2 –** The objective of aim 2 was to compare safety climate scores among individuals who were injured on the job in the previous 3 years. Based on national surveys [12], we should expect that 10.5% of the surveyed population will have had an injury in the last 3 years. On the other hand, previous literature suggests that it is possible that 75% of injuries to Hispanic construction workers are not reported [13] and other literature suggests other levels of under-reporting [2, 5]. Due to the underreporting of injury, our sample size estimates based on 10.5% injury prevalence in the surveyed population will result in a conservative estimate. In order to account for these discrepancies we have presented sample size estimates in **Figure 3.3** that display the sample size estimates for varying (1:9-1:3) injured worker ratios.

| ***Figure 3.3. Sample Size Estimates for Construction Worker Survey (Aim 2) for Varying Worker Injury Ratios (1:9-1:4)*** | | |
|---|---|---|
| ***Injury / Non-Injury*** | $n_0 + n$ | |
| ***$K_2$=1/9*** | ***362*** | ***$\alpha$ = 0.05<br>$\beta$ = 0.80<br>$\mu_1$ =13<br>$\mu_2$ = 11.4<br>$\sigma$ = 5.3*** |
| ***$K_2$=1/8*** | ***330*** | |
| ***$K_2$=1/7*** | ***298*** | |
| ***$K_2$=1/6*** | ***267*** | |
| ***$K_2$=1/5*** | ***234*** | |
| ***$K_2$=1/4*** | ***203*** | |
| ***$K_2$=1/3*** | ***173*** | |
| *α = Significance level<br>β = Power<br>μ = expected mean<br>σ = Standard deviation of expected mean<br>K = Ratio of expected unequal populations* | | |

**Figure *3.2*** illustrates the sample sizes necessary in order to detect mean score differences from 10-30% for aim 1 and aim 2. In order to detect a moderate difference (20%) (Cohen's d= 0.49) [14] between populations we estimated that we would need to complete surveys with approximately 203 individuals. The number of Hispanic participants and participants with previous injuries within the last 3 years were intermittently monitored. The observed ratio of Hispanic to non-Hispanic was approximately 1:2 and injured to non-injured was approximately 1:2.5. In order to satisfy the sample size needs of each aim, we conducted 179 surveys.

### Data Analysis (Aim 1)

The **primary objective** of **Aim 1** was to investigate the relationship between safety climate scores and ethnicity among construction workers. The **secondary objective** was to investigate the relationship between individual occupations, safety climate scores, and ethnicity. We hypothesized that Hispanic ethnicity will be associated with lower safety climate scores, which are indicative of a greater risk of occupational injury. We also expect the association between occupation and safety climate to differ between ethnicities.

Participant demographic and workplace characteristics were presented and chi-square and t-test analyses were performed in order to detect differences between Hispanic and non-Hispanic participants. Collinearity was assessed by examining each variables variance inflation factor (VIF), and the Shapiro-Wilks test was used to assess normality of safety climate scores. Cronbach’s alpha was computed for the safety climate score’s components in order to test for internal consistency on the safety climate scale.

Demographic and work place characteristics were compared between Hispanic and non-Hispanic participants using chi-square tests for categorical variables and t-tests for continuous variables. Univariate linear regression analyses were used to examine the crude associations between the safety climate score and demographic or workplace characteristics. Multivariate linear regression analyses considered safety climate scores (10-39) as the outcome of interest and ethnicity (Hispanic or non-Hispanic) as the exposure of interest. This regression model was composed of all individual characteristics (age, years working in construction, alcohol consumption, and employment status), workplace characteristics (number of employees in company and whether health insurance is provided by employer), and occupation (carpenter or roofer, painter or dry wall worker, laborer, supervisor, or other skilled trades). Additionally, interactions between ethnicity and each occupation were assessed. Manual step-wise backwards elimination was used to remove unnecessary variables from the model. **Figure 3.4** illustrates the regression model components and the formulas for the full regression models for both primary and secondary objectives. At each step, beginning with interaction terms, the variable producing the least significant contribution to the model was removed and the Bayesian Information Criteria (BIC) was observed [15]. The model with the lowest BIC was retained and is presented.

Coefficients (β) values were presented with standard errors (SE), and p-values. Associations were considered statistically significant at alpha = 0.05 and interactions were explored at alpha ≤ 0.10 All data were manually entered into Microsoft Excel and analyzed in SAS 9.4. (SAS Institute, Cary, North Carolina).

| **Figure 3.4 Regression Model components for investigating associations between ethnicity, occupation, and safety climate score.** | | |
|---|---|---|
| **Outcome of Interest** | Y = Safety Climate Score | Scores 10-39 (Continuous) |
| **Exposure of Interest** | $X_{1a}$= Ethnicity | Hispanic vs. Non-Hispanic |
| | $X_{1b\text{-}f}$ = Occupation | *Carpenter, roofer, electrician, laborer, other* |
| **Demographic Profile** | $X_1$ = Age | Continuous |
| | $X_2$ = Country of Birth | U.S., Mexico, Other |
| | $X_3$ = Length of time in the U.S. | Years |
| | $X_4$ = Language Spoken at home | 5 Levels and other |
| | $X_5$ = Number of years working in construction | Years |
| **Workplace Characteristics** | $X_6$ = Type of construction | Residential vs. Non-residential |
| | $X_7$ = Hours worked per week | Continuous |
| | $X_8$= Number of workers on site | 5 levels categorical |
| | $X_9$=Employment status | Permeant employed vs temporary / independent / unemployed |
| | $X_{10}$=Health insurance provided | Yes or No |

$$Y = \beta_0 + \overbrace{\boldsymbol{\beta_{1a}X_{1a}} + \boldsymbol{\beta_{1b-f}}}^{\text{Exposures of Interest}} \overbrace{+\boldsymbol{X_{1b-f}} + \boldsymbol{\beta_1X_1} + \boldsymbol{\beta_2X_2} \ldots + \boldsymbol{\beta_{10}X_{10}} + \boldsymbol{\beta_{1b}X_{1b}} \ldots + \boldsymbol{\beta_{1f}X_{1f}}}^{\text{Potential Confounding Variables}} + \overbrace{\boldsymbol{\beta_{1a1b}X_{1a}X_{1b}} \ldots + \boldsymbol{\beta_{1a1f}X_{1a}X_{1f}}}^{\text{Ethnicity x Occupation Interaction}}$$

**Data Analysis (Aim 2)**

**Aim 2** used a cross-sectional study design in order to investigate the role of ethnicity on the association between workplace injury and safety climate score. The **primary objective** is to investigate the association between the occurrence of workplace injury and safety climate. The **secondary objectives** include investigating associations, among those who have been injured at work, between safety climate score and, reporting injury to a supervisor.

Participant demographic and workplace characteristics were summarized and chi-square and t-test analyses were performed to detect statistical differences between injured and non-injured workers. Pearson correlation coefficients were calculated for all workplace characteristics, and the Shapiro-Wilks test was used to assess normality of safety climate scores. Safety climate scores and its individual components were presented and compared between injured and non-injured participants using t-tests. Cronbach's alpha was computed for the safety climate score's components in order to test for internal consistency on the safety climate scale.

Multivariate logistic regression was used to examine the association between safety climate scores (10-39) and injury in the previous 3 years (yes or no), while adjusting for other variables. The full logistic regression model considered injury as the outcome of interest, previous risk factors (occupation, number of employees, number of hours worked a week, and type of construction), and other individual and workplace characteristics (age, alcohol consumption, employment status, work provided health insurance). A logistic regression model was performed for the total population and stratified by ethnicity based on our a priori hypothesis. Manual backwards elimination was used for each model, eliminating the variable with the highest p-value and examining the Akaike information criterion (AIC) at each step [16]. The model with the lowest AIC was retained and presented with previously known risk factors preserved in the model.

Coefficients (β) values were presented with standard errors (SE), and p-values. **Figure 3.5** illustrates the logistic regression model components and the formula for the full regression model for both primary and secondary objectives.

Injury characteristics were presented and compared between Hispanics and non-Hispanic construction workers using chi-square tests. Among participants who had been injured, a logistic regression model was used to examine the association between safety climate and reporting an injury to a supervisor, while adjusting for other variables. Similar to previous logistic regression model, manual backward elimination, examining each model's AIC was used to find the best fitting model.

Associations were considered statistically significant at alpha = 0.05. All data was manually entered into Microsoft Excel and analyzed in SAS 9.4. (SAS Institute, Cary, North Carolina).

**Figure 3.5 Logistic Regression Model components for investigating the association between Ethnicity, Safety Climate Score and Workplace Injury**

| | | |
|---|---|---|
| **1° Outcome(s) of Interest** | $Y_1$ = Workplace Injury that resulted in days missed or medical treatment in previous 3 years | Yes or No |
| **2° Outcomes of Interest** | $Y_2$ = Report Injury to Supervisor | |
| **Exposure of Interest** | $X_1$ = Safety Climate Score | Score 10-39 |
| **Demographic Profile** | $X_2$ = Ethnicity | Hispanic vs. Non-Hispanic |
| | $X_3$ = Age | Years |
| | $X_4$ = Country of Birth | U.S., Mexico, Other |
| | $X_5$ = Length of time in the U.S. | Years |
| | $X_6$ = Number of years working in construction | Years |
| **Workplace Characteristics** | $X_7$ =Type of construction | Residential vs. Non-residential |
| | $X_8$ = Number of workers on site | 5 levels categorical |
| | $X_9$ = Employment status | Permeant vs temporary |
| | $X_{10}$ = Hours worked per week | Hours |

$$Log\left[\frac{Y}{(1-Y)}\right] = \beta_0 + \overbrace{\beta_1 X_1}^{\text{Exposure of Interest}} + \overbrace{\beta_2 X_2 + \beta_3 X_3 \ldots + \beta_{10} X_{10}}^{\text{Risk factors and confounding variables}}$$

**Biases**

There were biases inherent in the survey methods that were accounted for in this investigation. Steps were taken to account for (1) interviewer and (2) recall bias. *Interviewer bias:* It is possible that interviewers may influence questionnaire responses by encouraging or interpreting certain responses. In order to account for this possibility, interviewers were trained and instructed to abstain from interpreting questions or responses and were told to read each question exactly as worded.

*Recall Bias:* As with any measurement that is based on individuals remembering things from the past, memory is biased. It is possible that individuals who were injured more severely and more recently remembered more clearly their injury and individuals who had minor injuries in more distant past had more difficulty remembering. This bias would result a conservative estimation of injury history with less severe injuries omitted This will likely cause more individuals incorrectly being classified as non-injured, resulting in bias towards null and a conservative estimation of the association.

## Chapter 3 - Part 2: Mortality among Mexican construction workers. (Aim 3)

### Data Collection

The Consulate General of Mexico in Atlanta is overseen by the Mexican Secretary of Exterior Relations and is one of 50 diplomatic offices in the United States that acts to assist and protect Mexican citizens in the United States. This consulate serves Mexican nationals in Georgia, Alabama, and eastern Tennessee. In addition to representing its citizens in issues of documentation and protection, the consulate facilitates proper handling and documentation of deceased Mexican citizens. For all Mexican citizens who die in the U.S., the appropriate Consulate is involved for purposes of repatriation or legal issues, and documentation, including a death certificate, is maintained. Data has was abstracted from death certificates maintained by the Consulate General of Mexico's Office of Protection. A standard U.S. Death certificate is presented in Appendix F.

**Population**

The population for this investigation included all Mexican National Deaths above 16 years old that were reported to the Atlanta, Georgia Mexican Consulate between the years 2003-2013. For the time period of investigation were approximately 3200 death records, 1159 for construction industry workers and 104 in the construction industry with the cause of death indicated as occupationally related. All cases of death were coded using International Statistical Classification of Diseases and Related Health Problems (ICD), 10th revision [17]. Industry and occupations were coded using National Institute of Occupational Safety and Health's Industry and Occupation Coding Systems[18], based on 2010 Standard Occupation Classification System(SOC) [19] and 2012 North American Industry Classification System (NAICS) [20].

**Data Analysis (Aim 3)**

Age-adjusted Standardized Mortality Rates (SMR) were used to compare proportions of occupational-related deaths between construction industry occupations. Logistic regression models were used to examine the relationship between manners of death not related to occupation and employment in the construction industry (yes or no). Bivariate comparisons, SMR's, and logistic regression analyses were restricted to the male population due to the small number of female construction workers (<1%). Sensitivity analysis, including all females, were performed in order to determine how their removal impacted the study's results.

Population characteristics were presented for the entire study population and events leading to death were presented for individuals in the construction industry. Bivariate comparisons of population characteristics were made between individuals working in construction industries and other industries using chi square tests and t-tests.

Indirect age-standardized mortality ratios were calculated using five-year age increments with the overall study population as the standard population. SMRs were calculated for each construction occupation with over five occupational deaths. This resulted in four occupational categories used in the analysis: 1) carpenter, 2) roofer, 3) mason, 4) laborer, with the remaining occupations grouped as 'other'. Based on the age distribution of the entire study population the number of expected deaths was calculated for each occupation-specific age strata, and added together. The age-adjusted SMR was calculated by dividing the observed number of deaths by the expected number of deaths for each occupation. Ratios greater than 1.0 indicated having more occupational deaths than expected, and ratios less than 1.0 indicated fewer. Statistical significance of the SMR's was assessed using 95% confidence intervals [21]. The formulas for the age-adjusted SMR and Mantel-Haenszel Chi Square are presented in **Figure 3.6**.

**Figure 3.6 Formulas for Age-adjusted Proportionate Mortality Ratios and Test of Significance**

| | *Occupation Related Death* | *All Deaths* |
|---|---|---|
| *Construction Occupation X* | $n_i$ | $N_i$ |
| *All Construction Occupations* | $M_i$ | $T_i$ |

*i = i'th age group*
*$n_i$ = observed number of work related deaths in occupation X in the i'th age group*
*$M_i$ = total number of work related deaths in i'th age group*
*$N_i$ = total number of deaths in occupation B in the i'th age group*
*$T_i$ = total number of deaths in i'th age group*

$$E(n_i) = \frac{M_i N_i}{T_i}$$

$$Age - Adjusted\ Proportionate\ Mortality\ Ratio\ (PMR) = \frac{\sum_{i=1}^{5} n_i}{\sum_{i=1}^{5} E(n_i)}$$

Mantel-Haenszel Test for Significance

$$X_{MH}^2 = \frac{\left[\sum_{i=1}^{5} n_i - \sum_{i=1}^{5} E(n_i)\right]^2}{\sum_{i=1}^{5} \frac{M_i(T_i - M_i)N_i(T_i - N_i)}{T_i^2(T_i - 1)}}$$

Logistic regression was used to assess whether being a construction industry worker was associated with non-work related fatalities, while adjusting for age. There were no model reduction steps. Occupation was the primary exposure of interest and age was forced into the model because of its inherent association with death.  In order to compare each manner of death to all others and because the manners of death are mutually exclusive, separate logistic regression models were analyzed for each (accident, natural, homicide, suicide, and unknown). Adjusted odds ratios with 95% confidence intervals (CI) were presented. **Figure 3.7** illustrates the logistic regression model components and the formula for the full regression model.

| **Figure 3.7. Logistic Regression Model components for investigating the association between Manner of Death not related to Occupation and Construction Industry Occupation** | |
|---|---|
| Outcomes of interest | $Y_1$ = Manner of death - Suicide |
| | $Y_2$ = Manner of death – Homicide |
| | $Y_3$ = Manner of death – Accident |
| | $Y_4$ = Manner of death – Natural |
| Exposure of Interest | Construction Industry Employment |
| Potential Confounding Variables | X1=Age |
| | X2=Gender |

$$Log\left[\frac{Y}{(1-Y)}\right] = \beta_0 + \beta_1 X_1 + \beta_3 X_{age} + \beta_3 X_{gender}$$

Associations were considered statistically significant at α≤0.05 and all statistical analyses were performed using S.A.S. 9.3 (SAS Institute, Cary, NC, USA).

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# CHAPTER 4
# PERCEIVED SAFETY CLIMATE AND ETHNICITY AMONG CONSTRUCTION WORKERS

## Introduction

"Safety climate" refers to the relative priority of safety in the workplace and workers' perception of the importance of safety over production [1] and is understood as a snapshot of safety culture [2-4]. A higher safety climate is indicative of an employee's greater perception of the importance of safe conduct at their job [5]. Safety climate has been shown to be a reliable predictor of safety and safety-related outcomes, such as reduced injury frequency and severity, safe behaviors [6], company accident rates [7], and self-reporting injury [8]. Safety climate has been shown as a promising tool in shaping interventions by focusing on combining organizational factors and individual characteristics to improve workplace safety outcomes [9, 10]. Research has supported the importance of safety climate research in the construction industry [11], finding psycholosocial factors to be more influential to worker safety than the physical condition of the work site [6].

Attention to safety climate is critical in the construction industry, as it is made up of over 1.1 million workers [12] and perennially leads all other industries in the number of fatalities [13]. In 2013, the construction industry accounted for the largest share (18%) of occupational deaths among U.S. industries[13]. In the United States, the construction industry is composed of approximately 25%

Hispanic workers [14] and they are disproportionately affected by occupational fatalities and injuries. The rate of fatal work related injuries among the Hispanic construction workforce was approximately 32% higher than their non-Hispanic counterparts (11.5 vs 8.7 / 100,000 full time workers) in 2013 [13].

While nationally reported rates of non-fatal occupational injury in the construction industry were comparable to all industries combined in 2013 (3.8 vs 3.5 per 100 full time workers), a general consensus supports the notion that construction injuries are underreported [15-17] and have incomplete ethnicity data. Researchers have estimated that the nationally reported construction injury rates are between a 3-10 fold [16, 18] underestimation of actual injury rates and 40% of cases have missing data on race/ethnicity [19].

While safety climate has been studied among Hispanic construction workers [18, 20], it has not been studied in comparison with other ethnicities. The primary objective of this study is to investigate the relationship between safety climate scores and ethnicity among construction workers. Additionally, we explore the relationship between individuals' primary occupations, safety climate scores, and ethnicity. We hypothesize that Hispanic ethnicity will be associated with lower safety climate scores and that the association between occupation and safety climate will differ between ethnicities.

## Methods

### Data Collection

The perceived safety climate measure that was used was developed for construction workers and evolved [21, 22] from Zohar's inaugural work on safety climate measurement [5]. It was chosen for its simplicity/brevity and previously effective use in construction industry research among Hispanic populations [16, 20]. The safety climate measurement tool is composed of 10 questions (**Table 4.2**) and is summed for a total score with a minimum of 10 and maximum of 39 points. A higher score is indicative of a safer work environment as perceived by the worker.

Surveys were administered at local construction sites and home improvement stores in July and August 2015, in Athens, Georgia (GA). Surveys collected a brief demographic profile of the individual, workplace characteristics, occupation, and included a validated 10 question safety climate measure [20]. The surveys were created in English, translated to Spanish and back-translated to English to ensure accuracy. As an incentive for participation, a $5 donation for each respondent was contributed to the Boys and Girls Club of Athens, GA.

