Workplace Nonfatal Injuries among Immigrants to the U.S.*

Lingxin Hao

Department of Sociology
Johns Hopkins University
3400 N. Charles Street
Baltimore, MD 21218
Tel: (410) 516-4022
Fax: (410) 516-7590
Email: hao@jhu.edu

April 2008

* Prepared for presentation at the 2008 Annual Meeting of the Population Association and America. This research was supported by a grant SES-0518870 from the National Science Foundation.

Workplace Nonfatal Injuries among Immigrants to the U.S.

Abstract

This study investigate workplace injuries that lead to temporary work limitations or permanent work disability. To study the patterns and causes of workplace injuries among foreign-born workers, this paper considers sources of system errors and human errors for foreign-born workers. System errors are due to development gaps between the origin country and the U.S. and human errors are due to low English proficiency and education of immigrants, both of which result in immigrant unfamiliarity with American workplace. Acculturation is hypothesized to reduce this unfamiliarity. Data are drawn from three panels of Survey of Income and Program Participation (SIPP) from 1996 to 2004. The study yields three major findings. First, it finds strong evidence to support that immigrants are more likely to inflict workplace injuries than native-born workers, and simultaneously because of high-level unfamiliarity resulting from the dramatic transition of many immigrant workers from a third-work workplace to a first-world workplace. This detrimental effect is attenuated by the duration living in the U.S. due to acculturation. Second, besides the detrimental immigrant unfamiliarity effect, low-educated immigrants face severe exposure to risk of workplace injury. The bottom tail of the educational attainment distribution is not comparable between the native born and the foreign born, simply reflecting development gaps between the U.S. and many sending countries. Third, the large immigrant influx in the past decade coincides with the deteriorating workplace safety in the U.S., placing newcomers to a great danger of workplace injury. These findings bear important policy implications.

Workplace Nonfatal Injuries among Immigrants to the U.S.

Introduction

A substantial body of literature examines workplace injuries among American workers. However, because data are provided by the surveillance system of occupational injuries and diseases (BLS 2006), which contains little information on place of birth and date of arrival of foreign-born employees so fatal and nonfatal injury rates among immigrants cannot be easily ascertained. Little research has been done on workplace injuries among immigrants to the U.S. and even less on their determining factors.

Work-related injuries constitute a major domain of health. Its determinants, however, are distinctive from those of other health domains such as infectious and chronic diseases. Immigration has complicated the causes of workplace injuries because of the intriguing relationship between work and health. On the one hand, working people have better health status because employment increases socioeconomic status, which is positively associated with health. The importance of employment for health is particularly true for immigrants (Dunn and Dyck 2000). Employment provides resources for integration into the host country and a sense of control over one's life (Thurston and McGrath 1993). On the other hand, employment places individuals at risk of occupational injuries. Labor immigrants are likely to work in risky, hazardous working conditions (Loh and Richardson 2004; Portes and Rumbaut 2006). Immigrants establish their employment niches in agriculture, construction, meat packing, and consumer services, which have been undergoing substantial transformation to contract work in the past two decades. Because contract work can reduce labor costs and avoid regulatory immigration issues (Clinton 1997; Massey, Durand and Nolan 2002), full-time, stable employment in agriculture and construction has been transformed to part-time, contingent

employment. Little is known how workplace safety regulations are enforced in contract work, which hires disproportionately foreign-born workers.

This study investigate workplace injuries that lead to temporary work limitations or permanent work disability. The objective is to document the patterns of workplace injuries and analyze their determining factors among foreign-born workers in comparison with native-born workers. The data are drawn from three panels of the Survey of Income and Program Participation (SIPP) from 1996 to 2004, which provide critical information on work injury history and migration history required for this study.

This study is one of few first investigations into workplace injuries among immigrants in comparison with natives. Results from this study will provide fresh evidence for health policy makers to design preventive programs targeting the growing immigrant work force that are vulnerable to work-related injuries and the aftermath in their health.

Background

Loh and Richardson (2004) provide the basic trends in fatal occupational injuries in relations with immigration during 1996-2001. While the share of foreign-born employment increased by 22% in that period, the share of foreign-born fatal occupational injuries increased by 43% in the same period. In 2001, the fatality rate for all U.S. workers was 4.3 per 100,000 workers; the corresponding number is 5.7 for immigrant workers. According to the authors, one major reason for this disparity is that foreign-born workers are likely to work in occupations and industries with inherently higher risks of fatal injury. Other factors include low education and English proficiency. An earlier study finds that immigrants are more subject to workplace homicide than the native born. Immigrants are engaged in jobs such as cashiers, sale

supervisors, proprietors, and taxi driver, all are high on homicide than other occupations.

McCauley (2005) characterizes immigrants' jobs as high risk of injuries and diseases. Agriculture work is Mexicanized. Farm work is one of the most dangerous U.S. occupations. It employs less than 3% of the U.S. work force but accounts for 13% of workplace fatalities (U.S. Department of Labor, 2004). Sweatshops are labor intensive workplaces such as apparel, restaurants, food processing plants, and dry cleaners. These workers are typically Asians and Latinas. Day laborers usually are recruited to work with hazardous substances without giving adequate training about toxic materials. Thus labor immigrants are more vulnerable to work-related fatal and nonfatal injuries than their native-born counterparts.