Convenience sampling procedures were used. Individuals and groups were approached, asked if they were 18 years old and employed in the construction industry. Individuals were not targeted or intentionally oversampled based on race/ethnicity or gender. On construction sites, a manager was identified and asked for approval to request the participation of their workers. At home improvement stores, all individuals exiting the stores were approached. Each individual was told the purpose of the survey, read an informed consent script, and informed about the project incentive. Willingness to participate in the survey was tallied in order to calculate participation rate. Surveys conducted in Spanish were administered by a native Spanish language speaker and all surveyors were fluent in English.

A preliminary sample size target was calculated based on the ability to detect a 20% difference in perceived safety climate score, with 80% power and alpha = 0.05 between Hispanic and non-Hispanic respondents (3:1 ratio) [23]. The ratio of Hispanic participants was intermittently monitored in order to preserve the desired detectable difference, power, and accuracy while maintaining efficiency. All study procedures and survey instruments were approved by the University of Georgia's Institutional Review Board for Human Subjects Research.

**Data Analysis**

Participant demographic and workplace characteristics were presented and chi-square and t-test analyses were performed in order to detect differences between Hispanic and non-Hispanic participants. Collinearity was assessed by examining each variables variance inflation factor (VIF), and the Shapiro-Wilks test was used to assess normality of perceived safety climate scores. Cronbach's alpha was computed for the perceived safety climate score's components in order to test for internal consistency on the perceived safety climate scale.

Demographic and work place characteristics were compared between Hispanic and non-Hispanic participants using chi-square tests for categorical variables and t-tests for continuous variables. Univariate linear regression analyses were used to examine the crude associations between the perceived safety climate score and demographic or workplace characteristics. Multivariate linear regression analyses considered perceived safety climate scores (10-39) as the outcome of interest and ethnicity (Hispanic or non-Hispanic) as the exposure of interest. This regression model was composed of all individual characteristics (age, years working in construction, alcohol consumption, and employment status), workplace characteristics (number of employees in company and whether health insurance is provided by employer), and occupation (carpenter or roofer, painter or dry wall worker, laborer, supervisor, or other skilled trades). Additionally, interactions between ethnicity and each occupation were assessed. Manual step-wise backwards elimination was used to remove unnecessary variables from the model. At each step, beginning with interaction terms, the variable producing the least significant contribution to the model was removed and the Bayesian Information Criteria (BIC) was observed [24]. The model with the lowest BIC was retained and is presented. Significant interaction terms were explored by stratifying the regression model without further model reducing steps.

Coefficients (β) values were presented with standard errors (SE), and p-values. Associations were considered statistically significant at alpha = 0.05 and interaction was explored at alpha ≤ 0.10   All data was manually entered into Microsoft Excel and analyzed in SAS 9.4. (SAS Institute, Cary, North Carolina).

## Results

One hundred and seventy-nine surveys of construction workers were conducted and all surveys that were started were completed.  During a sample time frame, approximately 64% of eligible non-Hispanics and 69% of eligible Hispanics completed the survey over a three day participation rate sample.  The average participant was 43 years, approximately half of the respondents worked primarily in residential construction (47%), and were temporary employees or self-employed (47%). The majority worked for companies with less than 10 employees (75%), did not receive health insurance from work (76%), and drank at least one alcoholic beverage a day (63%).   The majority of individuals in the study sample were carpenters or roofers (39%), followed by laborers (22%), painters and dry wall workers (14%), other skilled trades (14%), and supervisors (11%).  Only 2 of the 179 participants were women.

Among Hispanic workers, 66% (n=38) were born in Mexico, 33% (n=19) were born in other Central and South American countries, and one respondent was born in the United States (Listed in **Table 4.1**).  Less than 10% of Hispanic respondents spoke exclusively English in their homes.  Hispanic workers were significantly younger, were more likely to be self-employed or temporary employees, were more likely to work as dry wall/painters or laborers, and less likely to be supervisors or roofers/carpenters than non-Hispanic workers.  All demographic and workplace characteristics and statistical comparisons between Hispanic and non-Hispanic participants are shown in **Table 4.1**.

**Table 4.2** displays the individual components (Q1-Q10) and the overall perceived safety climate scores and crude comparisons of the scores between Hispanic and non-Hispanic participants. Cronbach's alpha (0.81) indicated good internal consistency of the safety climate measure. Hispanic participants had significantly worse perceived safety climate composite scores than non-Hispanics ($t = -6.23$, $df = 177$, $p<0.0001$). Additionally, with the exception of attending regular safety meetings (Q4), Hispanic participants responded with significantly lower scores for each component than non-Hispanic participants. Results from univariate analyses of perceived safety climate score and participant characteristics are presented in **Table 4.3.** Without adjusting for other variables, Hispanic ethnicity, being a temporary or self-employed, not having health insurance from work, working for a company with fewer than ten employees, working fewer years in construction, and drinking more than 2 alcoholic beverages a day were significantly associated with lower perceived safety climate scores**.** Working in 'other skilled trade' and as a laborer were significantly associated with lower perceived safety climate, while being employed as a supervisor was significantly associated with a higher perceived safety climate.

**Table 4.4** presents the results of the multivariate linear regression model for perceived safety climate and ethnicity while adjusting for demographic variables, work place characteristics, and occupation. The full regression model included all demographic and workplace characteristics, occupation, and interaction terms for each occupation and ethnicity. After backwards elimination, the final model with the best fit was obtained (BIC=925.9). While adjusting for these variables, Hispanic ethnicity, drinking 2 or more alcoholic beverages per day, working for a company that does not provide health insurance, and working for a company with less than 10 employees were significantly associated with lower perceived safety climate scores. Additionally, the model revealed an interaction between Hispanic ethnicity and employment in 'other skilled trades' (p=0.0067).

**Table 4.5** presents a multivariate linear regression model stratified by ethnicity. Among both Hispanics and non-Hispanics, drinking at least 2 alcoholic beverages a day was associated with lower perceived safety climate, though the magnitude of association is approximately 25% stronger among Hispanics (β=-3.35 vs -2.65). Only among Hispanics, working for a company that does not provide health insurance, and being employed in 'other skilled trades' are associated with lower perceived safety climate scores. Among non-Hispanics, working in a company with less than 10 employees is significantly associated with lower perceived safety climate scores.

## Discussion

This study uses a cross-sectional study design to add valuable insight to the understanding of construction worker safety and ethnic disparities. We have provided evidence that, among a large group of construction workers, perceived safety climate scores, indicative of perceptions of the importance of occupational safety, are lower among Hispanic workers than non-Hispanic workers. It is notable that the lower perceived safety climate scores are not only a reflection of lower composite perceived safety climate, but an almost universal lower score for each individual component. Additionally, we found that ethnicity may complicate associations between workplace characteristic and perceived safety climate among some groups of construction workers, specifically among skilled trade occupations.

In addition to overall lower perceived safety climate among Hispanics, we found that working for a company that does not offer health insurance and being employed in a skilled trade [other than roofing or carpentry, or paint/dry wall] was associated with lower perceived safety climate. In both Hispanic and non-Hispanic groups, drinking in excess of 2 alcoholic beverages per day was associated with lower perceived safety climate and among non-Hispanic workers, working for a company with less than 10 employees was associated with lower perceived safety climate. Also, among Hispanics, this appears to be the case, but the association is not statistically significant. Perceived safety climate scores in our overall population ($\mu = 30.6$) and among Hispanic ($\mu=28.2$) and non-Hispanic ($\mu=31.9$) workers were higher than Arcury's safety climate study among Latino roofers ($\mu=26.5$) and among Latino residential construction workers ($\mu=23$) [15, 25].

While the association between working as a laborer and a lower perceived safety climate was not statistically significant, it is important to recognize the marginal p-value ($p=0.0674$). Attention to laborers' safety climate is warranted because construction laborers have the highest annual number of fatalities and injuries in the construction industry [13, 26]. We were surprised that we did not observe an association between carpentry/roofing and perceived safety climate, as these are considered to be very risky occupations. The rate of occupational fatalities among roofers is 4.5 times higher [13] and the rate of injury is 20% higher among carpenters than other construction workers[26] . It is possible that carpenters and roofers have become more attentive to safety via experiences with risks and injuries. Conventional safety climate models understand safety climate to be an antecedent to injury as well as subsequent to injuries, near misses, and cumulative safety related experiences [27], therefore a higher safety climate score could be the result of dangerous conditions and past injury experiences. The results of this study suggest attention should be paid to addressing safety climate among Hispanic construction workers. Little evidence exists supporting the use of broad stroke policies such as legislative or regulatory interventions in improving construction safety outcomes [28-30]. Hispanic construction workers report institutional challenges such as supervisor pressure, competition for jobs, and discouragement from raising safety concerns as barriers to workplace safety [31]. Additionally, Hispanics in the construction industry have relatively low health literacy [32] and report limited use of personal protective equipment (PPE) when they felt it limited productivity or was uncomfortable [25]. Low-wage, foreign-born Hispanic construction workers reported more frequent hazards at work, more frequent injuries, less knowledge of workers' compensation laws, less work training, and less health care access (access to a doctor and health insurance) than their counterparts in other industries [33]. Alternatively, effective interventions have focused on participatory approaches that are aware of social, economic, and cultural background of Hispanic workers [34]. Effective interventions for small businesses/companies have identified and partnered with respected intermediaries who have likeminded interest, such as vendors or service suppliers [28]. It is also essential to target employers, focusing on their obligation to provide safe workplaces [35]. In other industries, such as agriculture, community health educators (*promotores*) have been effective in educating workers and their families of occupational risks and promoting safer work place behavior [36-38]. These types of models could be effective in educating Hispanic construction workers.

The results of this study must be considered with the understanding of a few limitations. First, as with any cross-sectional study design, we are limited in our ability to detect cause and effect relationships. Additionally, our study sample was not representative of the construction industry in Georgia. Our study sample was composed of a greater portion of individuals who work for small companies and a greater share of Hispanic workers. In Georgia, construction companies with more than 10 employees employ the largest number of workers [39], while our study population was composed of mostly individuals working for smaller companies. Little is known about occupational injury and safety in small construction companies because the Occupational Safety and Health Administration (OSHA) exempts companies with 10 or fewer employees from reporting occupational injuries that do not involve fatalities or hospitalization of 3 or more employees [40]. Additionally, it is estimated that 25% of the construction labor force in the U.S. is Hispanic [41], while our study sample is composed of close to 40%. However, it is possible that our population more closely approximates the true percentage of Hispanic workers, as our sample selection is inclusive of formal and informal construction employment. Lastly, the number of surveys were based on sample size calculations that estimated an adequate population size that was necessary to detect perceived safety climate differences between ethnicities, therefore all secondary aims may be under powered due to limited sample size.

In contrast to other safety climate investigations, in other industries, which have investigated safety climate among workers who are all employed at the same company, we have compiled perceived safety climate from unspecified affiliation. While this approach is unconventional in the field of safety climate research, this may be the only way to compose a measure of safety climate among this population who are largely composed of independent workers and small companies. While safety climate is largely understood to be a company or organizational attribute, it has been found to exist at many different tiers of an organizational structure [42]. While treating safety climate as a population level characteristic may be unconventional, it is not new and has been used in the past among construction workers [16, 18, 20].

## Conclusion

This study provides evidence that disparities in perceived safety climate exist between Hispanic and non-Hispanic construction workers. The lower perceived safety climate scores among Hispanic workers indicate that the perception of the importance of safety on the job site is lower among Hispanic construction workers than non-Hispanic construction workers. While disparities exist between Hispanic and non-Hispanic construction workers it is important to recognize occupational injury is a concern and occupational safety research should be a priority for both ethnic groups. Future studies must investigate the mechanisms for which the perceptions of the importance of safety can be improved among all construction workers, catering to sub-populations' characteristics.

**Table 4.1. Characteristics of construction workers and comparisons between Hispanic (n=58) and non-Hispanic (n=121) respondents in Athens, Georgia, 2015**

| | Total N (%) | Non-Hispanic N (%) | Hispanic N (%) | p-value |
|---|---|---|---|---|
| **Age (Mean years, Std[1])** | 43 (12.1) | 46 (12.4) | 37 (8.9) | <0.0001[2] |
| **Years working construction (Mean, Std[1])** | 18 (13.2) | 9 (7.3) | 23 (20.6) | <0.0001[2] |
| **Hours worked per week (Mean, Std[1])** | 44 (14.2) | 46 (14.4) | 41 (13.7) | <0.0001[2] |
| **Gender** | | | | |
| Male | 157 (98.9) | 119 (98.3) | 58 (100) | 0.32 |
| Female | 2 (1.1) | 2 (1.7) | 0 | |
| **Alcohol consumption[3]** | | | | |
| None | 63 (36.6) | 46 (38.3) | 17 (32.7) | 0.72[4] |
| 2 or less drinks/day | 88 (51.2) | 59 (49.2) | 29 (55.8) | |
| More than 2/day | 21 (12.2) | 15 (12.5) | 6 (11.5) | |
| missing | 7 | 1 | 6 | |
| **Type of Construction** | | | | |
| Residential | 85 (47.5) | 54 (44.6) | 31 (53.5) | 0.46[4] |
| Commercial | 25 (14.0) | 19 (15.7) | 6 (10.3) | |
| Residential and commercial | 69 (38.6) | 48 (39.7) | 21 (36.2) | |
| **Language Spoken at Home** | | | | |
| English | 126 (70.4) | 121 (100) | 5 (8.6) | <0.0001[4] |
| Spanish | 22 (12.3) | 0 | 22 (37.9) | |
| Both | 31 (17.3) | 0 | 31 (53.5) | |
| **Health Insurance** | | | | |
| Yes | 43 (24.0) | 29 (24.0) | 14 (24.1) | 0.98[4] |
| No | 136 (76.0) | 92 (76.0) | 44 (75.9) | |
| **Employment Status** | | | | |
| Permanent Employee | 95 (53.0) | 71 (58.7) | 24 (41.4) | 0.03[4] |
| Temporary/Self Employed | 84 (46.9) | 50 (41.3) | 34 (58.6) | |
| **Number of Employees in Company** | | | | |
| Less than 10 | 135 (75.4) | 97 (80.2) | 38 (66.7) | 0.26[4] |
| 10-25 | 16 (8.9) | 9 (7.4) | 7 (12.3) | |
| 26-50 | 6 (3.4) | 3 (2.5) | 3 (5.3) | |
| 51 or more | 21 (11.7) | 12 (9.9) | 9 (15.8) | |
| missing | 1 | 1 | | |
| **Country of Birth** | | | | |
| United States | 121 (67.6) | 121 (100) | 1 (1.7)[5] | <0.0001[4] |
| Mexico | 38 (21.2) | 0 | 38 (65.5) | |
| Other[6] | 20 (11.2) | 0 | 19 (32.8) | |
| **Occupation[7]** | | | | |
| Laborer | 40 (22.3) | 11 (27.5) | 29 (72.5) | <0.0001[4] |
| Supervisor | 19 (10.6) | 17 (14.0) | 2 (3.4) | 0.03[4] |
| Other skilled trades[8] | 25 (14.0) | 19 (15.7) | 6 (10.3) | 0.33[4] |
| Painter/Dry wall | 25 (14.0) | 12 (9.9) | 13 (22.4) | 0.02[4] |
| Carpenter/roofer[9] | 70 (39.1) | 62 (51.2) | 8 (13.8) | <0.0001[4] |

[1] Standard Deviation, [2] Student's t-test, [3] Volume quantity not specified, [4] Chi-squared test, [5] Puerto Rico, [6] El Salvador (10), Guatemala (4), Peru (3), Honduras (2), [7] Statistical tests considered each occupation individually versus all others., [8]Mason (4), electrician (3), flooring installation (3), heating, venting, and air conditioning (3), pipe fitter (3), machine operator (2), mechanic (1), plumber (1), welder (1), window installation (1), appliance installation (1), concrete worker (1), [6] Carpenters (64) and roofers (6), [9] Carpenters (64) and roofers (6)

**Table 4.2. Safety climate individual component scores[1] of construction workers, Athens GA, 2015**

| | Total Mean (StD) | Non-Hispanic Mean (StD) | Hispanic Mean (StD) | P-value[2] |
|---|---|---|---|---|
| **Safety Climate (overall)** | 30.6 (4.11) | 31.9 (3.7) | 28.2 (3.9) | *<.0001* |
| **Q1- Safety practices are very important to the management where you work** | 3.6 (0.55) | 3.8 (0.41) | 3.2 (0.57) | *<.0001* |
| **Q2- Workers are regularly made aware of dangerous work practices or conditions where you work.** | 3.4 (0.65) | 3.6 (0.54) | 3.0 0.68) | *<.0001* |
| **Q3- Workers are praised for safe conduct where you work.** | 3.1 (0.69) | 3.2 (0.65) | 2.9 (0.73) | *<0.01* |
| **Q4- Workers received instructions on safety.** | 3.2 (0.73) | 3.3 (0.74) | 3.0 (0.69) | *0.02* |
| **Q5- Workers attend regular safety meetings.** | 2.6 (0.84) | 2.6 (0.84) | 2.7 (0.86) | 0.65 |
| **Q6- Proper safety equipment is always available.** | 3.3 (0.64) | 3.5 (0.61) | 3.1 (0.60) | *<.0001* |
| **Q7- Workers have almost total control over personal safety.** | 3.3 (0.64) | 3.4 (0.57) | 3.1 (0.48) | *<0.01* |
| **Q8- Taking risks is not part of my job.** | 2.7 (0.85) | 2.9 (0.90) | 2.4 (0.59) | *<.0001* |
| **Q9- The possibility of being injured at work in the next 12 months is not very likely.** | 2.7 (0.66) | 2.8 (0.68) | 2.5 (0.54) | *<0.001* |
| **Q10-Supervisors do as much as possible to make my job safe[3]** | 2.6 (0.66) | 2.8 (0.55) | 2.4 (0.80) | *<0.01* |

[1] (1) Strongly disagree, (2) Disagree, (3) Agree, (4) Strongly Agree
[2] Student's t-tests
[3] (1) Supervisors are only interested in doing the job fast and cheap, (2) Supervisors could do more to make my job safe, (3) Supervisors do as much as possible to make my job safe