Not only do the risk-prone work conditions of jobs expose immigrants to greater risks of injuries but also the nature of the employment system has been changing to worsen the disadvantage of immigrant workers. Many U.S. businesses are using contingency workers and contract services in lieu of hiring employees directly (Clinton 1997). Contingency workers are temporary or contract workers brought in for short- or long-term tasks. When the job's done, they leave. Aside from consulting positions, the Department of Labor reports that temporary jobs alone jumped 577% from the early 1980s to the late 1990s. Most of the growth in contract services has occurred in the lower-skilled occupations that hire immigrant workers such as cleaners, helpers, and laborers. One-fourth of all hired crop workers are employed by a contractor rather than working directly for a grower or farm operator (Villarejo and Baron 1999). By using contractors, employers can avoid dealing directly with regulatory and immigration issues that often raise management costs (Massey, Durand and Nolan 2002). Workers under this contract work system are primarily foreign born. They may not have sufficient safety training and access to occupational health and safety services. They may also be unaware of worker

rights to legal services if being injured in the U.S.

The topic of immigrant injuries begins to call U.S. researcher's attention recently. An ethnographic study finds that young Latino immigrants received inadequate training given the hazardous work they performed (O'Connor et al. 2005). Latino immigrant workers in the poultry processing industry face company-varying occupational safety environments and have higher rates of musculoskeletal symptoms but are less likely to seek medical care or miss work (Quandt et al. 2006). In a study of Hispanic construction workers many of whom are immigrants, the authors find that Hispanic construction workers consistently faced higher risks for every age group from 1992 to 2000 (Dong et al. 2004). In 2000, Hispanic construction workers were nearly twice as likely to be killed due to occupational injuries as their non-Hispanic counterparts.

Low levels of English proficiency among Latino immigrants may account for their high injury rates. In 2000, 26.7 million American residents (5 years and older) spoke Spanish at home, and about half of them (46.6%) said they speak English less than ''very well'' (U.S. Census, 2000). In the same year, 452,840, or nearly one-third of Hispanic construction workers speak only Spanish (CPWR 2002). This fact profoundly changes work-site communication, work-site culture, organization of work, and ultimately safety on the work site (Pransky et al. 2002). Previous analyses of occupational fatalities among immigrants in all industries noted that almost half of all foreign-born immigrant occupational fatalities were Hispanic (Windau 1997). In sum, published studies of Hispanic workers (Moure-Eraso et al. 1997; Mora and Davila 1998; Takaro et al. 1999) suggest the importance of organization of work and social, and economic factors in workplace injuries.

Theoretical Consideration

Minority workers' greater risks at occupational injury are attributable to sociopolitical and individual factors, termed as *system errors* and *human errors* in the injury literature (Kirschenbaum, Oigenblick, and Goldberg 2000). System errors refer the organizational and institutional factors that shape the understanding and practice of risk assessments and job procedures. Human errors look to characteristics of the injured worker for explanations of the differences in the probability of injury. In addition, these two types of errors operate separately or interdependently.

System Errors. Institutional racism and discrimination explain the disproportionate distribution of workplace injuries along the racial divides. Friedman-Jimenez (1989) found that black and Hispanic workers tended to be employed in more risky jobs. Other studies found that black people had 50% more disabling injuries than whites and the highest risk of occupational injury (Robinson 1989). While black workers and white workers were proportionately distributed in safe and hazardous industries, black workers were disproportionately employed in the more hazardous jobs in those industries. The majority of contemporary immigrants are racial minorities. They are more likely to work in dangerous occupations, e.g., laborers, food preparation workers, construction workers, and janitors (Waldinger 1996).

Human Errors. immigrants lack a sense of entitlements and for fear of being fired, so they are less likely to refuse unsafe work or to work more slowly (Bollini and Siem 1995). Some immigrants may be subject to victimization and acceptability of risk because of a belief in fatalism (Maurice et al. 1997). This may undermine action taking to prevent injury. Risk is "the way in which the environment is perceived through the lens of culture" (Kleinhesselink and Rosa 1991: 25). Acculturation occurs as the immigrant experiences changes in the physical,

environmental, political, social, economic, psychological, and cultural aspects of their lives. Culture then is not a stable force in immigrants' lives during acculturation and adaptation. Although immigrants are self selected on health (Bolaria 1988; Bollini and Siem 1995), they may have less knowledge of and access to preventive services, (Bolaria 1988; Bollini and Siem 1995).

Applying existing theories to the case of immigrants, we argue that, in order to understand immigrant workplace injury, we must pay close attention to the initial structural, institutional conditions at arrival of immigrants, particularly the conditions of the sending country vis a vis the U.S. conditions. International migration is a consequence of uneven development of nations and imbalanced economic and labor market development between the home and host societies. This imbalance dictates that immigrants experience an *accelerated industrialization* that jumps over a few development stages. The American system is foreign to newcomers, who are not familiar with the work conditions, production materials, machineries and tools, and rules and regulations. These are major sources of systemic errors. Individual immigrants' characteristics may also be responsible for workplace injury, resulting in human errors. However, these at-arrival conditions can be better because once arrived, immigrants start acculturation, adapting English, American culture, and lifestyle, and American labor market conditions. Successful acculturation can help better fit immigrant workers in American labor market and reduce the negative consequence of accelerated industrialization immigrant workers experience.

In sum, the gap in technology between the U.S. and the third-world sending countries constitutes system errors in American workplace because no consideration is given to the technical knowledge and experience possessed by labor immigrant workers in designing

workplace safety. Sources of human errors come from low English proficiency and low human capital among individual immigrant workers, prolonging their unfamiliarity with American workplace. These arguments lead to two testable hypotheses. First, immigrants are, on average, unfamiliar with American workplace, thereby being prone to workplace injury--the immigrant unfamiliarity hypothesis. Second, living in the U.S. for a substantial length of time facilitates acculturation, which reduce the proneness of workplace injury--the U.S. residence duration hypothsis.

Data

The data for this study are drawn from Survey of Income and Program Participation (SIPP) 1996, 2001, and 2004 panels. Each panel of the SIPP is a nationally representative, longitudinal survey. This study uses samples of working-age individuals, ranging from about 48,000 to 68,000. The key information required in this study is from the work disability history module, which provides data on the place and time of injury that led to work limitations. Moreover, the migration history module provides necessary information on country of birth, year of arrival, and immigrant status (permanent resident visa) at arrival. The SIPP provides basic demographic information on age, gender, race/ethnicity, and educational attainment. Our analysis will focus on the very basic demographic and socioeconomic characteristics to document the patterns and explanations for nonfatal workplace injuries among immigrants.

Missing data is not a big problem (about 2.3%). With valid data on all variables used in this analysis, the analytic sample size is 171,026, with 56,703 from the 1996 panel, 47,108 from the 2001 panel, and 67,215 from the 2004 panel. A total of 2,687 workplace injuries were observed in the three panels.

Methods: Survival Analysis

We define nonfatal workplace injuries as those occurring in workplace while on the job, which lead to temporary work limitation or permanent work disability. Examples of on-the-job injuries include broken bone/fracture, head injury, spiral cord injury, hernia, and missing legs, feet, arms, hands, and figures, and loss or damage of vision and hearing. Workplace injuries that are fatal or do not result in work limitation are not included in this study. Because workplace injuries can take place at any point in time during one's work ages after being exposed to the risk, we use life course perspective to understand the timing and patterns. Survival analysis provides an appropriate method because it considers the initial time when one is exposed to the risk of injury and the duration at risk before an injury happens or before the end of observation. Results based on cross-sectional observation of a sample from the population can be misleading when work history is ignored (Pergamit and Krishnamurty 2006), which can be directly addressed by survival analysis.

It is critical to define accurately the initial age at risk of workplace injury. First, the range of work ages is defined as from 16 to 67, according to the Bureau of Labor Statistics. However, not everyone is exposed to the risk of workplace injury from age 16 since some are still in school. In this study, the initial age at risk is defined as the age when the highest education was attained (approximately six plus years of schooling) or age 16, whichever is older. While this definition is reasonable for native-born workers and immigrants who came to the U.S. before attaining the highest education, it is not accurate for immigrants who came after age 16 and do not further pursue education in the U.S. Thus, for immigrant workers, the initial age at risk is defined as the age when the highest education was attained or the age at arrival, whichever

is older.

If a person reported having an injury on the job before our defined initial age at risk, this person is considered not from the population under the study. The technical term in survival analysis for these cases is left censoring. The number of left censored cases is quite small, 23 for the three panels combined. After left censoring, the number of workplace injuries is 2,687 occurring before age 68 for the three panels combined.

The duration at risk, i.e., the failure time in survival analysis terminology, is the number of years elapsed from the initial age at risk to the age when the event occurs or the end of observation before age 68, whichever comes first. Then the hazard of injury on the job is negatively related to the duration at risk.

Our conceptual model suggests that the key explanatory variables are immigrant status and duration of U.S. residence. Immigrant status is hypothesized as a risky factor for workplace injury given the dramatic transition from a third-world workplace to a first-world workplace for the majority of immigrants. Duration of U.S. residence is proposed to attenuate this negative effect of immigrant unfamiliarity. Because the duration at risk of on-the-job injury is highly correlated with duration of U.S. residence among immigrants (with a correlation coefficient 0.91), the effect of U.S. residence duration cannot be identified in survival analysis. Instead of separately testing the two hypotheses, I use joint tests of two combined hypotheses. This first combination ties immigrant unfamiliarity effect with no U.S. residence duration effect. The second combination ties immigrant unfamiliarity effect with U.S. residence duration effect. To test the first combination, I specify that the immigrant effect is time-invariant. To test the second combination, I specify that the immigrant effect declines over time in an exponential decay fashion. If learning the language and getting familiar with the work environment can be

achieved by living in the U.S. for a substantial length of time, then the immigrant unfamiliarity effect should not be constant with the time elapsed.

This paper uses the "half-life" decay function (an exponential function) to characterize the time-varying effect of immigrant status. The half-life of a quantity whose value decreases with time is the interval required for the quantity to decay to half of its initial value. The concept originated in the study of radioactive decay. I apply this term to the reduction of immigrant unfamiliarity effect due to acculturation (measured by U.S. residence duration). Suppose that immigrants are unfamiliar with the workplace risks upon arrival. The level of unfamiliarity is normalized to one. Learning the language and workplace environment can reduce this detrimental effect. Let *t* be the elapsed time (in years) and *r* be the decay rate (or decay constant). The exponential curve, e^{-rt}, can describe the decay process. At the initial year, $t = 0$, $e^{-rt} = e^{0} = 1$. To allow variations in acculturation, I consider a series of five decay rates. Suppose that the half-life unfamiliarity is progressively longer--3, 4,5, 6, and 7 years--called 3-year half-time, 4-year half-time and so on. We can solve for the decay rate, (r), corresponding to each scenario using the equation $e^{-rt} = 0.5$, yielding $r = 0.231, 0.173, 0.139, 0.116, 0.099$, respectively. Then, the detrimental immigrant effect in the 10th year is 0.099, 0.177,0.249,0.313, and .371, respectively. To reduce the immigrant unfamiliarity effect to 1% of the initial level, it will take 20 years under the first scenario and 47 years under the third scenario. Figure 1 shows the five decay functions. The decay function decreases most rapidly under the 3-year half-life rate and least rapidly under the 7-year half-life rate. The five scenarios cover an empirically reasonable range of acculturation variations. The analysis will consider each of five rates.

(Figure 1 about here)

The workplace injury literature has documented the substantial racial/ethnic disparities, with black workers are at greater risk than white workers at the same level of education. Lower education levels are closely related to unskilled and semi-skilled occupations, which are more hazardous than other occupations. Thus workplace injuries exhibit education gradient (Pergamit and Krishnamurty 2006). Since immigrants are subject to these risk factors just as the native-born, to test the time-invariant or time-varying immigrant unfamiliarity effect, one must hold constant race/ethnicity and education.