**Table 4.3. Unadjusted univariate linear regression for safety climate, and demographic and workplace characteristics, among construction workers in Athens, GA, 2015 (n=179)**

| | B[1] | SE[2] | p-value |
|---|---|---|---|
| **Ethnicity** | | | |
| Non-Hispanic | Ref | - | - |
| Hispanic | -3.71 | 0.59 | <0.0001 |
| **Age (years)** | 0.025 | 0.03 | 0.32 |
| **Years working in construction** | 0.062 | 0.02 | <0.01 |
| **Alcohol consumption** | | | |
| None | Ref | - | - |
| 2 or less/day | -0.31 | 0.66 | 0.64 |
| More than 2/day | -2.63 | 1.01 | <0.01 |
| **Type of Construction** | | | |
| Residential | ref | - | - |
| Commercial | 4.14 | 0.88 | <0.0001 |
| Residential and commercial | 1.11 | 0.63 | 0.08 |
| **Employment Status** | | | |
| Permanent Employee | ref | - | - |
| Temporary/Self Employed | -2.28 | -3.44 | <0.0001 |
| **Hours per week worked** | 0.1 | 0.20 | <0.0001 |
| **Health Insurance** | | | |
| Yes | Ref | - | - |
| No | -3.13 | 0.68 | <0.0001 |
| **Number of employees** | | | |
| Less than 10 | Ref | - | - |
| 10 or more | 2.76 | 1.43 | <0.0001 |
| **Occupations** | | | |
| Carpenter/roofers[3] | 0.18 | 0.63 | 0.78 |
| Supervisor | 2.38 | 0.98 | 0.02 |
| Laborer | -2.66 | 0.71 | <0.001 |
| Painter/dry wall | -0.59 | 0.88 | 0.51 |
| Other Trades[4] | -2.20 | 0.87 | 0.01 |

[1] Beta coefficient
[2] Standard error
[3] Carpenters (64) and roofers (6)
[4] Mason (4), electrician (3), flooring installation (3), heating, venting, and air conditioning (3), pipe fitter (3), machine operator (2), mechanic (1), plumber (1), welder (1), window installation (1), appliance installation (1), concrete worker (1)

**Table 4.4. Multivariate linear regression for safety climate versus verses ethnicity, demographic, and workplace characteristics, and occupation (n=179)[1]**

| | B[1] | SE[2] | p-value |
|---|---|---|---|
| **Ethnicity** | | | |
| Non-Hispanic | Ref | - | - |
| Hispanic | -2.28 | 0.40 | <0.0001 |
| **Alcohol consumption** | | | |
| None | Ref | - | - |
| 2 or less/day | -1.25 | 0.54 | 0.02 |
| More than 2/day | -3.10 | 0.80 | <0.0001 |
| **Health Insurance** | | | |
| Yes | Ref | - | - |
| No | -1.76 | 0.64 | <0.01 |
| **Number of employees** | | | |
| 10 or more | Ref | - | - |
| Less than 10 | -2.42 | 0.66 | <0.001 |
| **Hours per week worked** | 0.05 | 0.02 | <0.01 |
| **Laborer (versus all other occupations)** | -0.64 | 0.35 | 0.07 |
| **Other Trade[3] (versus all other occupations)** | -0.66 | 0.42 | 0.12 |
| **Other Trade * Ethnicity** | -0.98 | 0.40 | 0.01 |

[1] Beta coefficient
[2] Standard error
[3] Mason (4), electrician (3), flooring installation (3), heating, venting, and air conditioning (3), pipe fitter (3), machine operator (2), mechanic (1), plumber (1), welder (1), window installation (1), appliance installation (1), concrete worker (1)

**Table 4.5. Multivariate linear regression for safety climate versus ethnicity, demographic and workplace characteristics, and occupation (n=179)**

| | Non-Hispanic (n=121) | | | Hispanic (n=58) | | |
|---|---|---|---|---|---|---|
| | B[1] | SE[2] | p-value | B[1] | SE[2] | p-value |
| **Alcohol consumption** | | | | | | |
| **None** | Ref | - | - | Ref | - | - |
| **2 or less/day** | -1.11 | 0.63 | 0.08 | -1.87 | 1.00 | 0.06 |
| **More than 2/day** | -2.8 | 0.90 | <0.01 | -3.86 | 1.53 | 0.01 |
| **Health Insurance** | | | | | | |
| **Yes** | Ref | - | - | Ref | - | - |
| **No** | -0.90 | 0.78 | 0.25 | -2.96 | 1.18 | 0.01 |
| **Number of employees in Company** | | | | | | |
| **10 or more** | Ref | - | - | | | |
| **Less than 10** | -3.4 | 0.90 | <0.0001 | -1.83 | 1.03 | 0.08 |
| **Hours per week worked** | 0.06 | 0.02 | <0.01 | 0.03 | 0.04 | 0.42 |
| **Laborer (versus all other occupations)** | -0.31 | 0.51 | 0.54 | -0.83 | 0.51 | 0.10 |
| **Other Trades[3] (versus all other occupations)** | 0.29 | 0.44 | 0.52 | -1.95 | 0.78 | 0.01 |

[1] Beta coefficient
[2] Standard error
[3] Mason (4), electrician (3), flooring installation (3), heating, venting, and air conditioning (3), pipe fitter (3), machine operator (2), mechanic (1), plumber (1), welder (1), window installation (1), appliance installation (1), concrete worker (1)

## References - Chapter 4


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# CHAPTER 5
# PERCEIVED SAFETY CLIMATE AND INJURY AMONG CONSTRUCTION WORKERS

## Introduction

In 2014, the construction industry in the United States employed close to 10 million individuals [1]. Of these employed individuals, 200,000 were injured, 110,000 missed work due to their injuries [2], and 908 were injured fatally [3]. While the rates of injury in the construction industry have fallen in recent years, it is well-documented that occupational injuries are drastically underreported [4-6] and the number of construction industry fatalities has increased 16% from 2009. Additionally, there has not been recent improvements in the trends of construction industry fatality rates [3]. National programs, such as Healthy People 2020 and National Construction Agenda have recognized the burden and prioritized the reduction of construction industry injuries [7, 8].

Many risk factors for injury in the construction industry have been identified. Larger companies with more than ten employees are considered safer than small ones [9, 10] and certain occupations such as laborers and unskilled workers, carpenters, and roofers have been associated with higher risks of injury and fatalities. [5, 11, 12]. Additionally, Hispanic workers and working at residential construction sites has been associated with increased risks of fatal falls [13, 14].

Safety culture has been defined as ‘the product of individual and group values, attitudes, perceptions and patterns of behavior that determines a team or organization’s commitment to safety management’ [15]. “Safety climate” refers to the relative priority of safety in the workplace and workers’ perception of the importance of safety over production [16] and is understood as a snapshot of safety culture [17-19]. A higher or more positive safety climate is indicative of an employee’s greater perception of the importance of safe conduct at their job [20]. Safety climate has been shown to be a reliable predictor of safety and safety-related outcomes, such as reduced injury frequency and severity, safe behaviors [21], company accident rates [22], and self-reporting injury [23]. In one investigation among Hispanic roofers in North Carolina, a moderately significant association was found between lower safety climate and increased risk of injury [24].

Attention to safety climate and ethnic injury disparities in the construction industry are warranted, as 25% of construction workers are Hispanic and they are injured at a disproportionately high rate [25]. While there is literature that associates safety climate scores with safety related behaviors (Use of personal protective equipment, reporting injuries to supervisors, company accident rates, etc.) [21-23], there is limited evidence that safety climate is associated with injuries in the construction industry and it is unclear if safety climate’s association with injury differs by ethnic subgroup. The goal of this study is to investigate the role of ethnicity on the association between workplace injury and perceived safety climate among construction workers.

# Methods

## Data Collection

Surveys were sampled conveniently at local construction sites and home improvement stores in July and August 2015, in Athens, Georgia (GA). Surveys collected a brief demographic profile of the individual, workplace characteristics, occupation, and a validated 10-question safety climate measure [26]. The surveys were created in English, translated to Spanish and back-translated to English to ensure accuracy. Individuals and groups were approached, asked if they were 18 years old and employed in the construction industry. Individuals were not targeted or intentionally oversampled based on race/ethnicity or gender. On construction sites, a manager was identified and asked for approval to request the participation of their workers. At home improvement stores, all individuals exiting the stores were approached. Each individual was told the purpose of the survey, read an informed consent script, and informed of the project incentive. Participation consent was accepted verbally. Willingness to participate in the survey was tallied over a 3 day sample in order to calculate participation rate. All surveys were administered by study personnel in order to ensure that all survey questions were answered. Surveys conducted in Spanish were administered by a native Spanish language speaker and all surveyors were fluent in English. Our investigation did not ask foreign-born Hispanic workers to reveal their migration status. As an incentive for participation, a $5 donation for each respondent was contributed to the Boys and Girls Club of Athens, GA.

The safety climate measure used in the current study was developed for construction workers and evolved from Zohar's inaugural work on safety climate measurement [20, 27, 28]. It was chosen for its simplicity/brevity and previous effective use in construction industry research among Hispanic populations [5, 26]. The safety climate measurement tool is composed of 10 questions (listed in **Table 5.2**) and is summed for a total score with a minimum of 10 and maximum of 39. A higher score is indicative of a safer work environment as perceived by the worker.

In addition to perceived safety climate, individuals were asked their age, the number of years they worked in construction, the typical number of alcoholic beverages they drink per day, then number of workers in their company (less than 10, 10-25 workers, 26-50 workers, or 51+ workers) their ethnicity/race, and their usual occupation. Additionally, we inquired their employment status (permanent or temporary), their type of construction (residential, commercial, or both), and whether they receive health insurance from work. All individual were asked their country of birth and the language(s) spoken in their household. Lastly, we asked the participants if they had any injuries that limited their ability to do their job in the previous 3 years. If they had been injured, they were asked to describe how the injury happened, whether they missed work due to the injury, what type of medical treatment they received (hospital or doctor, first aid, or none), whether they reported the injury to a supervisor, or whether they filed for workers compensation.

All study procedures and survey instruments were approved by the University of Georgia’s Institutional Review Board for Human Subjects Research.

Implementation

**Data Analysis**

Participant demographic and workplace characteristics were summarized and chi-square and t-test analyses were performed to detect statistical differences between injured and non-injured workers. Pearson correlation coefficients were calculated for all workplace characteristics, and the Shapiro-Wilks test was used to assess normality of safety climate scores. Perceived safety climate scores and its individual components were presented and compared between injured and non-injured participants using t-tests. Cronbach’s alpha was computed for the perceived safety climate score’s components in order to test for internal consistency on the scale.

Multivariate logistic regression was used to examine the association between perceived safety climate scores (10-39) and injury in the previous 3 years (yes or no), while adjusting for other variables. The full logistic regression model considered injury as the outcome of interest, previous risk factors (occupation, number of employees, number of hours worked per week, and type of construction), and other individual and workplace characteristics (age, alcohol consumption, employment status, work provided health insurance). A logistic regression model was performed for the total population and stratified by ethnicity based on our a priori hypothesis.  Manual backwards elimination was used for each model, eliminating the variable with the highest p-value and examining the Akaike information criterion (AIC) at each step [29].  The model with the lowest AIC was retained and presented with previously known risk factors preserved in the model.  Coefficients (β) values were presented with standard errors (SE), and p-values.

Injury characteristics were presented and compared between Hispanics and non-Hispanic construction workers using chi-square tests.  Among participants who had been injured, a logistic regression model was used to examine the association between perceived safety climate and reporting an injury to a supervisor, while adjusting for other variables.  Similar to previous logistic regression model, manual backward elimination, examining each model's AIC was used to find the best fitting model.

Associations were considered statistically significant at alpha = 0.05. All data was manually entered into Microsoft Excel and analyzed in SAS 9.4. (SAS Institute, Cary, North Carolina).

## Results

One hundred and seventy-nine surveys of construction workers were completed and all surveys that were started were completed.  **Table 5.1** displays the characteristics of the survey participants.  Approximately 64% of eligible non-Hispanics and 69% of eligible Hispanics completed the survey (sampled 3 days).

The average age of the participants was 43 years (range: 19-70 years), approximately half of the respondents worked primarily in residential construction (47%), and were temporary employees or self-employed (47%). The majority worked for companies with less than 10 employees (75%), did not receive health insurance from work (76%), and drank at least one alcoholic beverage a day (63%). The majority of individuals in the study sample were carpenters or roofers (39%), followed by laborers (22%), painters and dry wall workers (14%), other skilled trades (14%), and supervisors (11%). Only two of the 179 participants were women. Of the total sample, 51 (28%) reported having had been injured in a way that limited their work in the previous 3 years.

Characteristics and comparisons of injured and non-injured participants are presented in **Table 5.1**. Of the Spanish-speaking participants, those who were injured were more likely to speak both Spanish and English in their household, rather than only Spanish (p=0.02; Table 5.1). Painters and drywall workers were less likely to be injured than individuals who did not work in those professions. There were no other statistically significant differences between those who had been injured or not in the previous 3 years.

**Table 5.2** displays the individual components (Q1-Q10) and the overall perceived safety climate scores and crude comparisons of the scores between injured and non-injured participants. Cronbach's alpha (0.81) indicated good internal consistency of the perceived safety climate measure. There was no significant difference in perceived safety climate scores between those who were injured

($\mu$=30.0) and not injured ($\mu$=30.9). With the exception of Q9, there were no significant differences in the individual safety climate component scores between injured and non-injured participants. Participants who were not injured in the previous 3 years were significantly less likely to believe that they would be injured in the next 12 months ($p<0.0001$; Table 5.2, Q9). Workers who had not been injured appear to have higher scores for Q4 (workers receive instructions on safety) and Q8 (taking risks is not part of my job), though the difference is not statistically significant.

**Table 5.3** presents the results of the multivariate logistic regression model for injury in the previous 3 years and perceived safety climate, while adjusting for confounding variables. All individual and workplace characteristics were removed in the backwards elimination process, and only previous risk factors were preserved. After adjusting for the type of construction performed (residential vs. residential and commercial), the number of employees in company (less than 10 vs. 10 or more), and occupation, there was not a significant association between perceived safety climate scores and injury in the previous 3 years. The stratified analysis, based on a priori hypothesis, revealed the same null association in both Hispanic and non-Hispanic populations.

Sensitivity analyses considered only injuries that resulted in one or more full day(s) of work missed and medical treatment provided by a physician or hospital. This injury definition more closely approximated the U.S. Department of Labor's Occupational Safety and Health Administration's (OSHA) definition of reportable injury that requires companies with over 10 employees to report death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness [30]. There were no differences in the results of the analysis using this injury outcome.

**Table 5.4** displays the characteristic of injuries among the 51 participants who reported an injury in the previous 3 years. The majority of respondents (69%) missed less than a full day of work due to their injury and over half (55%) received treatment at the hospital or doctor's office. Fifty three percent reported their injury to their supervisor and an overwhelming majority (90%) did not apply for federal workers compensations. The majority of injury events were due to contact with objects and equipment (47%), followed by falls (22%) and overexertion (22%). The characteristics of injuries did not differ significantly between Hispanic and non-Hispanic workers, though non-Hispanic participants appeared to receive medical treatment from hospitals and doctors more often than Hispanic participants though this association is not statistically significant ($p = 0.06$; Table 5.4).

**Table 5.5** displays a multivariate logistic regression model for the association between perceived safety climate and reporting an injury to a supervisor among those who had experienced an injury in the previous 3 years. Analysis revealed no significant association between perceived safety climate and reporting an injury to supervisor while adjusting for employment status, ethnicity, alcohol consumption and type of construction. Individuals who worked in commercial construction or a combination of commercial and residential construction were significantly more likely to report their previous injury to a supervisor.

## Discussion

This study has provided novel understanding of the relationship between safety climate and construction site injuries with a focus on the role of ethnicity. Among a group of construction workers in Athens, GA we did not find an association between perceived safety climate and previous recent occurrence of injury. Additionally, we found that the null association between injury and perceived safety climate was not modified by ethnicity.

Our results are not completely out of line with other research that did not find positive associations between safety climate and reduced injuries [31]. This study sampled a population of individual workers, while conventional methods typically include individuals within groups or organizations. The lack of affiliation may serve as a barrier for workers to communicate and learn about others' injuries and experiences, limiting the effect of others' experiences on their own perceptions of the importance of safety and safe behaviors. This presents a challenge for the expansion of safety climate research in the construction industry that should be aiming to include this population of independent individuals and small companies as a priority. Safety climate investigations in the construction industry present challenges that are unique compared to other industries. Construction industry employment is inherently risky and presents uniquely dynamic risk [32]. Compared to other industries construction workers are more dependent on their own personal behavior to reduce risk of injury [32]. Additionally, construction site locations are often changing and separate from management facilities and offices enhancing the disconnect between management and worker safety activities [33].

The characteristics of injury among our sample populations differ from what was expected. In our sample, the leading injury event was contact with objects or equipment, followed by falls and over exertion. In 2014, in the U.S. the leading cause of injury on construction sites was overexertion (33%), followed by falls (27%), and contact with objects and equipment (22%)[2]. Our population had a relatively high proportion of carpenters and other skilled workers that may expose them to specialized and dangerous equipment. Among our population of Hispanic workers, those who spoke both English and Spanish at home were more likely to have been injured than those who just spoke Spanish. It is possible that being bilingual expands workers abilities to participate in more tasks, elevating their risk of injury.

Among our population there were few individuals who filed for workers compensation, none of which were Hispanic. The association was not statistical significant, but it appears that Hispanic workers are less likely to report their injury to a supervisor and are less likely to receive treatment from their injury at a hospital or with a doctor. Additionally, individuals who work in commercial construction are more likely to report an injury to a supervisor. Surveillance improvement efforts that attempt to more fully capture the occurrence of injuries in the construction industry should consider these factors. In order to confirm these associations definitively, further research is necessary that includes a larger sample of injured individuals.

Perceived safety climate scores in our overall population (μ= 30.6), among Hispanic (μ=28.2) and non-Hispanic (μ=31.9) workers were higher than Arcury's safety climate study among Latino roofers (μ=26.5) and among Latino residential construction workers (μ=23) [4, 10]. The populations all reported lower component scores regarding safety meetings, and supervisors doing as much as possible to make the job site safe. Our population responded very highly that worker safety practices were very important to the management, while the populations in Arcury's study were less agreeable. The differences may be due to the large amount of workers in our population who work in small companies which may increase the familiarity workers have with their supervisor.

While this investigation presents many strengths, some limitations need to be acknowledged. First, this study presents the results of a cross-sectional survey, which is limited in its ability to detect cause-and-effect relationships. While safety climate is generally considered an antecedent to injury occurrence, it is not implausible that the occurrence of an injury could encourage a worker to place increased value to the importance of safety resulting in injury occurrence being associated with higher safety climate scores. In order to determine the temporal sequence of safety climate and injury, a prospective cohort study is necessary that begins with a group of uninjured construction workers, measures safety climate, and followed over time. An additional limitation is this investigation's inability to be generalized to the overall GA construction industry. Our study sample was composed of a greater percentage of individuals who work for small companies than GA's population of construction workers. In GA, construction companies with more than 10 employees employ the largest number of workers [34], while our study population was composed of mostly individuals working for smaller companies. This is the result of our participant recruitment. While this can be considered a limitation, it is also an advantage of our study. The large proportions of workers that are part of smaller companies (less than 10 employees) are not captured by OSHA occupational injury surveillance. Additionally, while our investigation cannot be interpreted as providing generalizable rates of injury, we have provided evidence that there is a very high burden of injuries among this specific population (18% the in last year). Lastly, the calculations that were used to estimate the sample size for this investigation considered the ability to detect differences in safety climate scores between injured and non-injured workers. Our secondary outcomes, specifically reporting injuries to a supervisor, do not have adequate sample size for making firm conclusions.