From the life cycle perspective, the younger one becomes at risk of workplace injury, the likelihood this person eventually has an event to occur is greater. People either have a high level of education or immigrants arriving at a later age are older initially at risk of workplace injury. The survival models will control for this demographic factor. Gender is another important demographic factor as men are more likely to be engaged in hazardous jobs than women. In addition, the workplace may have become more hazardous because of the increasing practice of contract work, which is less regulated than the mainstream labor market. Thus, I expect that later years of initial risk exposure can increase the hazard of workplace injury.

Let I_i be the indicator for immigrant status for individual *i*, R_i a set of dummy variables indicating black, Hispanic, Asian, and other race with white as the reference, E_i a set of dummy variables indicating 9-11, 12, and 13+ years of schooling with less than 9 years as the reference, A_i for age at initial of risk in units of 5-years, centered at age 20, P_i for the period at initial risk in units of 5-years, centered at 1980, and M_i an indicator for men. The hazard is the instantaneous risk of an event. Technically it is the limit of the number of events per unit time divided by the number at risk as the time interval decreases. The hazards of workplace injury at time *t* can be expressed in the following Cox proportional hazards model with a time-invariant

immigrant unfamiliarity effect:

(1) $$h(t) = h_0(t)\,\mathrm{e}^{\{\beta_1 R_i + \beta_2 E_i + \beta_3 A_i + \beta_4 P_i + \beta_5 M_i + \beta_6 I_i\}},$$

where $h_0(t)$ is the baseline hazard when all the covariates take the value of zero (that is for white, schooling less than 9, age 20 at initial risk, year 1980 at initial risk, female, and native-born). The estimate of β_6 allows me to test the immigrant unfamiliarity hypothesis while assuming no U.S. residence duration effect.[1]

Moving to the next model, I consider the joint test of both the immigrant unfamiliarity hypothesis and U.S. residence duration hypothesis by specifying a time-varying immigrant unfamiliarity effect, with one decay rate at a time ($r = 0.231, 0.173, 0.139, 0.116, 0.099$, respectively)

(2) $$h(t) = h_0(t)\,\mathrm{e}^{\{\beta_1 R_i + \beta_2 E_i + \beta_3 A_i + \beta_4 P_i + \beta_5 M_i + \beta_6 I_i (\exp(-rt))\}},$$

Now, the estimate of $\beta_6 \cdot \exp(-rt)$ captures the time-varying immigrant effect, which allows me to jointly test the immigrant unfamiliarity hypothesis and the U.S. residence duration hypothesis.[2]

Results

Table 1 shows the descriptive statistics of variables used in analysis by nativity. The dependent variable is workplace injury. The incidence rate is .016 for the native-born and smaller (.011) for the foreign born. However, the waiting time before an injury occurs or end of observation is much longer for natives (20.66 years) than for immigrants (13.85), both of which ranging from 1 year to 52 years. This fact supports the use of survival analysis to examine

[1] The effect of time-invariant immigrant effect on hazard ratio is e^{β_6} .

[2] The effect of time-varying immigrant effect on hazard ratio is $e^{\beta_6 \cdot \exp(-rt)}$.

workplace injury.

Over the years from 1996 to 2004, 12% of the sampled working-age individuals are immigrants. The racial/ethnic composition is very different between natives and immigrants: while 78% of natives are whites, only 25% of immigrants are. By contrast, among immigrants, 44% are Hispanic and 22% are Asian, compared to only 6% and 1% among natives. The educational attainment is also different by nativity. While about one half of either group have some college education, the percentage having very low education (<9) is 20% among immigrants compared to only 3% among natives. We observe huge differences in the age at initial risk between natives and immigrants. While 98% of natives were 16-24 years old at initial risk, the corresponding number is 49% for immigrants. No single native-born worker was over age 45 at initial risk but 4% of immigrants were. With the increasing immigrant inflows in the past four decades, we see that 65% of immigrants were exposed to initial risk of workplace injury in the last two decades, the corresponding number of natives is 40%. Thus, immigrants are more non-white and less educated and exposed to later periods of workplace injury risk. Because these characteristics are risk factors of workplace injury, our analysis much take them into account to accurately assess the true immigrant disadvantage and the impact of US residence duration in workplace injury.

(Table 1 about here)

Next we compare the cumulative hazard function for natives and immigrants. The Nelson-Aalen estimator is a non-parametric estimator of the cumulative hazard function based on a sample that are subject to right censoring. The Nelson-Aalen estimator is a staircase function with (1) the location of the steps placed at each observed failure time and (2) the vertical size of the steps is 1/(number at risk), where (number at risk) is the count of subjects just before the

injuries that are still observed to be no injruty. For example, at year 2, the cumulative hazard rises from .0001 to .0015 among natives and from .0003 to .0029 among immigrants. Looking down the columns, we see a steeper increase in cumulative hazard among immigrants than among natives: it rises to .0572 for immigrants compared with .0490 for natives in year 43. Beyond year 43, the number of immigrants being observed is very small to be statistically meaningful.[3] The test of the nativity differences in cumulative hazards is statistically significant. This result is in contrast to the result based on snapshot incidence rate of workplace injury shown in Table 1, where immigrants exhibit a lower rate than natives. Failure to examine the history from the initial time at risk, like the snapshot proportion, severely mask the true nativity difference.