Future research should address increasing communication between unaffiliated and autonomous workers that in part addresses the communication of the occurrence of injury. Additionally, the supervisor-worker relationship should be explored in order to understand how supervisors are best able to fulfill their role of maximizing safety on site. The best place for this to happen may be at locations in which workers congregate, such as hardware stores or restaurants that are frequented by construction workers. Among Hispanic workers in other industries, community health educators (promotores) have been shown to be effective in promoting occupational safety [35-37].

## Conclusion

It is clear that injuries in the construction industry are an important and burdensome issue. Our research did not corroborate disparities in risk of injuries between Hispanic and non-Hispanic construction workers that are present in surveillance data. Instead, the current study provides evidence that attention to construction industry injuries is justified across ethnicities, while paying attention to cultural differences that may challenge interventions.

**Table 5.1. Characteristics of construction workers and comparisons between injured (n=51) and non-injured (n=128) respondents in Athens, Georgia, 2015**

| | Total N (%) | Injured N (%) | Not Injured N (%) | p-value |
|---|---|---|---|---|
| **Age (Mean years, Std[1])** | 43 (12.1) | 43 (12.2) | 43 (12.1) | 0.97[2] |
| **Years working construction (Mean years, Std[1])** | 18 (13.2) | 19 (12.5) | 18 (13.6) | 0.88[2] |
| **Hours per week worked** | 44 (14.3) | 45 (13.3) | 43 (14.7) | 0.66[2] |
| **Gender** | | | | |
| Male | 177 (98.9) | 51 (100) | 126 (98.4) | 0.37[3] |
| Female | 2 (1.1) | 0 (0) | 2 (1.6) | |
| **Ethnicity** | | | | |
| Hispanic | 58 (32.4) | 18 (35.3) | 40 (31.3) | 0.60[3] |
| Non-Hispanic | 121 (67.6) | 33 (64.7) | 88 (68.8) | |
| **Alcohol consumption** | | | | |
| None | 63 (36.6) | 18 (38.3) | 45 (36.0) | 0.91[3] |
| 2 or less drinks/day | 88 (51.2) | 24 (51.1) | 64 (51.2) | |
| More than 2/day | 21 (12.2) | 5 (10.6) | 16 (12.8) | |
| missing | 7 | 4 | 3 | |
| **Type of Construction** | | | | |
| Residential | 85 (47.5) | 25 (49.0) | 60 (46.9) | 0.59[3] |
| Commercial | 25 (14.0) | 5 (9.8) | 20 (15.6) | |
| Residential and commercial | 69 (38.6) | 21 (41.2) | 48 (37.5) | |
| **Language Spoken at Home** | | | | |
| English | 126 (70.4) | 34 (66.7) | 92 (71.9) | *0.03[3]* |
| Spanish | 22 (12.3) | 3 (5.9) | 19 (14.8) | |
| Both | 31 (17.3) | 14 (27.5) | 17 (13.3) | |
| **Health Insurance** | | | | |
| Yes | 43 (24.0) | 12 (23.5) | 31 (24.2) | 0.92[3] |
| No | 136 (76.0) | 39 (76.5) | 97 (75.8) | |
| **Employment Status** | | | | |
| Permanent Employee | 95 (53.1) | 28 (54.9) | 67 (52.3) | 0.76[3] |
| Temporary/Self Employed | 84 (46.9) | 23 (45.1) | 61 (47.7) | |
| **Number of Employees in Company** | | | | |
| Less than 10 | 135 (75.8) | 42 (82.4) | 93 (73.2) | 0.23[3] |
| 10-25 | 16 (9.0) | 5 (9.8) | 11 (8.7) | |
| 26-50 | 6 (3.4) | 2 (3.9) | 4 (3.2) | |
| 51 or more | 21 (11.8) | 2 (3.9) | 19 (15.0) | |
| missing | 1 | 0 | 1 | |
| **Country of Birth** | | | | |
| United States | 122 (68.2) | 33 (64.7) | 89 (69.5) | 0.14[3] |
| Mexico | 38 (21.2) | 15 (29.4) | 23 (18.0) | |
| Other[4] | 19 (10.6) | 3 (5.9) | 16 (12.5) | |
| **Occupation[5]** | | | | |
| Laborer | 40 (22.3) | 11 (21.6) | 29 (22.7) | 0.87[3] |
| Supervisor | 19 (10.6) | 5 (9.8) | 14 (10.9) | 0.82[3] |
| Other skilled trades[6] | 25 (14.0) | 7 (13.7) | 18 (14.0) | 0.95[3] |
| Painter/Dry wall | 25 (14.0) | 3 (5.9) | 22 (17.2) | *0.05[3]* |
| Carpenter/roofer[7] | 70 (39.1) | 25 (49.0) | 45 (35.2) | 0.09[3] |

[1] Standard Deviation, [2] Student's t-test, [3] Chi-squared test, [4] El Salvador (10), Guatemala (4), Peru (3), Honduras (2), [5] Statistical tests considered each occupation individually versus all others., [6] Mason (4), electrician (3), flooring installation (3), heating, venting, and air conditioning (3), pipe fitter (3), machine operator (2), mechanic (1), plumber (1), welder (1), window installation (1), appliance installation (1), concrete worker (1), [7] Carpenters (64) and roofers (6)

**Table 5.2. Perceived safety climate individual component scores[1] of construction workers by recent occupational injury, Athens GA, 2015**

| | Total Mean (StD) (n=179) | Injured Mean (StD) (n=51) | Not Injured Mean (StD) (n=128) | P-value[2] |
|---|---|---|---|---|
| **Safety Climate (overall)** | 30.7 (4.1) | 30.0 (4.3) | 30.9 (4.0) | 0.19 |
| **Q1- Safety practices are very important to the management where you work** | 3.6 (0.55) | 3.6 (0.57) | 3.6 (0.54) | 0.74 |
| **Q2- Workers are regularly made aware of dangerous work practices or conditions where you work.** | 3.4 (0.65) | 3.4 (0.78) | 3.4 (0.60) | 0.78 |
| **Q3- Workers are praised for safe conduct where you work.** | 3.1 (0.69) | 3.1 (0.83) | 3.1 (0.63) | 0.93 |
| **Q4- Workers received instructions on safety.** | 3.1 (0.73) | 3.0 (0.86) | 3.2 (0.67) | 0.13 |
| **Q5- Workers attend regular safety meetings.** | 2.6 (0.84 | 2.5 (0.88) | 2.7 (0.82) | 0.08 |
| **Q6- Proper safety equipment is always available.** | 3.3 (0.64) | 3.4 (0.10) | 3.3 (0.05) | 0.35 |
| **Q7- Workers have almost total control over personal safety.** | 3.3 (0.56) | 3.3 (0.08) | 3.3 (0.05) | 0.99 |
| **Q8- Taking risks is not part of my job.** | 2.7 (0.85) | 2.6 (0.84) | 2.8 (0.88) | 0.22 |
| **Q9- The possibility of being injured at work in the next 12 months is not very likely.** | 2.7 (0.66) | 2.4 (0.61) | 2.8 (0.64) | <0.0001 |
| **Q10-Supervisors do as much as possible to make my job safe[2]** | 2.6 (0.66) | 2.7 (0.09) | 2.6 (0.06) | 0.62 |

[1] (1) Strongly disagree, (2) Disagree, (3) Agree, (4) Strongly Agree
[2] Student's t-tests
[3] (1) Supervisors are only interested in doing the job fast and cheap, (2) Supervisors could do more to make my job safe, (3) Supervisors do as much as possible to make my job safe
Note: Cronbach's alpha = 0.81

**Table 5.3. Logistic regression model for recent injury (In previous 3 years) and safety climate, adjusting workplace characteristics and stratified by ethnicity, among construction workers in Athens, GA (n=179)**

| | All | | Hispanic | | Non-Hispanic | |
|---|---|---|---|---|---|---|
| | **OR[1]** | **95% C.I.[2]** | **OR[1]** | **95% C.I.[2]** | **OR[1]** | **95% C.I.[2]** |
| **Safety Climate** | 1.09 | 0.99-1.20 | 1.13 | 0.92-1.37 | 1.04 | 0.91-1.18 |
| **Hours per week worked (5 hour increments)** | 0.93 | 0.81-1.06 | 0.88 | 0.65-1.19 | 0.77 | 1.07 |
| **Type of Construction** | | | | | | |
| **Residential** | ref | - | ref | - | ref | - |
| **Residential and commercial** | 0.91 | 0.43-1.93 | 0.16 | 0.03-0.85 | 1.69 | 0.65-4.35 |
| **Number of employees** | | | | | | |
| **Less than 10** | ref | - | ref | - | ref | - |
| **10 or more** | 1.60 | 0.59-4.10 | 6.73 | 1.02-44.3 | 0.83 | 0.20-2.13 |
| **Occupations[5]** | | | | | | |
| **Carpenter/roofers[3]** | 0.73 | 0.22-2.45 | 1.76 | 0.06-51.6 | 0.53 | 0.13-2.13 |
| **Laborer** | 1.26 | 0.33-4.79 | 0.24 | 0.24-167.5 | 1.44 | 0.26-8.03 |
| **Painter/dry wall** | 3.20 | 0.61-16.68 | 14.6 | 0.42-508.4 | 0.81 | 0.13-5.18 |
| **Other Trades[4]** | 0.84 | 0.20-3.52 | 0.82 | 0.02-37.0 | 2.85 | 0.24-34.0 |

[1] Beta coefficient
[2] Standard error
[3] Carpenters (64) and roofers (6)
[4] Mason (4), electrician (3), flooring installation (3), heating, venting, and air conditioning (3), pipe fitter (3), machine operator (2), mechanic (1), plumber (1), welder (1), window installation (1), appliance installation (1), concrete worker (1)
[5] Statistical tests considered each occupation individually versus all others.

**Table 5.4. Characteristics of injuries among surveyed construction workers, Athens GA, 2015 (n=51)**

| | Total | Hispanic | Non-Hispanic | |
|---|---|---|---|---|
| | N (%) | N (%) | N (%) | p-value |
| Days of Work Missed | | | | |
| Less than 1 | 35 (68.6) | 13 (72.2) | 11 (33.3) | 0.68 |
| 1 or more | 16 (31.4) | 5 (27.8) | 22 (66.7) | |
| Years ago | | | | |
| 1 | 32 (62.7) | 11 (61.1) | 21 (63.6) | 0.97 |
| 2 | 14 (27.5) | 5 (27.8) | 9 (27.3) | |
| 3 | 5 (5.9) | 2 (11.1) | 3 (9.1) | |
| Received Medical Treatment | | | | |
| Hospital/Doctor | 28 (54.9) | 7 (38.9) | 21 (63.6) | 0.06 |
| First Aid | 21 (41.2) | 9 (50.0) | 12 (36.4) | |
| None | 2 (3.9) | 2 (11%) | 0 (0) | |
| Reported Injury to Supervisor | | | | |
| Yes | 27 (53.0) | 7 (38.9) | 20 (60.6) | 0.14 |
| No | 24 (47.1) | 11 (61.1) | 13 (39.4) | |
| Applied for Workers Compensation | | | | |
| Yes | 5 (9.8) | 0 (0) | 5 (15.1) | 0.08 |
| No | 46 (90.2) | 18 (100) | 28 (84.9) | |
| Event | | | | |
| Contact with objects/equipment | 24 (47.1) | 8 (44.4) | 16 (48.5) | 0.38 |
| Fall | 11 (21.6) | 2 (11.1) | 9 (27.3) | |
| Overexertion | 11 (21.6) | 6 (33.3) | 5 (15.2) | |
| Animal | 1 (2.0) | 0 (0) | 1 (3.0) | |
| Exposure | 4 (7.8) | 2 (11.1) | 2 (6.1) | |
| Nature | | | | |
| Muscles/tendons/joints | 15 (29.4) | 6 (33.3) | 9 (27.3) | 0.26 |
| Surface Injury | 14 (27.5) | 6 (33.3) | 8 (24.2) | |
| Open Wounds | 13 (25.5) | 3 (16.7) | 10 (30.3) | |
| Broken Bones | 6 (11.8) | 1 (5.6) | 5 (15.2) | |
| Burns | 2 (3.9) | 2 (11.1) | 0 (0) | |
| Environment | 1 (2.0) | 0 (0) | 1 (3.0) | |

**Table 5.5. Logistic regression model for reporting Injury to supervisor (most recent injury in previous 3 years) and safety climate, adjusting for demographic and workplace characteristics, among construction workers in Athens, GA, (n=51)**

| | OR[1] | 95% CI[2] |
|---|---|---|
| **Safety Climate** | 0.90 | 0.73-1.10 |
| **Ethnicity** | | |
| **Non-Hispanic** | ref | - |
| **Hispanic** | 1.70 | 0.97-3.04 |
| **Employment Status** | | |
| **Temporary** | ref | - |
| **Permanent** | 3.08 | 0.73-13.11 |
| **Alcohol consumption** | | |
| **None** | ref | - |
| **2 or less drinks/day** | 3.02 | 0.56-16.24 |
| **More than 2/day** | 10.95 | 0.58-206.12 |
| **Type of Construction** | | |
| **Residential** | ref | - |
| **Residential and commercial** | 8.17 | 1.33-50.39 |

[1] Odds Ratio
[2] 95% Confidence Interval
[3] Carpenters (64) and roofers (6)
[4] Mason (4), electrician (3), flooring installation (3), heating, venting, and air conditioning (3), pipe fitter (3), machine operator (2), mechanic (1), plumber (1), welder (1), window installation (1), appliance installation (1), concrete worker (1)

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CHAPTER 6

# CONSTRUCTION INDUSTRY EMPLOYMENT AND MORTALITY AMONG MEXICAN IMMIGRANTS IN THE SOUTHEASTERN UNITED STATES, 2003-2013

## Introduction

In 2013, occupational injury affected over 3% of the United States (US) working population [1], resulting in 4,405 fatalities [2] and disproportionately impacting Hispanic workers [3]. The total days of work lost due to occupational injury exceeded 1.1 million in 2013[ 1], and is estimated to cost Americans close to $250 billion in direct and indirect costs each year [4].

In 2013 there were 856 construction fatalities in the US, making construction the industry leader in the number of occupational fatalities [2]. In 2013, the occupational mortality rate was about three-fold higher in the construction industry than in all industries combined (8.9 vs. 3.1 deaths per 100,000 workers). Additionally, the rate of construction-related fatalities among Hispanic workers was approximately 15% higher than non-Hispanic workers (9.9 vs. 8.6 fatalities per 100,000 workers) and there have not been improvements among either group over recent years [2, 5]. Moreover, foreign-born Hispanic workers are at greater risk for occupational fatalities than their native-born counterparts [6, 7], and in 2014, 40% of foreign-born occupational fatalities were from Mexico [2].

The Hispanic population comprises approximately 25% of the construction worker population throughout the U.S. Approximately half of these workers are foreign-born; the majority of these are of Mexican descent. [5, 8]. In recent years the construction industry has employed approximately 5% of the total population in the Southeastern United States (SEUS) [9]. In Georgia alone, privately-owned construction companies employed 155,000 individuals in 2014, an 11% increase from 2012 [9]. The Hispanic population grew 2 to 3.5 times faster in the SEUS than the U.S. as a whole from 2000-2010 and is a priority focus for public health, recognized by the National Institute for Occupational Safety and Health's National Occupational Research Agenda [8, 10].

Research has shown that Hispanic and foreign-born workers have higher rates of fatalities in certain occupations and are more likely to take risks in their jobs [6, 7, 11]. Hispanic construction workers identified supervisor pressure, competition for jobs, and intimidation against raising safety concerns as barriers to workplace safety [12]. These same groups also display relatively low health literacy [13] and poorer use of personal protective equipment (PPE) when they felt it limited productivity or was uncomfortable [14]. The literature is mixed regarding the role of language in construction safety. In some studies, language is reported as a barrier to workplace safety [12] and for some it is not [3, 13]. Lastly, conventional trainings targeting assertiveness have been less effective among Hispanic than non-Hispanic workers [15], and may not be adequately adapted to the needs of the diverse Hispanic population.

This study presents an occupational mortality analysis of deaths from an understudied and marginalized population. The purpose of this study was to investigate occupational and non-occupational mortality among Mexican immigrants in the SEUS. We investigate which construction industry occupations are most associated with occupational fatalities and whether construction industry employment is associated with non-occupational causes of death.

## Methods

The Consulate General of Mexico in Atlanta is overseen by the Mexican Secretary of Exterior Relations and is one of 50 diplomatic offices in the U.S. that act to assist and protect all Mexican citizens in the U.S. The Consulate General of Mexico in Atlanta serves Mexican nationals in Georgia, Alabama, and eastern Tennessee (east of Nashville). Data used in this analysis have been abstracted from publicly accessible death certificates maintained by the Consulate General's Office of Protection. The population for this analysis included all deaths of Mexican nationals who resided in Georgia, Alabama, and eastern Tennessee and whose bodies were repatriated to Mexico. All individuals were 15 years or older and were reported to the Consulate General of Mexico in Atlanta between the years 2003-2013.

Data were abstracted from death certificates, including the individuals' gender, age, manner of death (accidental, natural, homicide, or suicide), occupation, and industry. Industry and occupations were coded using National Institute of

Occupational Safety and Health's Industry and Occupation Coding Systems [16], based on 2010 Standard Occupation Classification System (SOC) [17] and 2012 North American Industry Classification System (NAICS) [18]. NAICS and SOC are the standard classifications used in U.S. federal statistics to classify workers into occupational and industry categories.

**Data Analysis**

Age-adjusted Standardized Mortality Rates (SMR) were used to compare proportions of occupational-related deaths between construction industry occupations. Logistic regression models were used to examine the relationship between manners of death not related to occupation and employment in the construction industry (yes or no). Bivariate comparisons, SMR's, and logistic regression analyses were restricted to the male population due to the small number of female construction workers (<1%). Sensitivity analysis, including all females, were performed in order to determine how their removal impacted the study's results.

Population characteristics were presented for the entire study population and events leading to death were presented for individuals in the construction industry. Bivariate comparisons of population characteristics were made between individuals working in construction industries and other industries using chi square tests and t-tests.

Indirect age-standardized mortality ratios were calculated using five-year age increments with the overall study population as the standard population. SMRs were calculated for each construction occupation with over five occupational deaths. This resulted in four occupational categories used in the analysis: 1) carpenter, 2) roofer, 3) mason, 4) laborer, with the remaining occupations grouped as 'other'. Based on the age distribution of the entire study population the number of expected deaths was calculated for each occupation-specific age strata, and added together. The age-adjusted SMR was calculated by dividing the observed number of deaths by the expected number of deaths for each occupation. Ratios greater than 1.0 indicated having more occupational deaths than expected, and ratios less than 1.0 indicated fewer. Statistical significance of the SMR's was assessed using 95% confidence intervals [19].

Logistic regression was used to assess whether being a construction industry worker was associated with non-work related fatalities, while adjusting for age. There were no model reduction steps. Occupation was the primary exposure of interest and age was forced into the model because of its inherent association with death. In order to compare each manner of death to all others and because the manners of death are mutually exclusive, separate logistic regression models were analyzed for each (accident, natural, homicide, suicide, and unknown). Adjusted odds ratios with 95% confidence intervals (CI) were presented Associations were considered statistically significant at $\alpha \leq 0.05$ and all statistical analyses were performed using S.A.S. 9.3 (SAS Institute, Cary, NC, USA).

## Results

Demographic characteristics of the study population are presented in **Table 6.1**. Data from 3,093 death certificates of Mexican citizens from 2003-2013 who were 15 years and older and resided in Georgia, eastern Tennessee, or Alabama at the time of death were included in the analysis. The majority of the population were Georgia residents (65%), followed by Alabama and eastern Tennessee (17% and 18%, respectively). The median age of death was 33 years and the majority were males (83%). The most common manner of death was accidental (36%), followed by natural death (35%), homicide (15%), and suicide (4%). Approximately 10% of death certificates abstracted indicated either pending investigation, undetermined, or were missing. One hundred and seventy-three (5.6%) of the deaths were recorded as occupationally related. The industry that employed the largest percent of the populations was construction (38%), followed by agriculture/forestry/fishing/hunting (12%), manufacturing (9%), leisure and hospitality (9%), and professional and retail services (7%).

**Table 6.2** displays the frequency of occupational fatality causes among construction workers. The majority of deaths were the result of falls (48%), followed by contact with objects or equipment (29%), and transportation accidents (13%). Additionally, fatalities came from electrocution (n=2), homicide (n=2), lightning (n=2), heat stroke (n=1), and complications from work-related injury due to lasting infection (n=2).

Due to the overwhelming frequency of males employed in the construction industry (99.3%), 529 females were excluded from the remaining analysis resulting in 2,564 individuals. Bivariate comparisons of population characteristics for construction and other industries are presented in **Table 6.3**. There were no significant differences between frequencies of population employed in the construction industry by resident state ($\chi^2$=1.6, df=2, p<0.4510; Table 6.3). The age of death of individuals in the construction industry was significantly younger than individuals employed in all other industries (33 vs. 40 years, t=-7.4, df=2501, p<0.0001; Table 6.3) and there were significant differences in manner of death between construction and other industry ($\chi^2$=51.8, df=4, p<0.0001; Table 6.3). Individuals who were employed in the construction industry had a higher proportion of death from accidental causes and homicide than other industries and lower proportions of natural death than individuals in other industries. There were more individuals from the construction industry who have missing, undetermined or pending manners of death. The percent of occupational death in the construction industry workers was approximately 2 times higher versus workers in all other industries (p<0.0001).

Age-adjusted standardized mortality ratios for occupational fatalities were calculated for the construction industry overall and the leading occupations with five or more individuals (**Table 6.4**). Over 75% of the individuals employed in the construction industry worked in four occupations; laborer (60%), carpenter (7%), mason (5%), and roofer (4%). The SMR reveals a significantly higher proportion of occupational deaths among the construction workers compared to other workers (SMR= 1.31, 95% CI: 1.07-1.58). While most construction industry occupations showed higher numbers of deaths than expected, carpentry (SMR =2.25, 95% CI: 1.20-3.83) and roofing (SMR =2.32, 95% CI: 1.12-4.26) were the only occupations that showed excessive deaths that were statistically significant. **Table 6.5** illustrates construction employment status and manners of death among Mexican males in Georgia, Alabama, and eastern Tennessee. Employment in the construction industry is suggestive of greater risk of an accidental death (OR=1.15, 95% CI: 0.98-1.36) or homicide (OR=1.18, 95% CI: 0.95-1.45), although these associations were not statistically significant. Employment in the construction industry was significantly associated with a decreased risk of natural death (OR=0.70, 95% CI 0.57-0.86) or suicide (OR=0.63, 95% CI: 0.42-0.92) as compared to employment in other industries while adjusting for age. Post hoc analysis revealed significant associations between occupationally related falls and carpenters ($\chi^2$=5.3, df = 1, p=0.0210) and roofers ($\chi^2$=21.9, df = 1, p<0.0001). In each logistic regression model, younger age of death was significantly associated with employment in the construction industry (p<0.0001). Sensitivity analysis, including males and females, showed no meaningful differences in the SMR results versus our analysis that excluded females.

## Discussion

The purpose of this study was to examine associations between employment in the construction industry and mortality among Mexican immigrants in the SEUS. This investigation confirms that the proportion of individuals who die from occupational injuries is higher among construction workers than individuals employed in other industries. Additionally, we found that employment in the construction industry was protective against suicide and death from natural causes among Mexican immigrants in Georgia, Alabama, and eastern Tennessee.

In 2013, the leading causes of U.S. occupational fatalities in construction were falls (36%), transportation (27%), and contact with objects and equipment (17%) [2]. The top three causes of occupational fatalities is the same among the population in our study, but the distribution differs significantly ($\chi^2$=15.3, df = 2, p=0.0005). The SEUS Mexican immigrant population is more susceptible to falls and fatal contact with objects and equipment, and less likely to be involved in fatal transportation accidents. This higher number of fatal falls among Hispanic workers may be due to risky workplace characteristics identified in previous studies, such as lack of training, distractions at work, limited personal protective equipment use [14], supervisor pressure, competition for jobs, intimidation against raising safety concerns [12]. or low health literacy [13].

Our study found that carpenters and roofers are the occupations with higher risks of occupational fatalities among Mexican immigrants. This is consistent with previous literature concerning carpenters and roofers and their increased risk of occupational fatalities [20]. We were surprised to not find significantly higher proportions of occupational fatalities among laborers. Previous literature has identified laborers and low-skilled individuals to be at elevated risk for occupational injury and fatalities [21, 22], specifically from falls [20]. While our results differ, this should not undermine the relatively large number of occupational fatalities among laborers, who totaled the largest number (n=58) of occupational fatalities of all occupations.

This is one of the first analyses that investigated associations between construction industry employment and non-occupational fatalities among immigrants. We found construction employment to be associated with lower proportions of natural deaths among Mexican immigrants. This finding warrants additional research. It is possible that construction industry employment lends itself to more physical activity [23], resulting in healthier lifestyles. This may deter prevalent chronic illness, but we were unable to assess this notion in our present study. Additionally, due to the physical health requirements of performing construction work it is possible that the *healthy migrant paradox* [23-27] is more relevant to the construction industry than to other less strenuous industries. This theory has been used to explain some health advantages among immigrants despite less earnings and lower education. The healthy migrant paradox is due to a *healthy worker bias*, in which it is presumed that the healthiest individuals migrate for work [26], and a *salmon bias* in which unhealthy individuals or those who become sick and cannot work return to their home country [28]. Lastly, the protective association with natural deaths may be due to competing mortality risks due to accidents.

This investigation complements previous research regarding mental health and Hispanic immigrants in the U.S. While the effect of migration can vary, regardless of country of origin or destination, migration is very stressful on individuals and their families [29]. Previous research has identified situational and structural stressors [30] such as separation from family, work environment, documentation status, and limited resources as risk factors for depression [31]. Additionally among younger individuals, migration has been shown to be a risk factor for suicidal ideation [32], a higher prevalence of conduct problems, phobic fears, and early substance use [33]. While this investigation does not provide a complete picture of the relationship between working in construction and suicide, it may serve as a stepping stone for further research.

There are limitations to this study that are inherent to the research design. First, SMR investigations were not intended to calculate relative risk in relation to any population not included in this investigation. The SMR analysis assigned relative frequency of certain causes of death in workers of specific occupations and industry, but is unable to calculate rates based on complete denominator populations or hours worked. In the case of Mexican immigrants in the SEUS, it is difficult to define the total population due its elusive and mobile nature. Second, death records often include incomplete and/or inaccurate data. In this investigation, we found that approximately 10% of data were either missing, pending, or undetermined, 4% did not include industry, and 5% of those who worked in construction industry did not have an occupation indicated. We included missing categories in each of the analyses, but did not find missing data to be associated with any of the exposures or outcomes of interest. Death certificate classifications of industry and occupation are most questionable in investigating long-term occupational exposures, such as certain toxins or carcinogens, where occupation may have changed many times prior to the death. Our investigation was concerned with causes of immediate death and deaths directly associated with the last occupation held by the individual, therefore the inaccuracies in industry and occupation coding are less problematic.

## Conclusion

The results of this study provide an initial description of fatal construction injuries among Mexican immigrants in SEUS, specifically in Georgia, Alabama, and eastern Tennessee. The analysis provides evidence that a large portion of the Mexican immigrant population is employed in the construction industry (38%) and face elevated risks for occupational fatalities. The results of this investigation should encourage greater surveillance of occupational illness and injury among foreign-born immigrants who work in construction, as well as other high risk industries. While the entire construction industry faces elevated risks of occupational fatalities, our analysis indicates that carpenters and roofers should be prioritized. Additional research should pursue intervention strategies, such as education to workers and employers that are customized to this population that target reductions of construction fatalities.

**Table 6.1. Demographic and population characteristics of deaths (age ≥ 15 years) reported to Consulate General of Mexico, in Atlanta GA, 2003-2013 (N=3,093)**

| | N (%) |
|---|---|
| Resident State | |
| Alabama | 532 (17.2) |
| Georgia | 2015 (65.2) |
| Eastern Tennessee | 546 (17.7) |
| Gender | |
| Male | 2564 (82.9) |
| Female | 529 (17.1) |
| Years of Age (median, range) | 33 (15-94) |
| Manner of Death | |
| Accident | 1127 (36.4) |
| Natural | 1080 (34.9) |
| Homicide | 457 (14.8) |
| Suicide | 123 (4.0) |
| Missing/Pending/Undetermined | 306 (9.9) |
| Occupational-Related Death | |
| Yes | 173 (5.6) |
| No | 2920 (94.4) |
| Industry[1] | |
| Construction | 1159 (37.7) |
| Agriculture, Forestry, Fishing and Hunting | 369 (11.9) |
| Manufacturing | 277 (9.0) |
| Leisure and Hospitality | 279 (9.0) |
| Professional and Business Services | 222 (7.1) |
| Wholesale and Retail Trade | 100 (3.2) |
| Other Services | 66 (2.1) |
| Transportation and Utilities | 51(1.7) |
| Education and Health Services | 21 (0.7) |
| Financial Activities | 10 (0.3) |
| Information | 8 (0.3) |
| Mining | 4 (0.1) |
| Public Administration | 4 (0.1) |
| Non-paid/Volunteer/Unemployed | 406 (13.1) |
| Missing or Insufficient Information | 117 (3.8) |

[1]Based on categories from 2012 U.S. Census Code

**Table 6.2. Construction industry fatalities (n=104) by event or exposure among deaths reported to the Consulate General of Mexico, in Atlanta GA 2003-2013**

| | N (%) |
|---|---|
| Falls | 50 (48.1) |
| Contact with objects or equipment | 31 (29.8) |
| Transportation | 14 (13.4) |
| Electrocution | 2 (1.9) |
| Homicide | 2 (1.9) |
| Other[1] | 5 (4.8 ) |

[1] Lightning (n=2), Heat stroke (n=2), complications of infection of injury (n=1).
Note: Of 69 non-construction occupational deaths, 52 were accidents, 15 homicide, and 2 suicides.

**Table 6.3. Bivariate comparisons among construction and non-construction industry male deaths (age ≥ 15 years) reported to the consulate general of Mexico, in Atlanta GA, 2003-2013 (N=3093)**

| | Construction Industry | Other Industries[1] | |
|---|---|---|---|
| | N (%) | N (%) | p-value |
| Resident State | | | |
| Alabama | 220 (19.1%) | 243 (17.2%) | 0.45[2] |
| Georgia | 721 (62.6%) | 909 (64.3%) | |
| Eastern Tennessee | 210 (18.3%) | 336 (18.5%) | |
| Age (mean, std[4]) | 33 (11.5) | 37 (16.5) | <0.0001[3] |
| Manner of Death | | | |
| Accident | 509 (44.2%) | 521 (31.8%) | <0.0001[2] |
| Homicide | 212 (18.4%) | 209 (12.6%) | |
| Natural | 249 (21.6%) | 475 (42.9%) | |
| Suicide | 43 (3.7%) | 72 (4.0%) | |
| Pending/Missing/Und[4] | 138 (12.0%) | 136 (8.7%) | |
| Occupation-Related Death | | | |
| Yes | 104 (9.0%) | 66 (4.7%) | <0.0001[2] |
| No | 1047 (91.0%) | 1347 (95.3%) | |

[1] See Table 1 for complete list of industries
[2] Chi Square
[3] 2-sided t-test
[4] Pending/Missing/Undetermined are three separate categories that have been combined. 'Pending' and 'Undetermined' entries are abstracted from death certificates. 'Missing' indicates that there was not an entry on the death certificate.

**Table 6.4. Standardized mortality ratios for construction industry occupational fatalities versus all industries combined among Mexican males fatalities reported to the Consulate General of Mexico, in Atlanta GA (age ≥ 15 years) , 2003-2013 (n=2564)**

| | N/Total (%) | SMR[2] | 95% C.I.[3] |
|---|---|---|---|
| Construction Industry | 104/1151 (9.0) | 1.31 | (1.07-1.58) |
| Carpenter | 13/87 (14.9) | 2.25 | (1.20-3.83) |
| Mason | 5/61 (8.2) | 1.16 | (0.38-2.67) |
| Laborer | 58/682 (8.7) | 1.22 | (0.93-1.58) |
| Roofer | 10/62 (15.7) | 2.32 | (1.12-4.26) |
| Other[1] | 10/200 (5.0) | 0.73 | (0.35-1.34) |
| Unknown | 8/59 (13.6) | 1.94 | (0.84-3.80) |

[1] Equipment Operator (3/17), Dry Wall (1/22), Electrician (2/10), Painter (1/81), Pipe Fitter (1/6), Iron/Steel worker (12), Manager (1/26)

[2] Standardized Mortality Ratio, indirectly age-adjusted to overall population using 5-year age increments.

[3] 95% confidence interval

**Table 6.5. Logistic regression[1] of associations between construction industry employment (yes vs. no) and manners of death adjusted for age[2] among Mexican male deaths reported to the Consulate General of Mexico, in Atlanta GA, 2003-2013 (n=2,564)**

| | Construction (n=1151) | Other Industry (n=1413) | OR (95% CI) |
|---|---|---|---|
| Accident | 509 (44.2%) | 521 (36.9%) | 1.15 (0.98-1.36) |
| Natural | 249 (21.6%) | 475 (33.6%) | 0.70 (0.57-0.86) |
| Homicide | 212 (18.4%) | 209 (14.8%) | 1.18 (0.95-1.45) |
| Suicide | 43 (3.7%) | 72 (5.1%) | 0.63 (0.42-0.92) |
| Missing/Pending/Und. | 138 (12.0%) | 136 (9.6%) | 1.22 (0.95-1.57) |

[1] Separate logistic regression models were used for each individual manner of death.
[2] Age was a significantly associated with outcome manner of death in each model ($p<0.0001$)

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# CHAPTER 7
# SUMMARY AND CONCLUSION

## Summary

This research addressed a significant problem in an underserved and understudied population at high risk for occupational injury and fatalities in the construction industry. Our investigation targeted Hispanic workers employed in the construction industry who are more likely to suffer occupational fatalities than other workers [1].

The overarching goal of this research was to investigate factors contributing to ethnic disparities of occupational injury among construction workers. This investigation used two separate approaches, focusing on two specific populations to accomplish this goal. First, in order to accomplish **aims 1 and 2**, we investigated the relationships between ethnicity, injuries, and safety climate. Second, in order to accomplish **aim 3**, we investigated occupational and non-occupational fatalities among Mexican immigrants who were employed in the construction industry, in Georgia, Alabama, and Tennessee.

**Aims 1 and 2** (Chapters 4 and 5) of the investigation surveyed 179 construction workers in Athens, Georgia in order to explore relationships between safety climate scores, injury, and ethnicity. We found that Hispanic workers had significantly lower safety climate scores, though these differences were not associated with differences in injury occurrence.

**Aim 3** (Chapter 6) used data extracted from death certificates that were held by the Consulate General of Mexico in Atlanta, Georgia to identify mortality risks among Mexican construction workers in the southeastern United States. Occupational risks among construction industry workers were identified using standardized mortality ratios and regression analysis was used to identify non-occupational manners of death associated with construction industry employment. We found that the proportion of individuals who die from occupational injuries is higher among all construction workers compared to the overall population. Roofers and carpenters were at an elevated risk compared to other construction industry workers. Additionally, we found that employment in the construction industry was protective against suicide and death from natural causes among Mexican immigrants.

## Interpretation of Findings

### Safety Climate

As discussed in chapters 4 and 5, 'safety climate' has emerged as an important predictor of safe behavior in the workplace [2], but has not been explored as a contributing factor to the injury and mortality disparities between Hispanic and non-Hispanic construction workers. This was the first investigation of safety climate perception among a heterogeneous population of Hispanic and non-Hispanic construction workers. As described in chapter 4, we found evidence that disparities in perceived safety climate exist between Hispanic and non-

Hispanic construction workers. The lower perceived safety climate scores among Hispanic workers indicated that the perception of the importance of safety on the job site was lower among Hispanic construction workers than their non-Hispanic counterparts. Additionally, we found that alcohol consumption, working for a company that does not provide health insurance, working for a company with less than 10 employees, and being employed as a laborer or in a skilled trade were significantly associated with less perceived safety climate. Subsequently, in chapter 5, in contrast to our hypothesis, we found that the significant differences in perceived safety climate were not associated with differences in past injury occurrence in the previous 3 years. This unexpected finding may be the result of confusion between the time sequence between safety climate and injury. As has been found in other studies, it is possible that higher safety climate scores are the result of previous injuries literature. A recent meta-analysis including 32 study populations, examined injury and safety climate relationships found that injuries are more predictive of safety climate than safety climate is of injuries, though the association was stronger among organization climate then psychological (individual) climate [2].