(Table 2 about here)

A graphic view can better depict the nativity pattern described in Table 2. In Figure 1(a), the immigrant curve lies above the native curve until age 47. The gaps exhibit an increasing trend because of the cumulative nature of the measurement. This pattern captures the total effect of immigrant status, which is very likely confounded with other factors, particularly race/ethnicity and education. Immigrants are more likely to be non-white and having a barbell shape of educational distribution. To gauge the degree of potential confounding, I also show the cumulative hazard function by race/ethnicity and by education in Figure 1. Figure 1(b) show that the curves for blacks and Hispanics are near each other and far above the curve for whites, which, in turn, well above the curve for Asians. Figure 1(c) shows the educational gradient: the cumulative hazard functions rank in the opposite order of educational levels, with the lowest education level is associated with the highest cumulative hazard. These figures strongly suggest

[3] More than 90 percent of the sampled immigrants had been in the U.S. for less than 30 years. For example, only 4 immigrants have been in the U.S. for 48 years and no one has been in the U.S. for 51 years.

that in order to obtain the true effect of immigrant status, we must take into account race/ethnicity and education.

(Figure 2 about here)

To ascertain the overall nativity effect, I estimate a simple Cox proportional model with only the indicator for immigrants, which is specified as time-invariant. The first row of Table 3 (M0) shows that being immigrant increases the hazard of workplace injury by 32% of that for natives and the effect is highly significant. Because many immigrants are Hispanics or Asian and a substantial proportion of immigrants have very low education, the immigrant effect is likely confounded with race/ethnic and education. Equation (1) controls for these factor and specifies a time-invariant effect of immigrant status. M1 in Table 3 shows that the time-invariant immigrant unfamiliarity effect is small in size and no longer significant.

(Table 3 about here)

The method section discusses that testing the the immigrant unfamiliarity hypothesis and the U.S. residence duration hypothesis is inseparable in survival analysis because the failure time is highly correlated with U.S. residence duration among immigrants. I set up two tests. The first test is for only immigrant unfamiliarity effect while assuming no U.S. residence duration effect. The second test is a joint test simultaneously for the immigrant unfamiliarity effect and the residence duration effect. In the survival analysis, the joint test is performed by specifying the immigrant effect as time-varying with a specific reduction function. I use an exponential function to characterize the reduction of immigrant effect due to acculturation. A series of five rates are used in models M2 to M6. Results are shown in the second half of Table 3.

The interpretation of the estimates for time-varying variables differ from those for time-invariant variables. We use the actual unit of the covariate to interpret estimates for time-

invariant variables, e.g., being immigrant increases the hazard by 32% in M1. The time-varying nature has to be incorporated in order to interpret estimates for time-varying covariates. In the specification of M2, the hazard is 142% greater for immigrants at the initial year than for natives, as the level of unfamiliarity is set to one in the initial year. For other years, we can calculate the remaining unfamiliarity by multiplying the hazard ratio (minus one) with e^{-rt}. For instance, in the 10th year, the proportional change in hazard is $(2.42-1)\cdot e^{-(.231*10)} = 1.42\cdot 0.099 = 0.142$, or 14.2% higher.

Table 3 shows that higher decay rates yield greater initial effect. As the rate increases from 3-year half-time to 7-year half time, the initial unfamiliarity declines from 2.42 to 1.53. This is reasonable if we view the survival time globally since a stronger initial effect declines more quickly. Their corresponding p-values also decline from .014 to .075. Although the subsample size of immigrants is large (20,932), the incidences of workplace injuries are only 229. Given this fact, I consider a p-value of .075 as statistically significant. The decay trend is just opposite to that for the initial effect across the five scenarios. For instance, in the 10th years, the proportional change in hazard goes from 14.2% for the 3-year half-life to 19.6% for the 7-year half-life. With systemic variations, this set of tests provide unambiguous evidence to support the immigrant unfamiliarity hypothesis and the U.S. residence duration hypothesis simultaneously. Figure 3 shows the five scenarios of time-varying immigrant effects against the failure time over 52 years. The five curves cross each other: the 3-year half-life scenario has the strongest effect before year 5 and becomes the weakest from year 7 to year 30, whereas the 7-year half-life scenario has the weakest effect before year 7 and become slightly stronger than other scenarios from year 20 to year 30. All scenarios converge at year 30.

(Figure 3 about here)

The results from M1-M6 are partial effects because these model include a set of demographic and socioeconomic factors determining workplace injuries. Table 4 presents their estimates in M3. As expected, blacks face greater hazard than whites. Less is known about Hispanic and Asian workers in the literature. By contrast to the total Hispanic disadvantage in Figure 1(b), Hispanics are statistically similar to whites in terms of the hazard of workplace injury, *ceteris paribus* (including immigrant status and residence duration). We find that Asian workers have a lower hazard of workplace injury than white workers, probably the industry and occupational niches of Asian workers are less hazardous. There are strong education gradients and male effects, consistent with the literature. Age at the initial year also matters. Holding race, education, and gender constant, older ages at the initial year reduce the hazard of workplace injury. Finally, the periods at the initial year also matter. Every 5 years increase the proportional hazard by 38%. This reveals that American workers have been exposed to worse workplace conditions since 1996, an era featured with weakened reinforcement of workplace safety and rising contract and contingency work.

(Table 4 about here)

Conclusions

Very few people with a serious injury can fully recover. The majority of this type of workplace injuries end up with work limitations and work disabilities. This induces great burdens to the individual workers, their families, and the society. The immigrant share of the American work force has been growing, along with the rising practice of contract and contingency work, whose employees are more likely foreign born. Yet, the literature lacks a understanding of the impact of immigration on workplace injuries. The purpose of this paper is

to fulfill a moderate goal to provide a first understanding of the problem based on a nationally representative sample.