**Morbidity and Mortality**

Chapters 5 and 6 investigated injury and fatality outcomes among construction workers in the SEUS and provided evidence that certain populations within the industry are at greater risk for injuries and death. In chapter 5, contrary to our hypothesis, our research did not corroborate disparities in risk of injuries between

Hispanic and non-Hispanic construction workers. Instead, it was noteworthy that 18% of construction workers had been injured in the last year, compared to 3.5% reported nationally [3], justifying attention to injuries in the construction industry across ethnicities. In chapter 6, we found evidence of excessive risk of occupational fatalities in the construction industry compared to other industries, where the proportion of Mexican immigrants in the SEUS who died from occupational injuries was 30% higher among construction workers. Among the Mexican immigrant construction workers, while adjusting for age, roofers and carpenters were over twice as likely to have died as a result of an occupational accident as compared to the remaining Mexican immigrant population. We were surprised that our results did not indicate an excess in risk among laborers, as had been seen in other investigations [4, 5].

In both Chapters 5 and 6, we found statistically significant deviations in the events leading to the injury or fatality, from national data. In 2013, the leading causes of U.S. occupational fatalities in construction were falls (36%), transportation (27%), and contact with objects and equipment (17%) [1]. In chapter 6, our results were similar, with the exception of transportation fatalities. We found that the SEUS Mexican immigrant population was more susceptible to falls and fatal contact with objects and equipment, and were less likely to be involved in fatal transportation accidents than the U.S. construction workers nationwide. In Chapter 5, the leading injury event was contact with objects or equipment (47%), followed by falls (22%), and over exertion (22%). This differs from the U.S., where in 2014, the leading cause of injury on construction sites was overexertion (33%), followed by falls (27%), and contact with objects and equipment (22%) [6]. These differences may be due risky workplace characteristics identified in previous studies, such as lack of training, distractions at work, limited personal protective equipment use [7], supervisor pressure, competition for jobs, intimidation against raising safety concerns [8], or low health literacy [9].

**Strengths and Weaknesses**

This investigation presents a novel approach to enhance the understanding of an important burden to an often marginalized population. Attention to injury disparities and characteristics in the construction industry are warranted, as 25% of construction workers are Hispanic and they are injured at a disproportionately high rate[10]. Chapters 4 and 5 describe novel research, where safety climate measures were examined between Hispanic and non-Hispanic construction populations. Chapter 6 is the first investigation that looks into differences in association between safety climate and injuries between different ethnicities. An important innovation presented in this investigation is the uniqueness of the populations. Chapters 4 and 5 presented results based on a population that is not represented in nationally reported statistics, as the population was mostly composed of workers from small (under 10 employees) companies. The population in chapter 6 was a unique addition to the literature because it was composed entirely of Mexican immigrants who resided and died in SEUS.

Additionally, chapter 6 is one of the first analyses that investigated associations between construction industry employment and non-occupational fatalities among immigrants.

While this investigation presents many strengths, some limitations need to be acknowledged. First, chapters 4 and 5 of this investigation presented the results of a cross-sectional survey, which is limited in its ability to detect cause-and-effect relationships. While safety climate is generally considered an antecedent to injury occurrence, there is evidence that the occurrence of an injury may lead to a higher safety climate score [2]. An additional limitation of the results presented in chapters 4 and 5 is this investigation's inability to be generalized to the overall GA construction industry. While also considered an advantage, our study sample was composed of a greater percentage of individuals who work for small companies than GA's population of construction workers [11]. Lastly, the number of surveys conducted for chapters 4 and 5, were based on sample size calculations that estimated adequate population size that were necessary to address the primary goals of this investigation, namely to detect safety climate differences between ethnicities and between injured and non-injured workers. All secondary aims may be under powered due to limited sample size.

Chapter 6 was subject to limitations that were inherent to the research design. First, the SMR analysis assigned relative frequency of certain causes of death in workers of specific occupations and industry, but is unable to calculate rates based on complete denominator populations. In the case of Mexican immigrants in the SEUS, it is difficult to define the total population due to its elusive and mobile nature and it is likely that there are a large number of Mexican immigrant deaths that were not captured by the Consulate General. Second, death records often include incomplete and/or inaccurate data. In this investigation, we found that approximately 10% of data were either missing, pending, or undetermined, 4% did not include industry, and 5% of those who worked in construction industry did not have an occupation indicated. As with any investigation that utilized data abstracted from death certificates, we are limited to the information captured by the death certificate. Death certificate classifications of industry and occupation are most limited due to the singularity of the entries, rather than a full history of occupation and industry. Our investigation was concerned with causes of immediate death and deaths directly associated with the last occupation held by the individual, therefore the brevity in industry and occupation entries are less problematic.

**Suggestions for Future Research**

The results of this investigation provide a stepping stone for several directions of future research. Ideally, large prospective cohort designs would be used in order to fully characterize risk factors and precursors to injuries. In order to investigate fatality outcomes, a case-control investigation may be more practical, but it would be essential to capture robust information regarding work-related activities and conditions. Efforts may be improved by targeting research activities to occupations at elevated risk, such as carpenters and roofers. Additionally, our results encourage greater surveillance activities of occupational injury among construction workers in order to more fully understand the burden. All future activities should have concentrated efforts to include attention to ethnic minority populations and their cultural differences that may challenge or improve interventions. A greater understanding of safety climate among construction workers working independently and for small companies is critical. Primarily, perceived safety climate should be investigated and if possible a measure should be developed and validated for independent and small company workers.

## Conclusion

The results of this investigation contribute to the understanding of factors that lead to ethnic disparities of injury and fatalities in the U.S. construction industry. This study provides evidence that disparities in perceived safety climate exist between Hispanic and non-Hispanic construction workers. Additionally, the results of this investigation suggest that while the entire construction industry faces elevated risks of occupational fatalities, attention to carpenters and roofers should be prioritized. Our research did not corroborate disparities in risk of injuries between Hispanic and non-Hispanic construction workers that are present in surveillance data, nor did we find associations between past injury occurrence and perceived safety climate. Instead the current study provides evidence that attention to construction industry injuries is justified across ethnicities, while paying attention to cultural differences that may be unique to specific sub-groups and challenge interventions.

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APPENDIX A: OCCUPATIONAL FATALITY RATE, IN THE UNITED STATES, BY ETHNICITY, 2003-2013

| | **All** | | | **Hispanic** | | | **Non-Hispanic** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Rate** | **95% C.I.** | **Count** | **Rate** | **95% C.I.** | **Count** | **Rate** | **95% C.I.** | **Count** |
| **2003-2013** | 3.6 | 3.6-3.7 | 56751 | 4.2 | 4.1-4.2 | 9064 | 3.6 | 3.5-6.6 | 47687 |
| **2013** | 3.1 | 3.0-3.1 | 4405 | 3.5 | 3.3-3.8 | 797 | 3.0 | 2.9-3.1 | 3608 |
| **2012** | 3.2 | 3.2-3.3 | 4628 | 3.4 | 3.2-3.7 | 748 | 3.2 | 3.1-3.3 | 3880 |
| **2011** | 3.4 | 3.3-3.4 | 4693 | 3.7 | 3.4-4.0 | 749 | 3.3 | 3.2-3.4 | 3944 |
| **2010** | 3.4 | 3.3-3.5 | 4690 | 3.6 | 3.3-3.8 | 707 | 3.3 | 3.2-3.4 | 3983 |
| **2009** | 3.3 | 3.2-3.3 | 4551 | 3.6 | 3.4-3.9 | 713 | 3.2 | 3.1-3.3 | 3838 |
| **2008** | 3.6 | 3.5-3.7 | 5214 | 4.0 | 3.7-4.2 | 804 | 3.5 | 3.4-3.6 | 4410 |
| **2007** | 3.9 | 3.8-4.0 | 5657 | 4.6 | 4.3-4.9 | 937 | 3.8 | 3.7-3.9 | 4720 |
| **2006** | 4.0 | 3.9-4.1 | 5657 | 5.0 | 4.7-5.4 | 937 | 3.9 | 3.8-4.0 | 4720 |
| **2005** | 4.0 | 3.9-4.1 | 5734 | 5.0 | 4.6-5.3 | 923 | 3.9 | 3.8-4.0 | 4811 |
| **2004** | 4.1 | 4.0-4.2 | 5764 | 5.0 | 4.7-5.4 | 902 | 4.0 | 3.9-4.1 | 4862 |
| **2003** | 4.0 | 3.9-4.2 | 5575 | 4.8 | 4.5-5.1 | 794 | 3.9 | 3.8-4.1 | 4781 |

Source: U.S. Department of Labor Bureau of Labor Statistics (USBLS), *Census of Fatal Occupational Injuries.* 2009-2014.

APPENDIX B: CONSTRUCTION INDUSTRY FATALITY RATE, IN THE UNITED STATES, BY ETHNICITY, 2003-2013

| | **All** | | | **Hispanic** | | | **Non-Hispanic** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Rate** | **95% C.I.** | **Count** | **Rate** | **95% C.I.** | **Count** | **Rate** | **95% C.I.** | **Count** |
| **2003-2013** | 11.3 | 10.9-11.6 | 11411 | 10.1 | 9.9-10.3 | 2898 | 9.8 | 9.6-10.0 | 8513 |
| **2013** | 9.2 | 8.6-9.8 | 856 | 10.7 | 9.4-12.0 | 243 | 8.8 | 8.1-9.4 | 613 |
| **2012** | 9.5 | 8.9-10.1 | 849 | 10.5 | 9.2-11.9 | 222 | 9.1 | 8.5-9.8 | 627 |
| **2011** | 8.6 | 8.1-9.2 | 781 | 9.3 | 8.1-10.6 | 197 | 8.4 | 7.8-9.1 | 884 |
| **2010** | 8.8 | 8.3-9.4 | 802 | 8.5 | 7.3-9.7 | 182 | 8.9 | 8.3-9.6 | 620 |
| **2009** | 9.1 | 8.5-9.6 | 879 | 10.1 | 8.9-11.4 | 222 | 8.8 | 8.1-9.4 | 657 |
| **2008** | 9.3 | 8.7-9.8 | 1016 | 9.7 | 8.6-10.9 | 253 | 9.1 | 8.5-9.7 | 763 |
| **2007** | 10.5 | 9.9-11.0 | 1239 | 11.0 | 9.9-12.2 | 317 | 10.3 | 9.6-10.9 | 922 |
| **2006** | 11.0 | 10.5-11.6 | 1297 | 12.8 | 11.6-14.0 | 360 | 10.5 | 9.9-11.1 | 937 |
| **2005** | 11.1 | 10.5-11.7 | 1243 | 13.0 | 11.7-14.4 | 321 | 10.6 | 9.9-11.2 | 922 |
| **2004** | 11.9 | 11.3-12.5 | 1278 | 14.4 | 12.9-15.9 | 317 | 11.2 | 10.5-11.9 | 961 |
| **2003** | 11.6 | 10.9-12.2 | 1171 | 13.3 | 11.8-14.8 | 264 | 11.1 | 10.4-11.8 | 907 |

Source: U.S. Department of Labor Bureau of Labor Statistics (USBLS), *Census of Fatal Occupational Injuries.* 2009-2014.

# APPENDIX C: CONSTRUCTION WORKER CONSENT SCRIPT AND SURVEY (ENGLISH & SPANISH)

The University of Georgia
College of Public Health

## *Safety Climate, Ethnic Disparities, and Occupational Injury among Construction Workers in Athens, Georgia*

**Instructions: This survey consists of 3 sections: 1) Participant Profile, 2) Safety Climate, and 3) Injury History. All three sections must be complete in order for the survey to be included in the study.**

1) **Before beginning each survey ensure that the individual is 18 years of age or older.**
2) **Read informed consent verbatim to participant.**
3) **Answer any questions the participant has.**
4) **Write your name, date, and time of the survey on the bottom of this page.**
5) **Conduct survey.**
6) **Thank participant for their time and give them a copy of the 'consent letter' and $5 gift card.**

INFORMED CONSENT SCRIPT:

Hi, my name is ____________. I am a research assistant in the College of Public Health at The University of Georgia. We are studying construction site safety and are conducting surveys among construction workers in Athens. The purpose of this study is to investigate how construction workers feel about the importance of safety and the risk of injury while working in construction. We would like to find out information to help reduce the number of injuries and fatalities that occur on construction sites.

Your participation will involve a brief survey that will take no more than 15 minutes. Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time with no penalty or loss of benefits to which you are otherwise entitled. If you request to stop, we will destroy the information that had been collected and it will not be used in any way in our study.

All information that is collected in the survey is kept strictly confidential. We will not share your responses with your employer. We do not request your name, email address, birth date or any other information that can be traced back to you. The results of the research study may be published, but there will be no way for the information to be traced back to you.

The findings from this project will provide information that makes construction sites safer for individuals like you and your co-workers. We are not aware of any risk or harm that is associated with this survey.

Upon completion of the survey we will provide you contact information for the individuals at UGA responsible for the research so that you may ask any questions after we are finished.

By completing this survey, you are agreeing to participate in the above described research project.

You may ask questions now or at any point during the survey. Do you agree to take the survey? **[If yes, proceed].**

**Date____________ Time__________**

| Participant Profile (Section 1) | |
|---|---|
| Age | Years______ |
| Race/Ethnicity | ◯ Non-Hispanic White ◯ Hispanic<br>◯ Non-Hispanic Black ◯ Other____________ |
| What is your primary occupation? | ◯ Carpenter ◯ Laborer/General<br>◯ Roofer ◯ Electrician<br>◯ Mason ◯ Painter<br>◯ Tile Setter ◯ HV/AC<br>◯ Supervisor ◯ Other__________ |
| Country of Birth | ◯ U.S. ◯ Mexico ◯ Other_____________ |
| Years in the U.S. (if born in another country) | Years______ |
| Language spoken at home | ◯ English ◯ Spanish<br>◯ English and Spanish ◯ Other____________ |
| Number of years working construction | Years______ |
| Approximate number of workers in your construction company | ◯ Less than 10 ◯ 10-25 ◯ 26-50 ◯ 51 or more ◯ Don't Know |
| Employment status | ◯ Permanent employee ◯ Temporary or Self employed |
| Type of construction | ◯ Residential ◯ Non-residential |
| Do you receive health insurance from your job? | ◯ Yes ◯ No ◯ Don't know |
| Approximately how many hours/week do you work? | Number of hours/week ___________ |
| Do you drink alcohol? | ◯ No ◯ Yes, about 2 drinks or less/day ◯ Yes, more than about 2 |

| Safety Cimate (Section 2) | | | | |
|---|---|---|---|---|
| | Strongly disagree | Disagree | Agree | Strongly agree |
| Safety practices are very important to the management where you work | ◯ | ◯ | ◯ | ◯ |
| Workers are regularly made aware of dangerous work practices or conditions where you work. | ◯ | ◯ | ◯ | ◯ |
| Workers are praised for safe conduct where you work. | ◯ | ◯ | ◯ | ◯ |
| Workers received instructions on safety. | ◯ | ◯ | ◯ | ◯ |
| Workers attend regular safety meetings. | ◯ | ◯ | ◯ | ◯ |
| Proper safety equipment is always available. | ◯ | ◯ | ◯ | ◯ |
| Workers have almost total control over personal safety. | ◯ | ◯ | ◯ | ◯ |
| Taking risks is not part of my job. | ◯ | ◯ | ◯ | ◯ |
| The possibility of being injured at work in the next 12 months is not very likely. | ◯ | ◯ | ◯ | ◯ |

| | | |
|---|---|---|
| Supervisors do as much as possible to make my job safe. | ◯ | Supervisors are only interested in doing the job fast and cheap |
| | ◯ | Supervisors could do more to make my job safe |
| | ◯ | Supervisors do as much as possible to make my job safe |

***Instructions for surveyor: The following section for the participants work site injury history. If the participant has not had any work site injuries in the last 3 years, check 'No" and the survey is complete. If the participant has had injury(ies), continue the survey. If the participant has had multiple injuries, use the following page(s) of the survey to document them.***

| Injury History-Incident 1 (Section 3) | | | |
|---|---|---|---|
| Have you had an injury at work that limited your work-related activities in the last 3 years? | ◯ **Yes (If yes, continue to following questions)**<br>◯ **No (If no, the survey is complete)** | | |
| If yes, what type of injury did you have? | ◯ Cut or laceration<br>◯ Bruise or contusion<br>◯ Strain or sprain<br>◯ Flame or chemical burn<br>◯ Head injury like a concussion or knocked unconscious<br>◯ Dislocated joint, or broken or fractured bone<br>◯ Electrical shock<br>◯ Other_______________ | | |
| Please describe the injury and how it occurred. | | | |
| How long ago did this injury occur? | Years_____ | Months_______ | |
| How many days of work did you miss? | Number of Days ____________ | ◯ Did not miss work | |
| Did you receive medical treatment? | ◯ Yes, doctor or hospital | ◯ Yes, first aid | ◯ No |
| Did you report the injury to a supervisor? | Yes ◯ | No ◯ | |
| Did you file for workers compensation? | Yes ◯ | No ◯ | |

The University of Georgia

College of Public Health

# *Seguridad climática, las disparidades étnicas y lesiones laborales entre los Trabajadores de la Construcción en Athens, Georgia*

**Instrucciones: Esta encuesta consista en 3 secciones: 1) Participante del perfil, 2) el clima de seguridad, y 3) Historial de lesiones laborales. Las tres secciones deben ser completa para que la encuesta para ser incluidos en el estudio.**

1) Antes de comenzar cada encuesta asegurar que el individuo tiene 18 años de edad o más.
2) Leer el consentimiento informado textualmente al participante.
3) Responder a cualquier pregunta que el participante tiene.
4) Escriba su nombre, la fecha y la hora de la encuesta en esta página.
5) Conducta la encuesta.
6) Da gracias al participante por su tiempo y darles una copia de la "documento de consentimiento" y $ 5 tarjeta de regalo.

**GUIÓN CONSENTIMIENTO INFORMADO:**

Hola, mi nombre es _____________. Soy un asistente de investigación en la Facultad de Salud Pública de la Universidad de Georgia. Estamos estudiando la seguridad de obra y realizando encuestas entre los trabajadores de la construcción en Athens. El propósito de este estudio es investigar cómo los trabajadores de la construcción se sienten acerca de la importancia de la seguridad y el riesgo de lesiones mientras trabajaba en la construcción. Nos gustaría encontrar información para ayudar a reducir el número de lesiones y muertes que se producen en las obras de construcción.

Su participación consistirá en una breve encuesta que se llevará a no más de 15 minutos. Su participación en el estudio es voluntaria y usted puede elegir no participar o para detener en cualquier momento sin penalidad o pérdida de beneficios a los que tiene derecho de otra manera. Si usted solicita que parar, vamos a destruir la información que se había reunido y no será utilizada de ninguna manera en nuestro estudio.

Toda la información que se recoge en la encuesta es estrictamente confidencial. No compartiremos sus respuestas con su empleador. No solicitamos su nombre, dirección de correo electrónico, fecha de nacimiento o cualquier otra información que se puede remontar de nuevo a usted. Los resultados del estudio de investigación pueden ser publicados, pero no habrá manera de que la información se remonta a usted.