The study focuses on separating out important demographic and socioeconomic factors that are usually observed in survey (race/ethnicity, education, gender, age, and periods) from two basic effects of immigration (immigrant unfamiliarity and U.S. residence duration). Apparently many other important factors ought to be considered, particularly the industry, occupation, and sector histories of each worker. The examination of these factors are deferred for three reasons. First, the included demographic and social factors are good predictors of those factors not included in the study. Second, due to substantial missing data, examining work histories will not only restrict the sample but also give rise to sample selection bias. Third, workplace injury is a small probability event. The data used in this study is the only one that is not from surveillance but from probability samples of the entire U.S. population at three different periods. Even so, the total number of work place injuries is just over 2,500 and those occurring to immigrants is just over 200. Thus for small probability events and small subgroups, a suitable analytic strategy is to use the reduced-form model that takes into account only the very basic demographic and socioeconomic factors.

The study addresses the pitfall of snapshot analysis of workplace injuries because the resulting pattern is misleading by treating groups with different time of exposure to risk as if they are similar. This is particularly problematic when we study the impact of immigration given a simple fact that many immigrant workers arrive at an older age than the initial working age of the native born. The analytic framework of survival analysis exactly addresses this issue and hence is appropriate for this study.

The study yields three major findings. First, it finds strong evidence to support that

immigrants are more likely to inflict workplace injuries than native-born workers because of high-level unfamiliarity resulting from the dramatic transition of many immigrant workers from a third-work workplace to a first-world workplace. Simultaneously this detrimental effect is attenuated by the duration living in the U.S. due to acculturation. Second, besides the detrimental immigrant unfamiliarity effect, low-educated immigrants face severe exposure to risk of workplace injury. The bottom tail of the educational attainment distribution is not comparable between the native born and the foreign born, simply reflecting development gaps between the U.S. and many sending countries. Third, the large immigrant influx in the past decade coincides with the deteriorating workplace safety in the U.S., placing newcomers to a great danger of workplace injury.

These findings bear important policy implications. Given the disproportionate immigrant share in construction, agriculture, and contract work, it is imperative to reinforce workplace safety regulations and strengthen safety training programs in immigrant-heavy industries. Moreover, it is imperative to establish standard regulations and training programs in contract work which has not been under the radar. It is my hope that this study will call sufficient attention from policymakers and the public to take a significant first step to prevent workplace injuries among immigrants.

References

Bolaria, BS. 1988. The health effects of powerlessness: Women and racial minority immigrant workers. In B. Singh Bolaria and H.D. Dickinson (Eds) Sociology of health care in Canada (pp.439-459). Toronto, OH: Harcourt Brace jovanovich.

Bollini, P. and Siem, H. 1995. No real progress towards equity: Health of migrants and ethnic minorities on the eve of the year 2000. Social Science and Medicine 41(6):819-828.

CPWR. 2002. The construction chart book, the U.S. construction industry and its workers. Third edition. Silver Spring, MD: The Center to Protect Workers' Rights.

Dong, Xiuwen and James W. Platner. 2004. "Occupational Fatalities of Hispanic Construction Workers From 1992 to 2000." AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 45:45–54

Friedman-Jimenez, G. 1989. Occupational disease among minority workers: A commpn and preventable public health problems. American Association of Occupational Health Nursing Journal 37(2)64-70.

Kirschenbaum, A., Oigenblick, L., and Goldberg, A.I. 2000. "Well being, work environment and work accidents." *Social Science and Medicine*.

Loh, Katherine and Scott Richardson. 2004. "Foreign-born workers: trends in fatal occupational injuries, 1996-2001." *Monthly Labor Review* June 2004:42-53.

Massey, Douglas S., J. Durand, and N. J. Malone. 2002. *Beyond Smoke and Mirrors: Mexican Immigration in an Era of Economic Integration*. New York: Russell Sage Foundation.

McCauley, Linda A. 2005. "Immigrant Workers in the United States: Recent Trends, Vulnerable Populations, and Challenges for Occupational Health." American Association of Occupational Health Nurses Journal 53(7):313-319.

Mora MT, Davila A. 1998. Gender, earnings, and the English skill acquisition of Hispanic workers in the United States. Economic Inquiry 36(4):631–644.

Moure-Eraso R, Wilcox M, Punnett L, MacDonald L, Levenstein C. 1997. Back to the future: Sweatshop conditions on the Mexico–US border, II: Occupational health impact of maquiladora industrial activity. American Journal of Industrial Medicine 31:587–599. O'Connor, Tom, Dana Loomis, Carol Runyan, Janet Abboud dal Santo, and Michael Schulman. 2005. Adequacy of Health and Safety Training Among Young Latino Construction Workers. JOEM 47(3):272-277.

Pergamit, Michael and Parvati Krishnamurty. 2006. "Multiyear Nonfatal Work Injury Rates." *Monthly Labor Review* May 2006:35-38.

Quandt, Sara A. Joseph G. Grzywacz, Antonio Marı´n Lourdes Carrillo, Michael L. Coates, Bless Burke, and Thomas A. Arcury. 2006. "Illnesses and Injuries Reported by Latino

Poultry Workers in Western North Carolina." AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 49:343–351

Pransky G, Moschenberg D, Benjamin K, Portillo S, Thackrey JL, Hill- Fotouhi C. 2002. Occupational risk and injuries in non-agricultural immigrant Latino worker. Am J Ind Med 42:117–123.

Robinson, J.C. 1989. Trends in racial inequality and exposure to work-related hazard , 1968-1986. American Journal of Occupational Health Nursing 37(2): 56-63.

Takaro TK, Gonzalez Arroyo M, Brown GD, Brumis SG, Knight EB. 1999. Community-based survey of maquiladora workers in Tijuana and Tecate, Mexico. Int J Occup Environ Health 5:313–315.

Waldinger, Roger. 1996. *Still the Promised City? African-Americans and New Immigrants in Postindustrial New York*. Cambridge, MA: Harvard University Press.

Windau J. 1997. Occupational fatalities among the immigrant population. Compensation and Working Conditions. Bureau of Labor Statistics, http://data.bls.gov/.