Los resultados de este proyecto proporcionarán información que hace que las obras de construcción más segura para los individuos como usted y sus compañeros de trabajo. No tenemos conocimiento de ningún riesgo o daño que se asocia con esta encuesta.

Al término de la encuesta le proporcionaremos la información de contacto de los individuos en UGA responsables de la investigación de modo que usted puede hacer cualquier pregunta después de que terminemos.

Al completar esta encuesta, usted está de acuerdo para participar en el proyecto de investigación antes descrito. Usted puede hacer preguntas ahora o en cualquier momento de la encuesta. ¿Está de acuerdo a la encuesta? **[En caso afirmativo, proceder].**

**Fecha_____________ Hora___________**

| Perfil de Participante (Sección 1) | |
|---|---|
| Edad | Años______ |
| Raza / Etnia | ◯ No Hispano, Blanca ◯ Hispano o latino<br>◯ No Hispano, Negro ◯ Otro____________ |
| ¿Cuál es su ocupación principal? | ◯ Carpintero ◯ Obrero/trabajador general<br>◯ Techador ◯ Electricista<br>◯ Albañil ◯ Pintor<br>◯ Embaldosador ◯ Sistemas de climatización (HV/AC)<br>◯ Supervisor ◯ Otro__________ |
| País de nacimiento | ◯ EE.UU. ◯ México ◯ Otro____________ |
| Años en los EE.UU. (si nació en otro país) | Años______ |
| Idioma hablado en el hogar | ◯ Inglés ◯ Español<br>◯ Inglés y español ◯ Otro___________ |
| Número de años de trabajo de la construcción | Años______ |
| Número aproximado de los trabajadores en su empresa de construcción | ◯ Menos de 10 ◯ 10-25 ◯ 26-50 ◯ 51 or mas ◯ No se. |
| Estado de empleo | ◯ Empleado permanente ◯ Empleado temporal o independiente |
| Typo de construcción | ◯ Residencial ◯ No residencial |
| ¿Recibe el seguro de salud de su trabajo? | ◯ Sí ◯ No ◯ No se |
| ¿Aproximadamente cuántas horas / semana trabaja usted? | Number of hours/week __________ |
| ¿Bebe alcohol? | ◯ No ◯ Sí, cerca de 2 bebidas o menos / día ◯ Sí, mas de 2/día |

| Seguridad Climático (Sección 2) | | | | |
|---|---|---|---|---|
| | muy en desacuerdo | Desacuerdo | Acuerdo | Muy en acuerdo |
| Prácticas de seguridad son muy importantes para la administración en la que trabaja. | ◯ | ◯ | ◯ | ◯ |
| Los trabajadores están advertidos regularmente de las prácticas o condiciones de trabajo peligrosas en las que trabaja. | ◯ | ◯ | ◯ | ◯ |
| Los trabajadores son elogiados por conducta segura en la que trabaja | ◯ | ◯ | ◯ | ◯ |
| Los trabajadores recibieron instrucciones sobre la seguridad. | ◯ | ◯ | ◯ | ◯ |
| Los trabajadores asisten a las reuniones de seguridad regulares. | ◯ | ◯ | ◯ | ◯ |
| El equipo apropiado de seguridad está siempre disponible. | ◯ | ◯ | ◯ | ◯ |
| Los trabajadores tienen un control casi total sobre la seguridad personal. | ◯ | ◯ | ◯ | ◯ |
| Tomar riesgos no es parte de mi trabajo. | ◯ | ◯ | ◯ | ◯ |
| La posibilidad de ser lesionado en el trabajo en los próximos 12 meses no es muy probable. | ◯ | ◯ | ◯ | ◯ |

| | | |
|---|---|---|
| Supervisores hacer tanto como sea posible para hacer mi trabajo seguro. | ◯ | Los supervisores sólo están interesados en hacer el trabajo rápido y barato |
| | ◯ | Los supervisores podrían hacer más para hacer mi trabajo seguro |
| | ◯ | Los supervisores hacen todo lo posible para hacer mi trabajo seguro |

***Instrucciones para el encuestador: La siguiente sección para los participantes trabajan historial de lesiones sitio. Si el participante no ha tenido lesiones del lugar de trabajo en los últimos 3 años, echa 'No' y la encuesta se ha completado. Si el participante ha tenido una lesión (es), continuar con la encuesta. Si el participante ha tenido múltiples lesiones, utilice la página siguiente (s) de la encuesta para documentarlos.***

| Historial de lesiones-Incidente 1 (Sección 3) | |
|---|---|
| ¿Ha tenido una lesión en el trabajo que limitaba sus actividades relacionadas con el trabajo en los últimos 3 años? | ◯ **Sí (Si sí, continuará siguientes preguntas)**<br>◯ **No (Si no, la encuesta se ha completado)** |
| En caso afirmativo, ¿qué tipo de lesión tuvo? | ◯ **Corte o laceración**<br>◯ **Contusión**<br>◯ **Distensión muscular o esguince**<br>◯ **Quemada de llama o químico**<br>◯ **Lesión en la cabeza como una concusión o inconsciente que resulta de un golpe**<br>◯ **Luxación articulaciones o roto o hueso fracturado**<br>◯ **Choque eléctrico**<br>◯ **Otro____________** |
| Por favor, describa la lesión y cómo ocurrió | |
| ¿Hace cuánto tiempo se produjo esta lesión? | Años_____ meses_______ |
| ¿Cuántos días de trabajo que te perdiste? | Numero de dias ___________ ◯ Ninguno |
| ¿Recibió tratamiento médico? | ◯ Sí, médico u hospital ◯ Sí, primeros auxilios ◯ No |
| ¿Reportó la lesión a un supervisor? | Sí ◯ No ◯ |
| ¿Solicita compensación para Trabajadores? | Sí ◯ No ◯ |

# APPENDIX D: COMPANY PARTICIPATION RECRUITMENT LETTER

The University of Georgia

College of Public Health

6/22/2015

<Name>
<Title>
<Address>

Dear <Name>,

The University of Georgia's College of Public Health is currently conducting research assessing construction site safety in and around Athens, Georgia. The project is titled, "*Safety Climate, Ethnic Disparities, and Occupational Injury among Construction Workers in Athens, Georgia*". We are interested in [1] workers' perception of the importance of safety to their employer and [2] their own perception of risk of injury.

We are recruiting companies to participate in our research by allowing us to complete brief surveys with their employees. We would like to survey men and women who are 18 years or older. The survey is anonymous and does not collect any 'sensitive' information. The survey takes no more than 15 minutes, includes a 10-question survey about safety, briefly asks about employees' work environments, and asks about their injury history at work. All individuals surveyed will be told the purpose of the survey, assured that their participation is voluntary, and will be allowed to stop the survey at any time. Each participant will receive a $5 gift card to Walmart.

If you would like to be a part of the study we can arrange with you the most convenient time and place for your employees to complete the survey.

All study activities have been approved by the University of Georgia's ethical review board for human subjects' research.

We believe it is everyone's best interest to learn more about workplace safety in order to reduce injuries and fatalities on construction sites in Georgia. All information we collect will be collected and reported with anonymity and data will be kept confidential and secure.

If you have any questions or concerns, please contact Michael Welton by phone at (619)254-6582-8149 or by email michael.welton@gmail.com. If you have any questions or concerns regarding the rights of survey participants in this study, you may contact the UGA Institutional Review Board (IRB) Chairperson at 706.542.3199 or irb@uga.edu, and refer to this number: STUDY00002177.

Sincerely,

Sara Wagner Robb

Sara Wagner Robb, PhD
Assistant Professor
Department of Epidemiology & Biostatistics
College of Public Health
University of Georgia

Rhodes Hall, Health Sciences Campus / 105 Spear Road / Athens, Georgia 30602
An Equal Opportunity / Affirmative Action Institution

APPENDIX E: PARTICIPANT RECRUITMENT SCRIPT

(ENGLISH & SPANISH)

The University of Georgia

**Safety Climate, Ethic Disparities, and Injury History among Athens, Georgia Construction Workers.**

**Participant Recruitment Script - English Version**

**Summer 2015**

**Instructions:**

1) This script must be read to all individuals who are being recruited for their participation.

2) This script is **NOT** informed consent.

3) If the individual agrees to participate in the survey, proceed with the informed consent script.

*Hello, my name is ____________, and I am a research assistant and student at the University Georgia, College of Public Health. We are asking men and women who work in the construction industry to participate in a 15 minute survey about their experiences and perceptions of construction site safety.*

*Each year in the United States thousands of workers are injured on construction sites and more people die while working in construction than any other industry. The purpose of our research is to investigate factors associated with increased risk for construction site injury.*

*We are recruiting both men and women, who work in the construction industry are 18 years or older. If you decide to participate in our survey we will not ask your name and your participation is completely anonymous. Participating in the survey will take approximately 15 minutes, there will not be any harm or discomfort, and $5 will be donated to the Athens Area Boys and Girls Club.*

*Your participation in this research is important and has the potential to help make construction sites safer places to work for workers like you.*

*The principal investigator of this project is Dr. Sara Robb, a professor at the University of Georgia. Please ask feel free to ask any questions you have now. However, if you have questions later, you may contact Michael Welton at mdwelton@uga.edu or at (619)254-6582. If you have any questions or concerns regarding your rights as a research participant in this study, you may contact the Institutional Review Board (IRB) Chairperson at 706.542.3199 or irb@uga.edu, and refer to this number:* STUDY00002177. *All of this information is provided in this document* ***[Give the individual a copy of participant consent letter].***

*Are you interested in taking the survey?*

*[If they respond "yes", proceed with informaed consent script]*

*[If they respond "No", thank them for their time]*

The University of Georgia

**Trabajadores de Construcción en Athens, Georgia.**

**Guión de Participante Reclutamiento**

**Verano 2015**

Instrucciones:

1) Este script debe ser leído a todos los individuos que están siendo reclutados por su participación.

2) Este script **NO** es el consentimiento informado.

3) Si la persona está de acuerdo en participar en la encuesta, proceda con el guión de consentimiento informado.

*Hola, mi nombre es ____________, y yo soy un asistente de investigación y estudiante de la Universidad de Georgia, Facultad de Salud Pública. Estamos pidiendo a los hombres y mujeres que trabajan en la industria de la construcción a participar en una encuesta de 15 minutos acerca de sus experiencias y percepciones de seguridad en el lugar de la construcción.*

*Cada año en los Estados Unidos miles de trabajadores se lesionan en las obras de construcción y más personas mueren mientras se trabaja en la construcción que cualquier otra industria. El objetivo de nuestra investigación es investigar los factores asociados a un mayor riesgo de lesiones obra.*

*Estamos reclutando hombres y mujeres, que trabajan en la industria de la construcción quien son 18 años de edad o más. Si usted decide participar en nuestra encuesta no nos preguntamos su nombre y su participación es completamente anónima. La participación en la encuesta se llevará aproximadamente 15 minutos, no habrá ningún daño o malestar, y El Club de Niños y Niñas recibirá $5 por su participación.*

*Su participación en esta investigación es importante y tiene el potencial para ayudar a hacer las obras de construcción lugares más seguros para trabajar para los trabajadores como usted.*

*El investigador principal de este proyecto es Dr. Sara Robb, profesor de la Universidad de Georgia. Por favor, pregunte sin dude cualquier pregunta que tenga ahora. Sin embargo, si usted tiene preguntas más tarde, puede comunicarse con Michael Welton en mdwelton@uga.edu o al (619)254 -6582. Si usted tiene alguna pregunta o duda sobre sus derechos como participante de la investigación en este estudio, puede comunicarse con la Junta de Revisión Institucional (IRB) Presidente al (706)542-3199 o irb@uga.edu, y se refieren a este número:* STUDY00002177. *Toda esta información se proporciona en este documento [Dar al individuo una copia del documento de consentimiento participante].*

*¿Está usted interesado en participar?*

*[Si responden "sí", continúe con la escritura consentimiento informado]*

*[Si responden "no", les damos las gracias por su tiempo]*

# APPENDIX F: UNITED STATES STANDARD DEATH CERTIFICATE AND INSTRUCTIONS

**U.S. STANDARD CERTIFICATE OF DEATH**

LOCAL FILE NO.　　　　STATE FILE NO.

NAME OF DECEDENT ______________________
For use by physician or institution

**To Be Completed/ Verified By: FUNERAL DIRECTOR:**

| | | |
|---|---|---|
| 1. DECEDENT'S LEGAL NAME (Include AKA's if any) (First, Middle, Last) | 2. SEX | 3. SOCIAL SECURITY NUMBER |

| | | | | |
|---|---|---|---|---|
| 4a. AGE-Last Birthday (Years) | 4b. UNDER 1 YEAR: Months / Days | 4c. UNDER 1 DAY: Hours / Minutes | 5. DATE OF BIRTH (Mo/Day/Yr) | 6. BIRTHPLACE (City and State or Foreign Country) |

| | | |
|---|---|---|
| 7a. RESIDENCE-STATE | 7b. COUNTY | 7c. CITY OR TOWN |

| | | | |
|---|---|---|---|
| 7d. STREET AND NUMBER | 7e. APT. NO. | 7f. ZIP CODE | 7g. INSIDE CITY LIMITS? ◻ Yes ◻ No |

| | | |
|---|---|---|
| 8. EVER IN US ARMED FORCES? ◻ Yes ◻ No | 9. MARITAL STATUS AT TIME OF DEATH ◻ Married ◻ Married, but separated ◻ Widowed ◻ Divorced ◻ Never Married ◻ Unknown | 10. SURVIVING SPOUSE'S NAME (If wife, give name prior to first marriage) |

| | |
|---|---|
| 11. FATHER'S NAME (First, Middle, Last) | 12. MOTHER'S NAME PRIOR TO FIRST MARRIAGE (First, Middle, Last) |

| | | |
|---|---|---|
| 13a. INFORMANT'S NAME | 13b. RELATIONSHIP TO DECEDENT | 13c. MAILING ADDRESS (Street and Number, City, State, Zip Code) |

14. PLACE OF DEATH (Check only one: see instructions)

IF DEATH OCCURRED IN A HOSPITAL: ◻ Inpatient ◻ Emergency Room/Outpatient ◻ Dead on Arrival

IF DEATH OCCURRED SOMEWHERE OTHER THAN A HOSPITAL: ◻ Hospice facility ◻ Nursing home/Long term care facility ◻ Decedent's home ◻ Other (Specify):

| | | |
|---|---|---|
| 15. FACILITY NAME (If not institution, give street & number) | 16. CITY OR TOWN , STATE, AND ZIP CODE | 17. COUNTY OF DEATH |

| | |
|---|---|
| 18. METHOD OF DISPOSITION: ◻ Burial ◻ Cremation ◻ Donation ◻ Entombment ◻ Removal from State ◻ Other (Specify):______________ | 19. PLACE OF DISPOSITION (Name of cemetery, crematory, other place) |
| 20. LOCATION-CITY, TOWN, AND STATE | 21. NAME AND COMPLETE ADDRESS OF FUNERAL FACILITY |
| 22. SIGNATURE OF FUNERAL SERVICE LICENSEE OR OTHER AGENT | 23. LICENSE NUMBER (Of Licensee) |

**To Be Completed By: MEDICAL CERTIFIER**

| | | |
|---|---|---|
| **ITEMS 24-28 MUST BE COMPLETED BY PERSON WHO PRONOUNCES OR CERTIFIES DEATH** | 24. DATE PRONOUNCED DEAD (Mo/Day/Yr) | 25. TIME PRONOUNCED DEAD |
| 26. SIGNATURE OF PERSON PRONOUNCING DEATH (Only when applicable) | 27. LICENSE NUMBER | 28. DATE SIGNED (Mo/Day/Yr) |
| 29. ACTUAL OR PRESUMED DATE OF DEATH (Mo/Day/Yr) (Spell Month) | 30. ACTUAL OR PRESUMED TIME OF DEATH | 31. WAS MEDICAL EXAMINER OR CORONER CONTACTED? ◻ Yes ◻ No |

**CAUSE OF DEATH (See instructions and examples)**

32. PART I. Enter the chain of events--diseases, injuries, or complications--that directly caused the death. DO NOT enter terminal events such as cardiac arrest, respiratory arrest, or ventricular fibrillation without showing the etiology. DO NOT ABBREVIATE. Enter only one cause on a line. Add additional lines if necessary.

Approximate interval: Onset to death

IMMEDIATE CAUSE (Final disease or condition ------> resulting in death) a.________________ ________

Due to (or as a consequence of):

Sequentially list conditions, if any, leading to the cause listed on line a. Enter the **UNDERLYING CAUSE** (disease or injury that initiated the events resulting in death) **LAST**

b.________________ ________

Due to (or as a consequence of):

c.________________ ________

Due to (or as a consequence of):

d.________________ ________

PART II. Enter other significant conditions contributing to death but not resulting in the underlying cause given in PART I

33. WAS AN AUTOPSY PERFORMED? ◻ Yes ◻ No

34. WERE AUTOPSY FINDINGS AVAILABLE TO COMPLETE THE CAUSE OF DEATH? ◻ Yes ◻ No

| | | |
|---|---|---|
| 35. DID TOBACCO USE CONTRIBUTE TO DEATH? ◻ Yes ◻ Probably ◻ No ◻ Unknown | 36. IF FEMALE: ◻ Not pregnant within past year ◻ Pregnant at time of death ◻ Not pregnant, but pregnant within 42 days of death ◻ Not pregnant, but pregnant 43 days to 1 year before death ◻ Unknown if pregnant within the past year | 37. MANNER OF DEATH ◻ Natural ◻ Homicide ◻ Accident ◻ Pending Investigation ◻ Suicide ◻ Could not be determined |

| | | | |
|---|---|---|---|
| 38. DATE OF INJURY (Mo/Day/Yr) (Spell Month) | 39. TIME OF INJURY | 40. PLACE OF INJURY (e.g., Decedent's home; construction site; restaurant; wooded area) | 41. INJURY AT WORK? ◻ Yes ◻ No |

42. LOCATION OF INJURY: State: City or Town:
Street & Number: Apartment No.: Zip Code:

| | |
|---|---|
| 43. DESCRIBE HOW INJURY OCCURRED: | 44. IF TRANSPORTATION INJURY, SPECIFY: ◻ Driver/Operator ◻ Passenger ◻ Pedestrian ◻ Other (Specify) |

45. CERTIFIER (Check only one):
◻ Certifying physician-To the best of my knowledge, death occurred due to the cause(s) and manner stated.
◻ Pronouncing & Certifying physician-To the best of my knowledge, death occurred at the time, date, and place, and due to the cause(s) and manner stated.
◻ Medical Examiner/Coroner-On the basis of examination, and/or investigation, in my opinion, death occurred at the time, date, and place, and due to the cause(s) and manner stated.