Table 1. Descriptive Statistics of Variables Used in Analysis: By Nativity

Variable	Total		Native		Immigrant	
	Mean	SD	Mean	SD	Mean	SD
Workplace injury	0.016	0.12	0.016	0.13	0.011	0.10
"Failure" time	19.82	13.26	20.66	13.49	13.85	10.61
Immigrant status	0.12	0.33	0.00	0.00	1.00	0.00
Race						
White	0.71	0.45	0.78	0.42	0.25	0.44
Black	0.12	0.33	0.13	0.33	0.07	0.26
Hispanic	0.11	0.31	0.06	0.25	0.44	0.50
Asian	0.04	0.19	0.01	0.10	0.22	0.42
Other race	0.02	0.14	0.02	0.14	0.01	0.10
Educational attainment						
<9 years	0.05	0.21	0.03	0.16	0.20	0.40
9-11 years	0.11	0.31	0.11	0.31	0.11	0.31
12 years	0.30	0.46	0.31	0.46	0.25	0.44
13+ years	0.54	0.50	0.55	0.50	0.44	0.50
Male	0.48	0.50	0.48	0.50	0.49	0.50
Age at initial risk						
16-24	0.92	0.27	0.98	0.14	0.49	0.50
25-44	0.08	0.26	0.02	0.14	0.47	0.50
45-67	0.004	0.07	0.00	0.00	0.04	0.19
Period of initial risk						
Before 1965	0.14	0.35	0.16	0.37	0.04	0.20
1965-1974	0.19	0.39	0.20	0.40	0.11	0.31
1975-1984	0.24	0.42	0.24	0.43	0.20	0.40
1985-1994	0.22	0.41	0.20	0.40	0.34	0.47
1995-2004	0.21	0.41	0.20	0.40	0.31	0.46
Number of observations	171,026		150,994		20,032	
Number of workplace injuries	2,687		2,458		229	

Author's compilation using data from SIPP 1996, 2001, and 2004 panels.

Table 2. Cumulative Hazard of Workplace Injury: By Nativity

Failure time (year)	Native	Immigrant
1	0.0001	0.0003
7	0.0015	0.0029
13	0.0044	0.0061
19	0.0088	0.0125
25	0.0159	0.0220
31	0.0246	0.0297
37	0.0369	0.0448
43	0.0490	0.0572
49	0.0592	0.0572

Author's compilation using data from SIPP 1996, 2001, and 2004 panels. The difference in the cumulative hazard function between natives and immigrants are statistically significant.

Table 3. Testing Time-Varying Immigrant Effect: Hazard Ratios

Hypothesis testing	Coefficient	p-value
M0: time-invariant, total immigrant effect	1.32**	0.000
M1. time-invariant, partial immigrant effect	1.02	0.834
Joint test: both immigrant effect and U.S. residence duration effect		
M2. half-life in 3 years	2.42*	0.014
M3. half-life in 4 years	2.02*	0.023
M4 half-life in 5 years	1.79*	0.037
M5 half-life in 6 years	1.64†	0.054
M6 half-life in 7 years	1.53†	0.075

Note: Cox proportional hazard models are estimated. Models (M1-M6) control for race/ethnicity, education, gender, and age and period at initial time. Panel 1 lists coefficient for immigrant status from the model where the immigrant effect is time-invariant, thereby testing the combination of only immigrant effect and no US residence length effect. Panel 2 list coefficients for immigrant status for five scenarios of time-varying immigrant effect, thereby testing both hypotheses. The five scenarios assume increasing timing for a half-life immigrant effect in 3, 4, 5, 6, and 7 years, using an exponential function.

** $p<.01$ * $p<.05$ † $p<.10$

Table 4. Estimated Hazard Ratios for Other Covariates from M3

Variable	Coefficient
Race/Ethnicity	
Black	1.31**
Hispanic	1.06
Asian	0.46**
Other race	1.78**
Year of schooling	
9-11	0.80*
12	0.47**
13+	0.37**
Male	1.76**
Age at initial time (in 5 years)	0.81**
Year at initial time (in 5 years)	1.38**

Note: The Cox proportional hazard model with the specification of M3 is estimated. The model includes time-varying immigrant status.