Signature of certifier:______________________________

46. NAME, ADDRESS, AND ZIP CODE OF PERSON COMPLETING CAUSE OF DEATH (Item 32)

| | | | |
|---|---|---|---|
| 47. TITLE OF CERTIFIER | 48. LICENSE NUMBER | 49. DATE CERTIFIED (Mo/Day/Yr) | 50. **FOR REGISTRAR ONLY**- DATE FILED (Mo/Day/Yr) |

**To Be Completed By: FUNERAL DIRECTOR**

| | | |
|---|---|---|
| 51. DECEDENT'S EDUCATION-Check the box that best describes the highest degree or level of school completed at the time of death. ◻ 8th grade or less ◻ 9th - 12th grade; no diploma ◻ High school graduate or GED completed ◻ Some college credit, but no degree ◻ Associate degree (e.g., AA, AS) ◻ Bachelor's degree (e.g., BA, AB, BS) ◻ Master's degree (e.g., MA, MS, MEng, MEd, MSW, MBA) ◻ Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD) | 52. DECEDENT OF HISPANIC ORIGIN? Check the box that best describes whether the decedent is Spanish/Hispanic/Latino. Check the "No" box if decedent is not Spanish/Hispanic/Latino. ◻ No, not Spanish/Hispanic/Latino ◻ Yes, Mexican, Mexican American, Chicano ◻ Yes, Puerto Rican ◻ Yes, Cuban ◻ Yes, other Spanish/Hispanic/Latino (Specify) ______________ | 53. DECEDENT'S RACE (Check one or more races to indicate what the decedent considered himself or herself to be) ◻ White ◻ Black or African American ◻ American Indian or Alaska Native (Name of the enrolled or principal tribe) ________ ◻ Asian Indian ◻ Chinese ◻ Filipino ◻ Japanese ◻ Korean ◻ Vietnamese ◻ Other Asian (Specify)________ ◻ Native Hawaiian ◻ Guamanian or Chamorro ◻ Samoan ◻ Other Pacific Islander (Specify)________ ◻ Other (Specify)________ |

54. DECEDENT'S USUAL OCCUPATION (Indicate type of work done during most of working life. DO NOT USE RETIRED).

55. KIND OF BUSINESS/INDUSTRY

REV. 11/2003

## MEDICAL CERTIFIER INSTRUCTIONS for selected items on U.S. Standard Certificate of Death

(See Physicians' Handbook or Medical Examiner/Coroner Handbook on Death Registration for instructions on all items)

### ITEMS ON WHEN DEATH OCCURRED

Items 24-25 and 29-31 should always be completed. If the facility uses a separate pronouncer or other person to indicate that death has taken place with another person more familiar with the case completing the remainder of the medical portion of the death certificate, the pronouncer completes items 24-28. If a certifier completes items 24-25 as well as items 29-49, items 26-28 may be left blank.

### ITEMS 24-25, 29-30 – DATE AND TIME OF DEATH

Spell out the name of the month. If the exact date of death is unknown, enter the **approximate** date. If the date cannot be approximated, enter the date the body is found and identify as **date found**. Date pronounced and actual date may be the same. Enter the exact hour and minutes according to a 24-hour clock; estimates may be provided with "Approx." placed before the time.

### ITEM 32 – CAUSE OF DEATH (See attached examples)

Take care to make the entry legible. Use a computer printer with high resolution, typewriter with good black ribbon and clean keys, or print legibly using permanent **black** ink in completing the CAUSE OF DEATH Section. **Do not abbreviate** conditions entered in section.

**Part I (Chain of events leading directly to death)**

•Only **one** cause should be entered on each line. Line (a) **MUST ALWAYS** have an entry. **DO NOT** leave blank. Additional lines may be added if necessary.

•If the condition on Line (a) resulted from an underlying condition, put the underlying condition on Line (b), and so on, until the full sequence is reported. **ALWAYS** enter the **underlying cause of death** on the lowest used line in Part I.

•For each cause indicate the best estimate of the interval between the presumed onset and the date of death. The terms "unknown" or "approximately" may be used. General terms, such as minutes, hours, or days, are acceptable, if necessary. **DO NOT** leave blank.

•The terminal event (for example, cardiac arrest or respiratory arrest) should not be used. If a mechanism of death seems most appropriate to you for line (a), then you must always list its cause(s) on the line(s) below it (for example, cardiac arrest **due to** coronary artery atherosclerosis *or* cardiac arrest **due to** blunt impact to chest).

• If an organ system failure such as congestive heart failure, hepatic failure, renal failure, or respiratory failure is listed as a cause of death, always report its etiology on the line(s) beneath it (for example, renal failure **due to** Type I diabetes mellitus).

•When indicating neoplasms as a cause of death, include the following: 1) primary site *or* that the primary site is unknown, 2) benign or malignant, 3) cell type *or* that the cell type is unknown, 4) grade of neoplasm, and 5) part or lobe of organ affected. (For example, a primary well-differentiated squamous cell carcinoma, lung, left upper lobe.)

•Always report the fatal injury (for example, stab wound of chest), the trauma (for example, transection of subclavian vein), and impairment of function (for example, air embolism).

### PART II (Other significant conditions)

•Enter all diseases or conditions contributing to death that were not reported in the chain of events in Part I and that did not result in the **underlying cause of death**. See attached examples.

•If two or more possible sequences resulted in death, or if two conditions seem to have added together, report in Part I the one that, in your opinion, most directly caused death. Report in Part II the other conditions or diseases.

### CHANGES TO CAUSE OF DEATH

Should additional medical information or autopsy findings become available that would change the cause of death originally reported, the original death certificate should be amended by the certifying physician by **immediately** reporting the revised cause of death to the State Vital Records Office.

### ITEMS 33-34 - AUTOPSY

•33 - Enter "Yes" if either a partial or full autopsy was performed. Otherwise enter "No."

•34 - Enter "Yes" if autopsy findings were available to complete the cause of death; otherwise enter "No". Leave item blank if no autopsy was performed.

### ITEM 35 - DID TOBACCO USE CONTRIBUTE TO DEATH?

Check "yes" if, in your opinion, the use of tobacco contributed to death. Tobacco use may contribute to deaths due to a wide variety of diseases; for example, tobacco use contributes to many deaths due to emphysema or lung cancer and some heart disease and cancers of the head and neck. Check "no" if, in your clinical judgment, tobacco use did not contribute to this particular death.

### ITEM 36 - IF FEMALE, WAS DECEDENT PREGNANT AT TIME OF DEATH OR WITHIN PAST YEAR?

*This information is important in determining pregnancy-related mortality.*

### ITEM 37 - MANNER OF DEATH

•Always check Manner of Death, which is important: 1) in determining accurate causes of death; 2) in processing insurance claims; and 3) in statistical studies of injuries and death.

•Indicate "Pending Investigation" if the manner of death cannot be determined whether due to an accident, suicide, or homicide within the statutory time limit for filing the death certificate. This should be changed later to one of the other terms.

•Indicate "Could not be Determined" **ONLY** when it is impossible to determine the manner of death.

### ITEMS 38-44 - ACCIDENT OR INJURY – to be filled out in all cases of deaths due to injury or poisoning.

•38 - Enter the exact month, day, and year of injury. Spell out the name of the month. **DO NOT** use a number for the month. (Remember, the date of injury may differ from the date of death.) Estimates may be provided with "Approx." placed before the date.

•39 - Enter the exact hour and minutes of injury or use your best estimate. Use a 24-hour clock.

•40 - Enter the general place (such as restaurant, vacant lot, or home) where the injury occurred. **DO NOT** enter firm or organization names. (For example, enter "factory", **not** "Standard Manufacturing, Inc." )

•41 - Complete if anything other than natural disease is mentioned in Part I or Part II of the medical certification, including homicides, suicides, and accidents. This includes all motor vehicle deaths. The item must be completed for decedents ages 14 years or over and may be completed for those less than 14 years of age if warranted. Enter "Yes" if the injury occurred at work. Otherwise enter "No". An injury may occur at work regardless of whether the injury occurred in the course of the decedent's "usual" occupation. Examples of injury at work and injury not at work follow:

| Injury at work | Injury not at work |
|---|---|
| Injury while working or in vocational training on job premises | Injury while engaged in personal recreational activity on job premises |
| Injury while on break or at lunch or in parking lot on job premises | Injury while a visitor (not on official work business) to job premises |
| Injury while working for pay or compensation, including at home | Homemaker working at homemaking activities |
| Injury while working as a volunteer law enforcement official etc. | Student in school |
| Injury while traveling on business, including to/from business contacts | Working for self for no profit (mowing yard, repairing own roof, hobby) |
| | Commuting to or from work |

•42 - Enter the complete address where the injury occurred including zip code.

•43 - Enter a brief but specific and clear description of how the injury occurred. Explain the circumstances or cause of the injury. Specify **type of gun** or **type of vehicle** (e.g., car, bulldozer, train, etc.) when relevant to circumstances. Indicate if more than one vehicle involved; specify type of vehicle decedent was in.

•44 -Specify role of decedent (e.g. driver, passenger). Driver/operator and passenger should be designated for modes other than motor vehicles such as bicycles. Other applies to watercraft, aircraft, animal, or people attached to outside of vehicles (e.g. surfers).

Rationale: Motor vehicle accidents are a major cause of unintentional deaths; details will help determine effectiveness of current safety features and laws.

**REFERENCES**

For more information on how to complete the medical certification section of the death certificate, refer to tutorial at http://www.TheNAME.org and resources including instructions and handbooks available by request from NCHS, Room 7318, 3311 Toledo Road, Hyattsville, Maryland 20782-2003 or at www.cdc.gov/nchs/about/major/dvs/handbk.htm

## Cause-of-death – Background, Examples, and Common Problems

Accurate cause of death information is important

- to the public health community in evaluating and improving the health of all citizens, and
- often to the family, now and in the future, and to the person settling the decedent's estate.

The cause-of-death section consists of two parts. **Part I** is for reporting a chain of events leading directly to death, with the **immediate cause** of death (the final disease, injury, or complication directly causing death) on line a and the **underlying cause** of death (the disease or injury that initiated the chain of events that led directly and inevitably to death) on the lowest used line. **Part II** is for reporting all other significant diseases, conditions, or injuries that contributed to death but which did not result in the underlying cause of death given in Part I. **The cause-of-death information should be YOUR best medical OPINION.** A condition can be listed as "probable" even if it has not been definitively diagnosed.

### Examples of properly completed medical certifications

**CAUSE OF DEATH (See instructions and examples)**

32. PART I. Enter the chain of events--diseases, injuries, or complications--that directly caused the death. DO NOT enter terminal events such as cardiac arrest, respiratory arrest, or ventricular fibrillation without showing the etiology. DO NOT ABBREVIATE. Enter only one cause on a line. Add additional lines if necessary.

| | | Approximate interval: Onset to death |
|---|---|---|
| IMMEDIATE CAUSE (Final disease or condition ---------> resulting in death) | a. Rupture of myocardium<br>Due to (or as a consequence of): | Minutes |
| Sequentially list conditions, if any, leading to the cause listed on line a. Enter the | b. Acute myocardial infarction<br>Due to (or as a consequence of): | 6 days |
| UNDERLYING CAUSE (disease or injury that initiated the events resulting | c. Coronary artery thrombosis<br>Due to (or as a consequence of): | 5 years |
| in death) LAST | d. Atherosclerotic coronary artery disease | 7 years |

PART II. Enter other significant conditions contributing to death but not resulting in the underlying cause given in PART I

Diabetes, Chronic obstructive pulmonary disease, smoking

33. WAS AN AUTOPSY PERFORMED? ■ Yes ☐ No

34. WERE AUTOPSY FINDINGS AVAILABLE TO COMPLETE THE CAUSE OF DEATH? ■ Yes ☐ No

35. DID TOBACCO USE CONTRIBUTE TO DEATH?
■ Yes ☐ Probably
☐ No ☐ Unknown

36. IF FEMALE:
■ Not pregnant within past year
☐ Pregnant at time of death
☐ Not pregnant, but pregnant within 42 days of death
☐ Not pregnant, but pregnant 43 days to 1 year before death
☐ Unknown if pregnant within the past year

37. MANNER OF DEATH
■ Natural ☐ Homicide
☐ Accident ☐ Pending Investigation
☐ Suicide ☐ Could not be determined

**CAUSE OF DEATH (See instructions and examples)**

32. PART I. Enter the chain of events--diseases, injuries, or complications--that directly caused the death. DO NOT enter terminal events such as cardiac arrest, respiratory arrest, or ventricular fibrillation without showing the etiology. DO NOT ABBREVIATE. Enter only one cause on a line. Add additional lines if necessary.

| | | Approximate interval: Onset to death |
|---|---|---|
| IMMEDIATE CAUSE (Final disease or condition ---------> resulting in death) | a. Aspiration pneumonia<br>Due to (or as a consequence of): | 2 Days |
| Sequentially list conditions, if any, leading to the cause listed on line a. Enter the | b. Complications of coma<br>Due to (or as a consequence of): | 7 weeks |
| UNDERLYING CAUSE (disease or injury that initiated the events resulting | c. Blunt force injuries<br>Due to (or as a consequence of): | 7 weeks |
| in death) LAST | d. Motor vehicle accident | 7 weeks |

PART II. Enter other significant conditions contributing to death but not resulting in the underlying cause given in PART I

33. WAS AN AUTOPSY PERFORMED? ■ Yes ☐ No

34. WERE AUTOPSY FINDINGS AVAILABLE TO COMPLETE THE CAUSE OF DEATH? ■ Yes ☐ No

35. DID TOBACCO USE CONTRIBUTE TO DEATH?
☐ Yes ☐ Probably
■ No ☐ Unknown

36. IF FEMALE:
☐ Not pregnant within past year
☐ Pregnant at time of death
☐ Not pregnant, but pregnant within 42 days of death
☐ Not pregnant, but pregnant 43 days to 1 year before death
☐ Unknown if pregnant within the past year

37. MANNER OF DEATH
☐ Natural ☐ Homicide
■ Accident ☐ Pending Investigation
☐ Suicide ☐ Could not be determined

38. DATE OF INJURY (Mo/Day/Yr) (Spell Month): August 15, 2003

39. TIME OF INJURY: Approx. 2320

40. PLACE OF INJURY (e.g., Decedent's home; construction site; restaurant; wooded area): road side near state highway

41. INJURY AT WORK? ☐ Yes ■ No

42. LOCATION OF INJURY: State: Missouri City or Town: near Alexandria
Street & Number: mile marker 17 on state route 46a Apartment No.: Zip Code:

43. DESCRIBE HOW INJURY OCCURRED:
Decedent driver of van, ran off road into tree

44. IF TRANSPORTATION INJURY, SPECIFY:
■ Driver/Operator
☐ Passenger
☐ Pedestrian
☐ Other (Specify)

### Common problems in death certification

The **elderly decedent** should have a clear and distinct etiological sequence for cause of death, if possible. Terms such as senescence, infirmity, old age, and advanced age have little value for public health or medical research. Age is recorded elsewhere on the certificate. When a number of conditions resulted in death, the physician should choose the single sequence that, in his or her opinion, best describes the process leading to death, and place any other pertinent conditions in Part II. If after careful consideration the physician cannot determine a sequence that ends in death, then the medical examiner or coroner should be consulted about conducting an investigation or providing assistance in completing the cause of death.

The **infant decedent** should have a clear and distinct etiological sequence for cause of death, if possible. "Prematurity" should not be entered without explaining the etiology of prematurity. Maternal conditions may have initiated or affected the sequence that resulted in infant death, and such maternal causes should be reported in addition to the infant causes on the infant's death certificate (e.g., Hyaline membrane disease **due to** prematurity, 28 weeks **due to** placental abruption **due to** blunt trauma to mother's abdomen).

When **SIDS** is suspected, a complete investigation should be conducted, typically by a medical examiner or coroner. If the infant is under 1 year of age, no cause of death is determined after scene investigation, clinical history is reviewed, and a complete autopsy is performed, then the death can be reported as Sudden Infant Death Syndrome.

**When processes such as the following are reported, additional information about the etiology should be reported:**

Abscess
Abdominal hemorrhage
Adhesions
Adult respiratory distress syndrome
Acute myocardial infarction
Altered mental status
Anemia
Anoxia
Anoxic encephalopathy
Arrhythmia
Ascites
Aspiration
Atrial fibrillation
Bacteremia
Bedridden
Biliary obstruction
Bowel obstruction
Brain injury
Brain stem herniation
Carcinogenesis
Carcinomatosis
Cardiac arrest
Cardiac dysrhythmia
Cardiomyopathy
Cardiopulmonary arrest
Cellulitis
Cerebral edema
Cerebrovascular accident
Cerebellar tonsillar herniation
Chronic bedridden state
Cirrhosis
Coagulopathy
Compression fracture
Congestive heart failure
Convulsions
Decubiti
Dehydration
Dementia (when not otherwise specified)
Diarrhea
Disseminated intra vascular coagulopathy
Dysrhythmia
End-stage liver disease
End-stage renal disease
Epidural hematoma
Exsanguination
Failure to thrive
Fracture
Gangrene
Gastrointestinal hemorrhage
Heart failure
Hemothorax
Hepatic failure
Hepatitis
Hepatorenal syndrome
Hyperglycemia
Hyperkalemia
Hypovolemic shock
Hyponatremia
Hypotension
Immunosuppression
Increased intra cranial pressure
Intra cranial hemorrhage
Malnutrition
Metabolic encephalopathy
Multi-organ failure
Multi-system organ failure
Myocardial infarction
Necrotizing soft-tissue infection
Old age
Open (or closed) head injury
Paralysis
Pancytopenia
Perforated gallbladder
Peritonitis
Pleural effusions
Pneumonia
Pulmonary arrest
Pulmonary edema
Pulmonary embolism
Pulmonary insufficiency
Renal failure
Respiratory arrest
Seizures
Sepsis
Septic shock
Shock
Starvation
Subdural hematoma
Subarachnoid hemorrhage
Sudden death
Thrombocytopenia
Uncal herniation
Urinary tract infection
Ventricular fibrillation
Ventricular tachycardia
Volume depletion

If the certifier is unable to determine the etiology of a process such as those shown above, the process must be qualified as being of an unknown, undetermined, probable, presumed, or unspecified etiology so it is clear that a distinct etiology was not inadvertently or carelessly omitted.

The following conditions and types of death might seem to be specific or natural but when the medical history is examined further may be found to be complications of an injury or poisoning (possibly occurring long ago). Such cases should be reported to the medical examiner/coroner.

Asphyxia
Bolus
Choking
Drug or alcohol overdose/drug or alcohol abuse
Epidural hematoma
Exsanguination
Fall
Fracture
Hip fracture
Hyperthermia
Hypothermia
Open reduction of fracture
Pulmonary emboli
Seizure disorder
Sepsis
Subarachnoid hemorrhage
Subdural hematoma
Surgery
Thermal burns/chemical burns

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