** p<.01 * p<.05

Figure 1. Five Decay Functions for Time-Varying Immigrant Effect

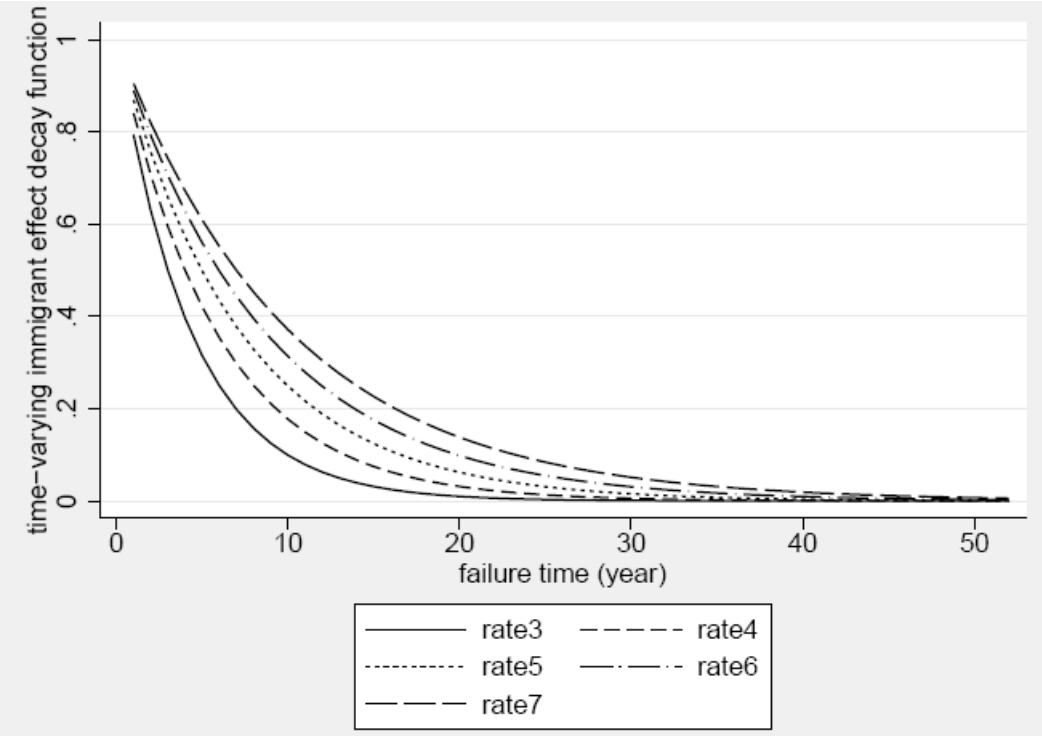
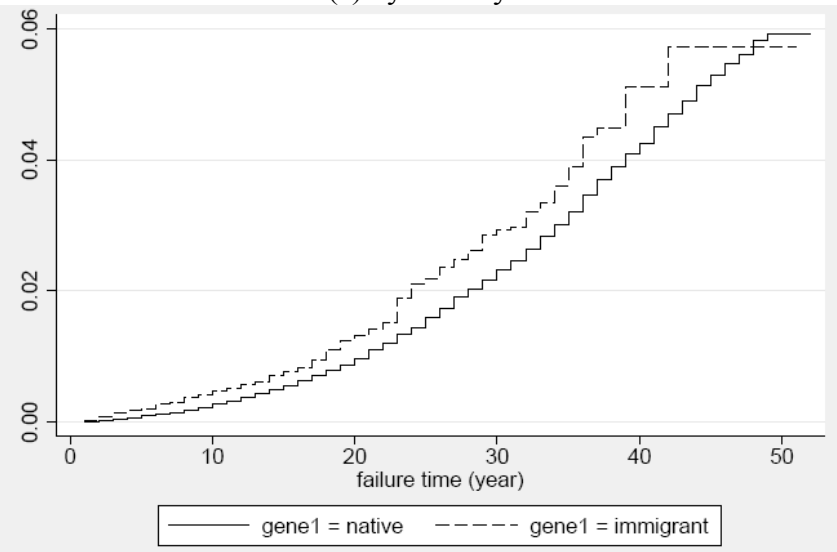
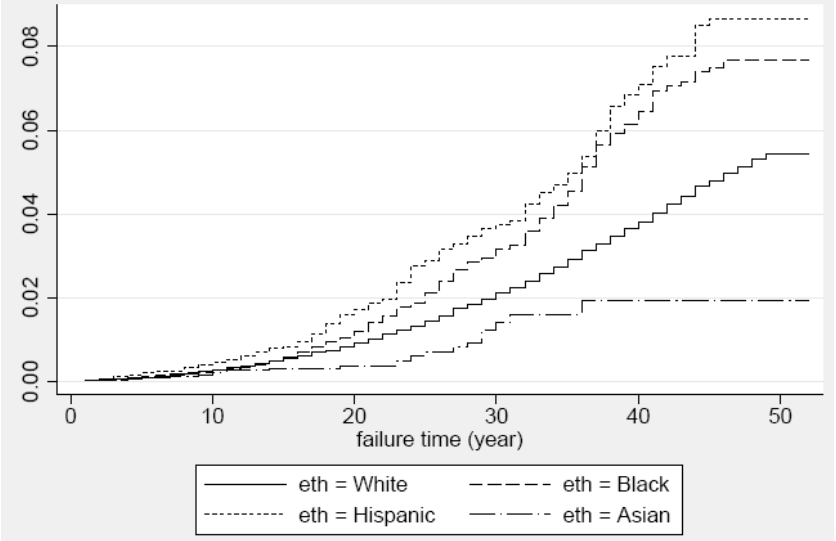


Figure 2. Cumulative Hazard Function for Workplace Injuries

(a) by nativity



(b) by race/ethnicity



(c) by educational levels

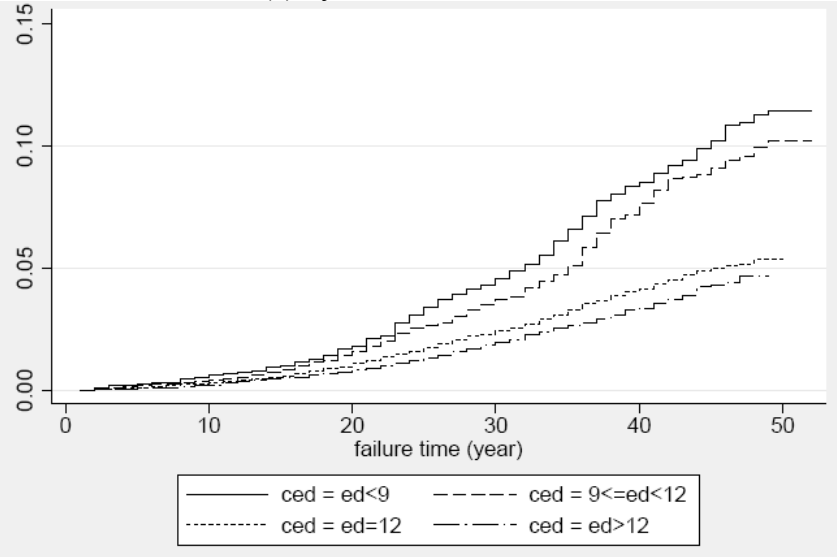


Figure 3. Estimated Time-Varying Immigrant Effects